

ZOOPLANKTON ALONG THE TAMIL NADU COAST

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ABSTRACT

Zooplankton abundance along two sectors at Cape Comorin and Tuticorin of Tamil Nadu coast, southeast coast of India was studied. High biomass contributed by Ostracods, Salps, Chaetognaths etc., were observed along Tuticorin transect. In the Cape Comorin area copepods and decapods were dominant. The dense swarm of the ostracod *Cypridina dentata* (34556/100 m³) off Tuticorin was a noteworthy feature. The fluctuations in numerical abundance and percentage composition of all the major planktonic groups are illustrated and discussed.

INTRODUCTION

Our knowledge about Indian Ocean, its physical, chemical and biological aspects has increased considerably in recent years (Prasad, 1969; Panikkar and Rao, 1973) based on the extensive studies undertaken during the International Indian Ocean Expedition (IIOE) and the great amount of valuable material and data collected and analysed at the Indian Ocean Biological Centre. These studies revealed relatively high level of zooplankton biomass along the southwest coast of India.

Further studies on zooplankton (Nair, Peter and Paulinose, 1977) have shown that in the Bay of Bengal biomass values increased from north to south. A general account of the zooplankton production from the shelf and slope areas off the southwest coast of India is given in the reports of UNDP/FAO/IFP (1974), Menon and George (1977). The areas off Cape Comorin and Tuticorin still remain relatively unexplored. The present study is an attempt to fill this lacuna.

MATERIAL AND METHODS

Plankton samples were collected for the eggs and larvae survey of Sardines and Mackerels by the Pelagic Fishery Project, Cochin, during 1971-75 (UNDP/FAO/IFP-1974). A total of 83 oblique collections with a Bengo net (20 cm diameter and 0.5 mesh size fitted with a calibrated flow meter) were made off Cape Comorin and off Tuticorin along two transects (Fig.1) during seven cruises (February, April, May, August, October, November and December) in 1974 and preserved in 4% formalin were used. Depth of collections varied between 10 and 120 m to surface. Plankton biomass was calculated as ml/m³ of water filtered based on flow meter reading. Displacement volumes of plankton were estimated and samples were analysed for fish eggs and larvae at the Regional Centre of National Institute of Oceanography, Cochin. The samples were further analysed to determine the abundance and percentage representation of major groups.

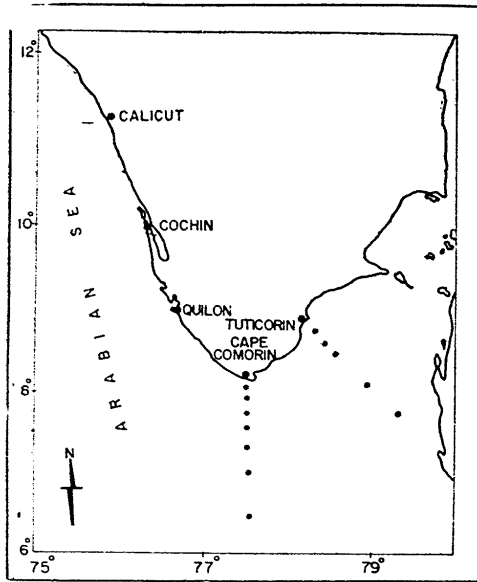


Fig. 1. Map showing the station location in sections off Cape Comorin and off Tuticorin.

RESULTS

Hydrography

Temperature, salinity and dissolved oxygen for surface and depth of plankton collection (varied between 10 m and 120 m) off Cape Comorin and off Tuticorin are shown in Figs. 2-15. Surface temperature variation off Cape Comorin was from 22.60 to 29.80°C. The lowest was observed in October and highest in April. Surface temperature off Tuticorin varied from 25.90 in October to 31.20°C in April. Surface salinity in the Cape Comorin region fluctuated between 32.16‰ in December and 35.22‰ during November and off Tuticorin, salinity varied from 32.17 in November to 35.29‰ in April at the surface. The range in dissolved oxygen value at the surface off Cape Comorin was 1.80 to 5.15 ml/l, both in October while at Tuticorin surface value ranged from 3.95 in May to 5.20 ml/l in October.

Biomass

Biomass values expressed as ml/100 m³ for section off Cape Comorin are represented as graphs in figs. 2-8. The highest biomass value (69 ml/100 m³) was noticed during October and minimum (2 ml/100 m³) in December. The maximum was due to the abundance of copepoda and the low biomass value at station 1 in December could be attributed to the enormous number of decapod larvae forming more than 50% in numerical abundance but of little significance volumetrically. Copepods and ostracods when present in swarms can contribute to high biomass but tunicates, siphonophores and medusae even when numerically less abundant can form a significant fraction. High biomass value at Station 3 (Fig. 2) was due to the abundance of ostracods. The increase in biomass at station 4 (Fig. 3) was due to the large size of the tunicates. Biomass maximum was never found at the first station (nearest to the shore) in any cruise.

In Figs. 9-15 are shown biomass values for the stations off Tuticorin. Maximum value (132 ml/100 m³) was observed from station 4 during the month of February (Fig. 9) contributed by the abundance of ostracods. High biomass values were also noticed during November, i.e., 126 and 108 ml/100 m³ (Fig. 14). Biomass minimum was seen (4 ml/100 m³) in August at station 3, where though copepods form the most dominant group, numerical representation of all the groups was very poor. In general, it was observed that the Tuticorin region maintained relatively high abundance of zooplankton, when compared to the Cape Comorin area.

Faunistic composition

Results from the enumeration of the zooplankton are presented in figures in two forms: fish eggs and larvae as number/m³ and relative abundance of all other groups as percentage distribution.

Copepoda

Copepods showed highest numerical abundance and contributed to the bulk of the standing crop. As the principal source of energy in the building of higher trophic levels, their numerical abundance at different stations during different periods provides a good measure of production. Ecologically the copepods are the major grazers. The maximum density (46268/100m³) was obtained from the 2nd station off Cape Comorin during October. In percentage distribution also (81.27%) maximum abundance of copepods was seen in the same station. Contrary to this the minimum percentage abundance and minimum numerical abundance of copepods were not observed at the same station. The latter 1064/100m³ was at station 4 off Tuticorin during the month of December and the former 6.98% was at the near-shore station off Cape Comorin during the month of April (Fig.3). Generally copepod concentration was noticed to be little away from the nearshore station (Figs. 2-15) along both the transects. Another noteworthy feature was the dominance in percentage abundance of copepods in general along the Cape Comorin transect. It was less pronounced along the Tuticorin section, where ostracods were evidently overriding the copepod population during certain months. At some of the nearshore stations swarms of the calanoid copepod *Temora turbinata* were noticed whereas some samples were dominated by another calanoid copepod *Undinula vulgaris*. The genera *Candacia*, *Temora* and *Centropages* were represented in almost all the samples.

Decapods

In most of the samples decapods stood second in abundance. In general, decapods were more abundant nearer to the coast and their population gradually decreased towards the offshore (Figs. 2-15). The high density amounting to 23285/100 m³ was recorded from the nearshore station off Cape Comorin during April. At the same station percentage distribution was 71.13. Minimum percentage abundance (0.79) was found at 6th station during November. Decapods declined to 0.62% at station 3 in November. An opposite trend, dominance towards the offshore was observed during November (Fig.14) in the Tuticorin sector. Decapod abundance was more off Cape Comorin than off Tuticorin. Decapods were mainly constituted by larvae of crabs and prawns.

Chaetognatha

This group was well represented in all stations and in all collections. Highest chaetognath density of 18155/100 m³ was encountered in the third station off Tuticorin during February (Fig. 9). At the same station was recorded maximum percentage distribution (48.04%). Strangely the minimum percentage was also in February at the nearshore station in Tuticorin transect (Fig.9). Species of the genus *Sagitta* such as *S. enflata*, *S. pacifica*, *S. robusta* and *S. bedoti* were commonly recorded.

Ostracoda

The area off Tuticorin appeared to be richer in ostracod population than off Cape Comorin. The maximum density of 34556/100 m³ was noticed from the third station off Tuticorin in November. The maximum percentage distribution (73.97%) was also observed from the same station (Fig. 14), their density increased with increase in the distance from shore. It was found that the samples with ostracod dominance

which was due to a swarm of *Cypridina dentata* had an oily appearance. Ostracods contributed to high biomass whenever they appeared in swarms, *Cypridina dentata* being the dominant species.

Tunicata

Though salps and doliolids were numerically fewer they contributed much to the biomass. The maximum numerical abundance (2444/100 m³) and percentage abundance (33.03%) were noticed in April from the third station off Cape Comorin.

Siphonophora

Highest recorded density of 7066/100 m³ was at a nearshore station off Tuticorin in April (Fig. 10). Siphonophora occurred in all the collections. Though numerically less abundant compared to copepods, they play an important role in the food web as pure carnivores and constitute a small percentage.

Euphausiacea

Maximum density of 2727/100 m³ was noticed from offshore station off Cape Comorin during August. The percentage distribution of this group was more or less same along both the sectors.

Medusa

Maximum density of 1580/100 m³ was encountered in August in the Cape Comorin nearshore station. Though present in all samples they were sparse in number, the highest percentage occurrence being 5.84 at the above station. *Aglaura hemistomax*, *Liriope tetraphylla* and *Bhopalenema velatum* were common forms.

Amphipoda

Amphipoda were also sparsely represented. Numerical abundance was maximum in October with a density of 1659/100 m³ in offshore section of Tuticorin while the highest percentage distribution (8.82%) was noticed from the sixth station at Cape Comorin during November.

Miscellaneous

Groups like Mollusca, Foraminifera, Cladocera, Polychaeta and *Ctenophora* are represented as miscellaneous in Figs. 2-15. Among these groups molluscs were found in most of the collections with a maximum of 11.02% from nearshore station off Cape Comorin.

Fish eggs

Maximum density of fish eggs (1018/m³) was observed during August from offshore station off Comorin (Fig. 5). Minimum density was observed from Tuticorin during December (Fig. 15). It was quite interesting to observe the complete absence of fish eggs from all the collections from the section off Tuticorin during the month of May. Maximum number of fish eggs from Tuticorin was noticed in nearshore station during April (Fig. 10).

Fish larvae

Fish larvae were represented in all the samples. They were more in Cape Comorin sections than Tuticorin. Highest density of 333/m³ was found from the same station where the fish eggs maximum was noticed.

DISCUSSION

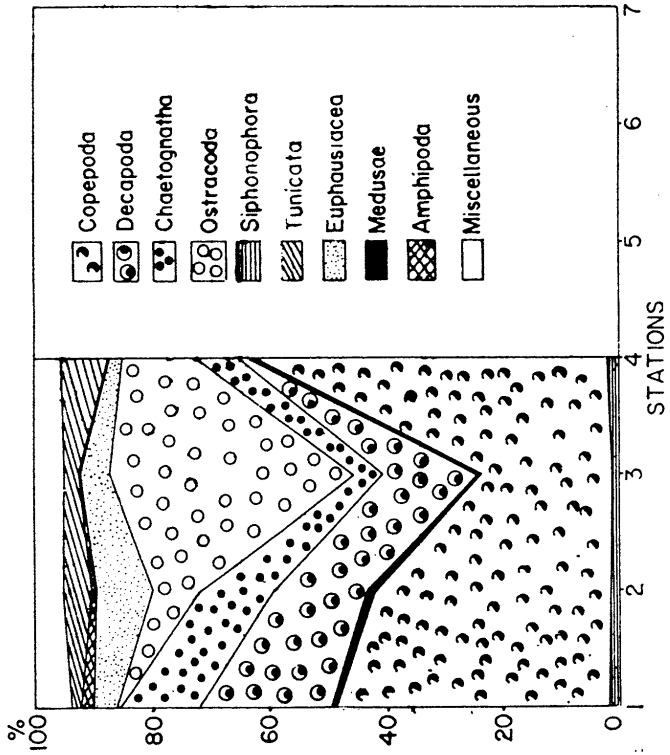
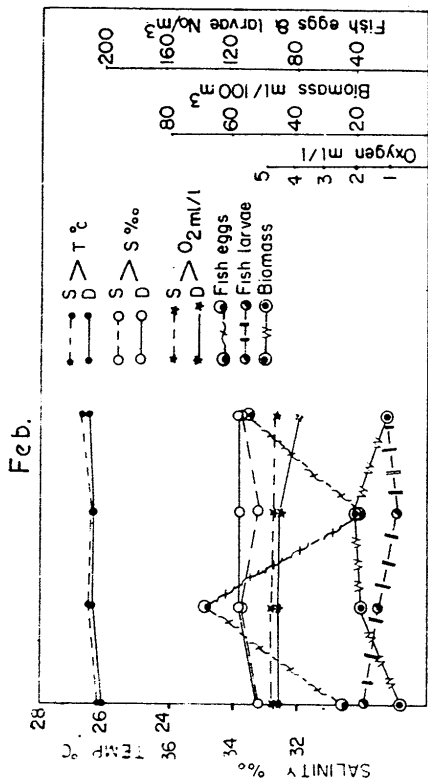
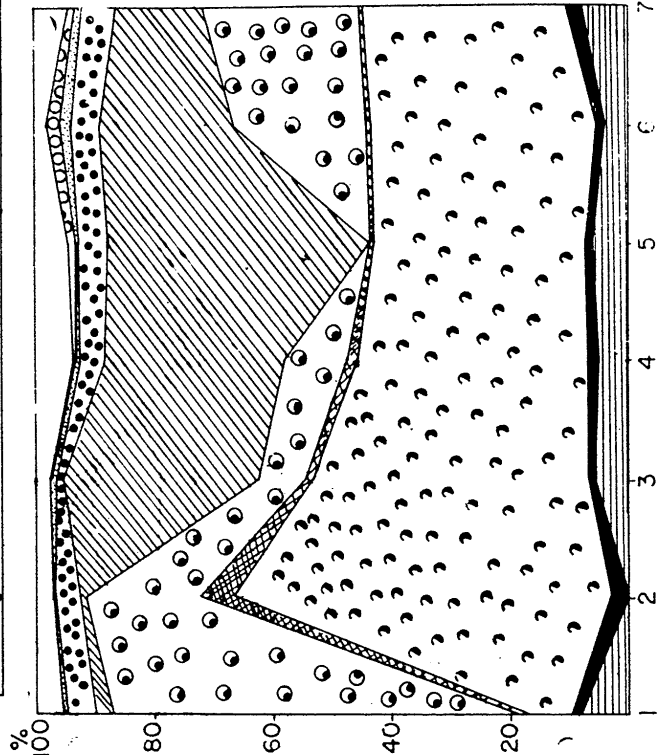
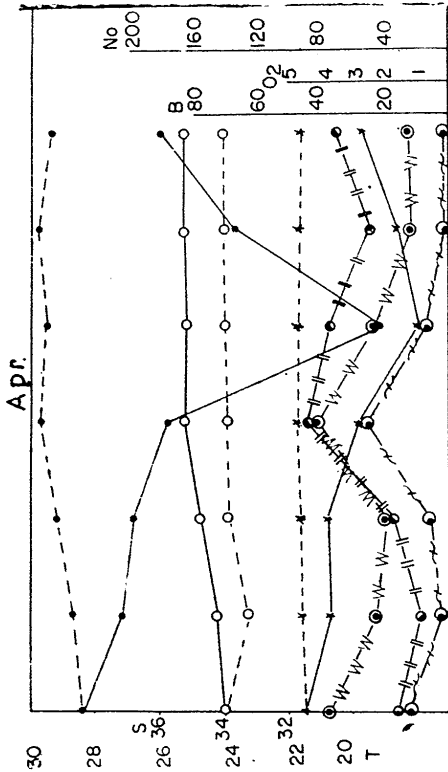
During the present investigation the maximum zooplankton biomass was obtained from Tuticorin area. High biomass values at three stations along the Tuticorin sector during the month of February and November were due to swarms of ostracods. The maximum biomass value obtained off Cape Comorin mainly due to abundance of copepods was much less than that along the Tuticorin sector. Daniel and Jothinayagam (1977) recorded that the high numbers of ostracods resulted in high biomass.

According to Sewell (1932) Antarctic bottom water rich in nutrients strikes the south end of Ceylon and upwells in the Gulf of Mannar. Prasad (1958) has observed that the waters of Gulf of Mannar are inherently rich in nutrients and may even be richer than waters of Palk Bay. Cushing (1971) has indicated the upwelling off the coast of Ceylon between December and January as stated by Kabanova (1968). All the zooplankton samples studied here were collected from the water strata ranging from depth of 10-120 m where entire stratum is constituted by surface water (Gallagher, 1966).

The maximum biomass value observed (132 ml) from the Tuticorin sector was in February which coincides well with the upwelling reported by Kabanova. So also during the southwest monsoon the upwelling along the coast is most intense between 5°N and 11°N where the entire warm surface layer is removed and subsurface water with temperatures well below 20°C reaches the sea surface (Warren, Stommel and Swallow, 1966). Maximum biomass (69 ml) observed from Cape Comorin area was during this season.

The zooplankton biomass studies are important for gaining an insight into the fish production of the oceans (Lenz, 1973). Based on the biomass value, in Tuticorin area a high fish population can be expected. Peter, Iyer, John and Radhakrishnan (1977) observed that stations away from the coast were found to have values 2-3 times higher than those nearer the coast. Such a generalized statement could not be drawn from the results of the present study but highest biomass values were observed from stations away from the shore.

Copepod abundance was maximum during October from the second station off Cape Comorin. High copepod density in the area had been observed by Kasturirangan, Saraswathy and Gopalakrishnan (1973). Panikkar and Rao (1973) observed dense patches of copepods off Madras and southern tip of India and indicated that upwelling may take place there too. They further stated that the extensive production of copepods takes place during winter monsoon and it was suggested that although primary production values are highest during the summer monsoon, there is some time lag for the development of zooplankton populations. Decapods, in general, were found to occur more towards the shore and agrees with the findings of Nair, Peter and Paulinose (1977). Year round breeding has been reported for certain species of decapods (George and



Figs. 2-15. Shows the percentage distribution of zooplankton excluding fish eggs and larvae. Fish eggs and larvae (No/m³), biomass (ml/100m³) and temperature (°C), salinity (‰) and oxygen (ml/l) at surface and depth of plankton collection plotted as graph. Cape Comorin Figs. (2-8), Tuticorin Figs. (9-15).

Fig. 3.

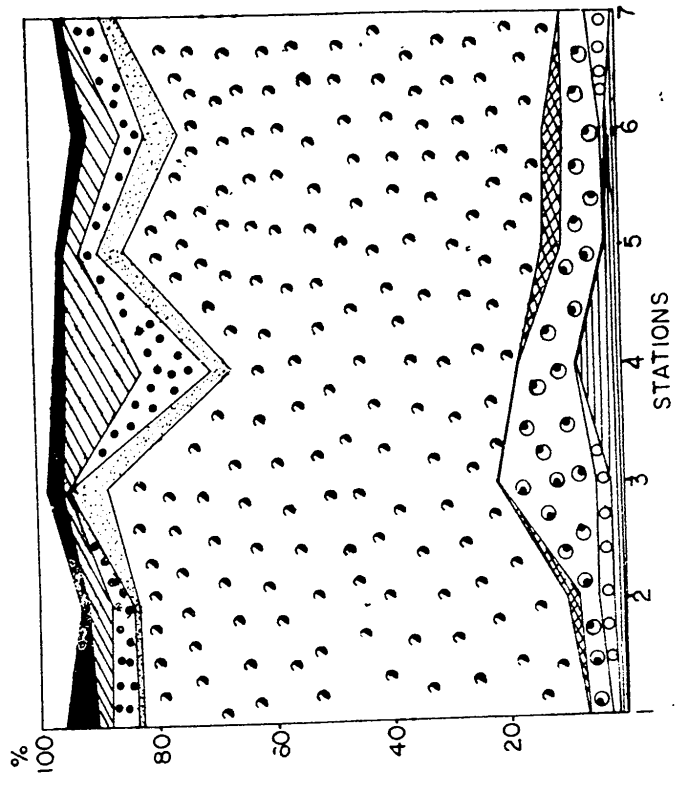
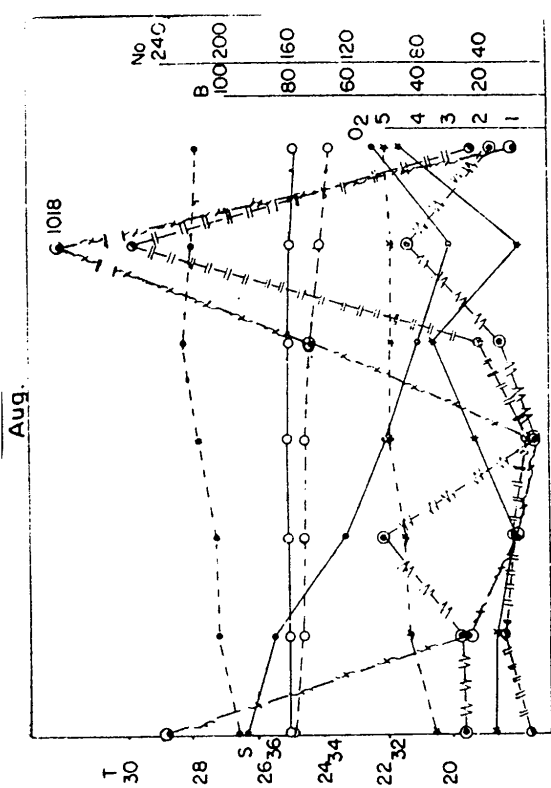


Fig. 5.

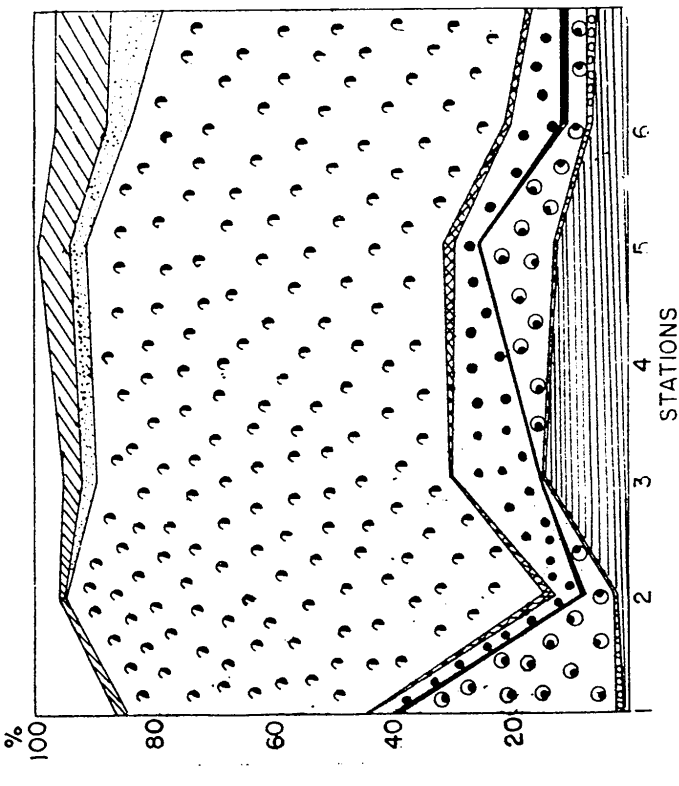
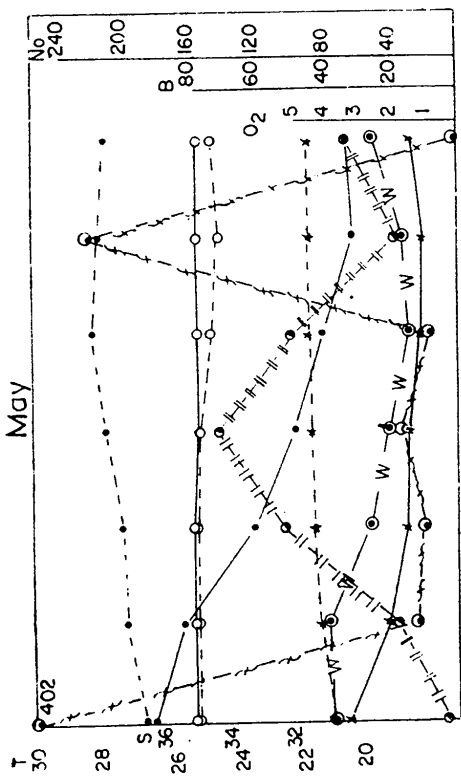


Fig. 4.

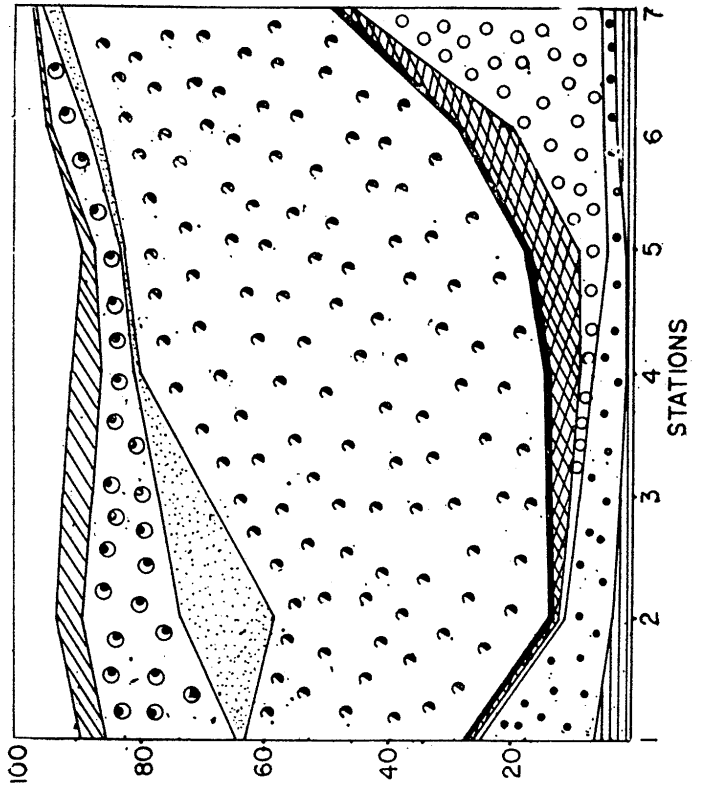
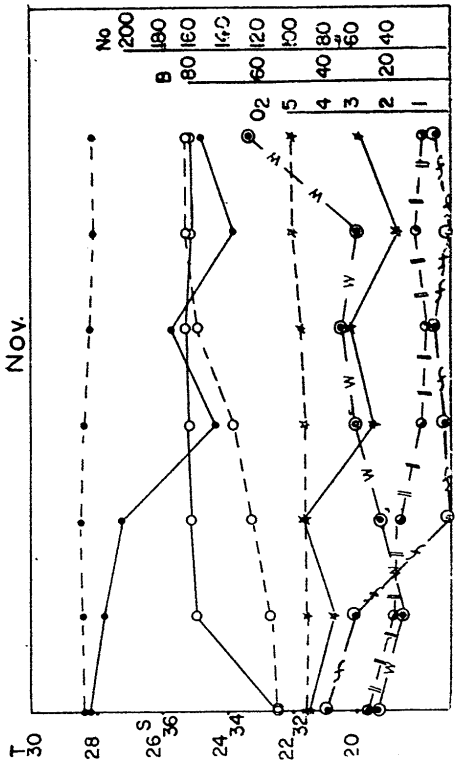


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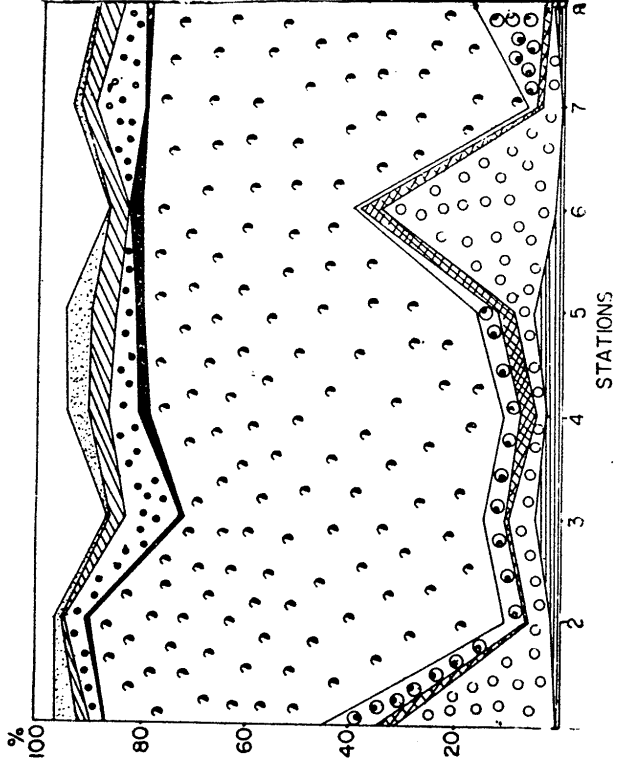
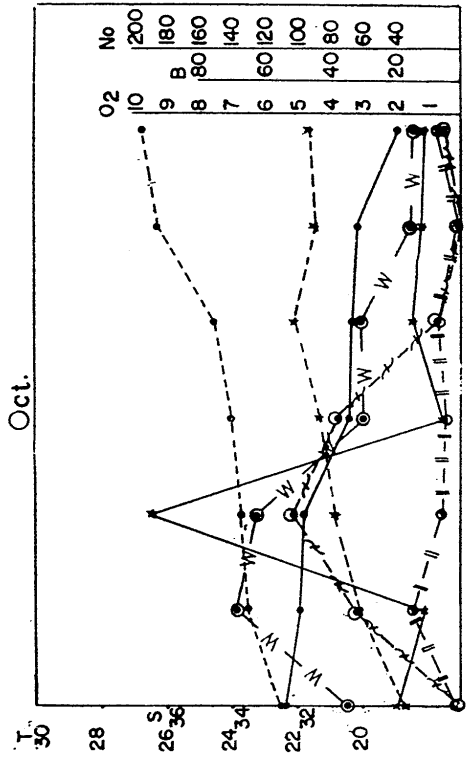


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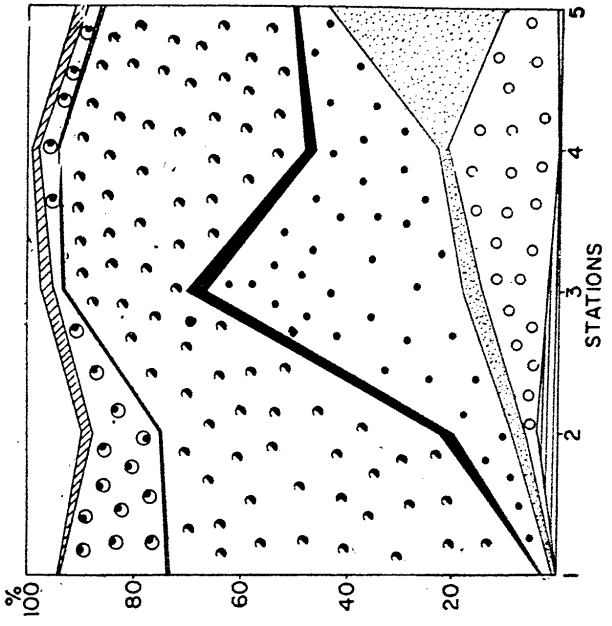
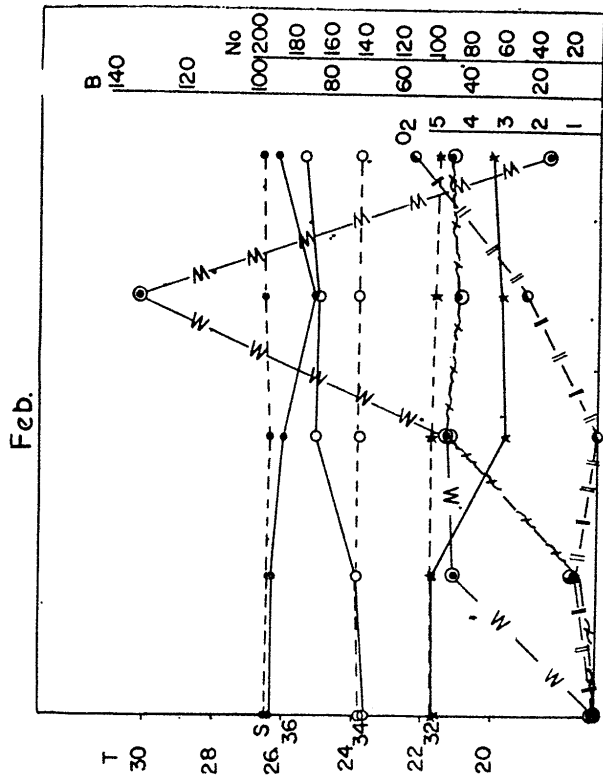


Fig. 9.

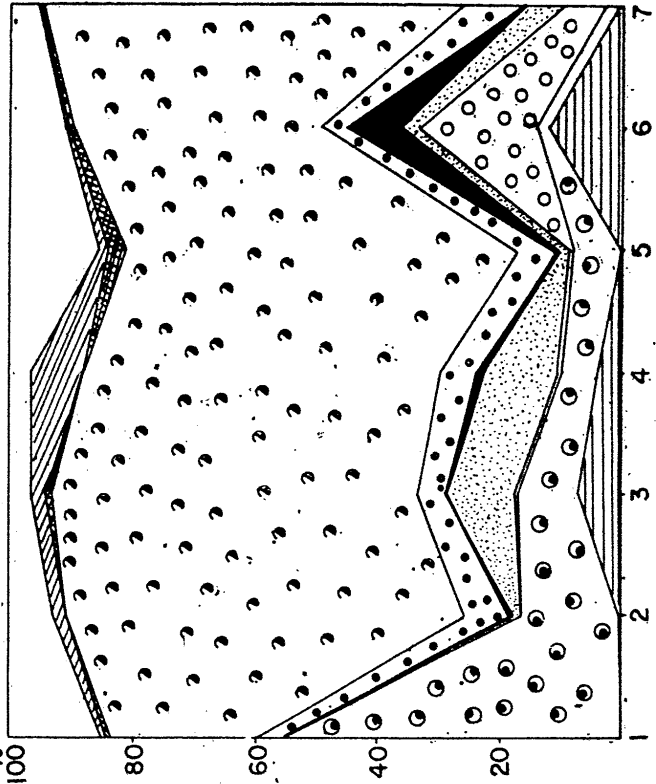
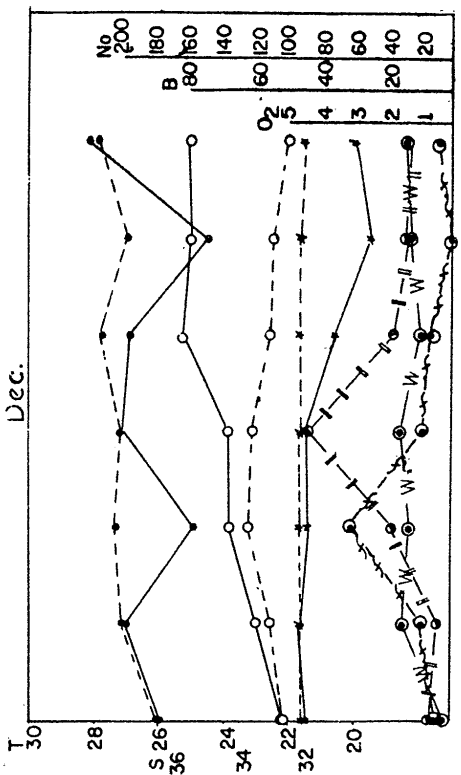


Fig. 8.

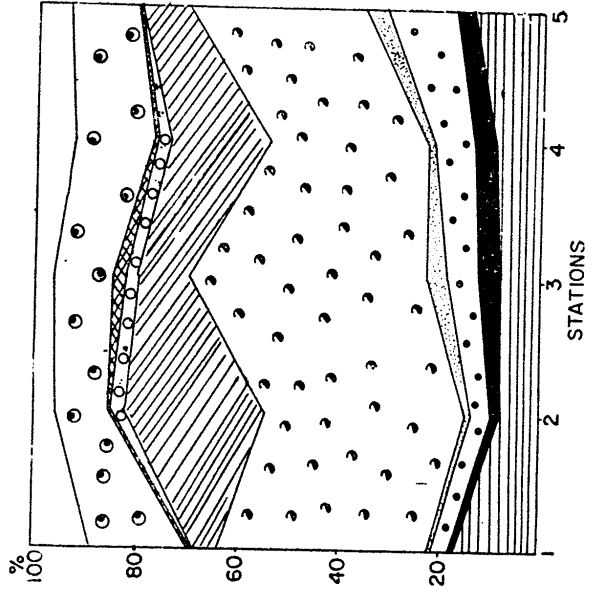
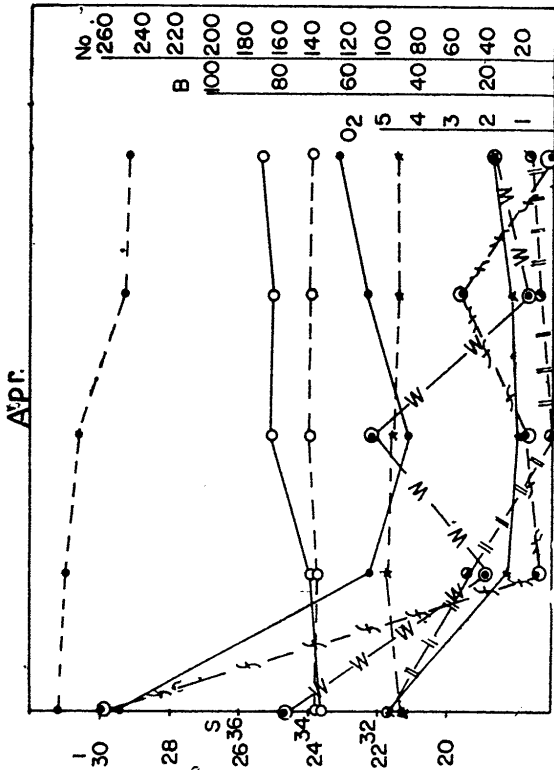


Fig. 10.

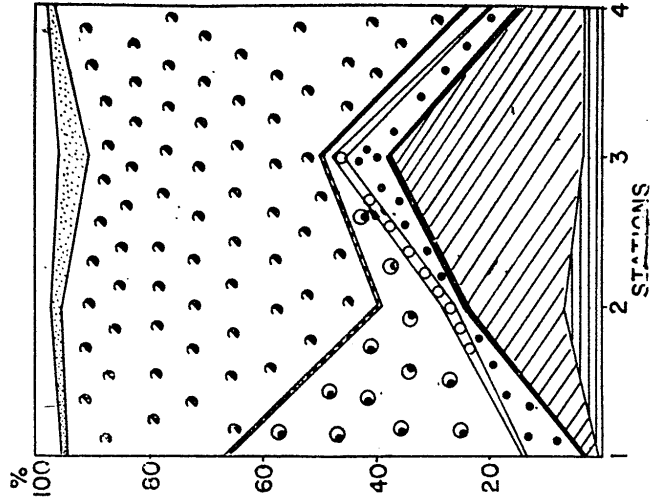
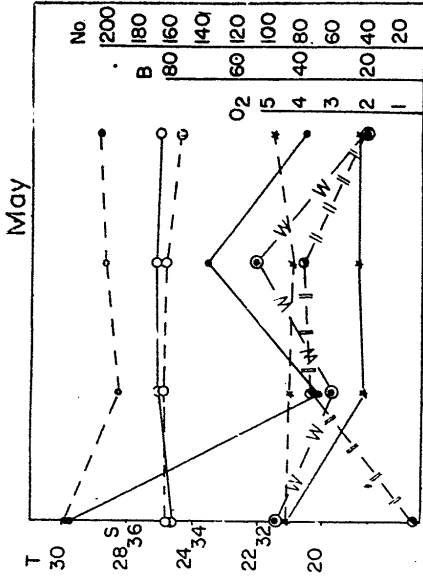


Fig. 11.

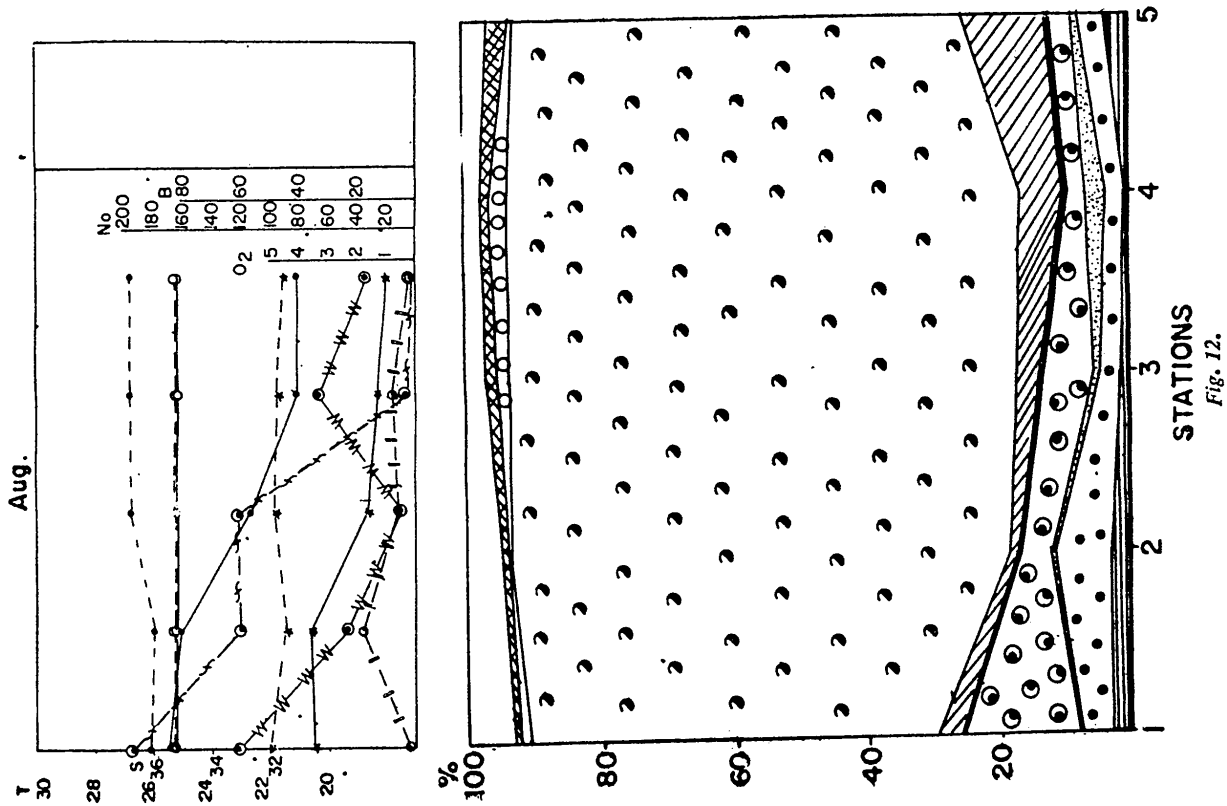


Fig. 12.

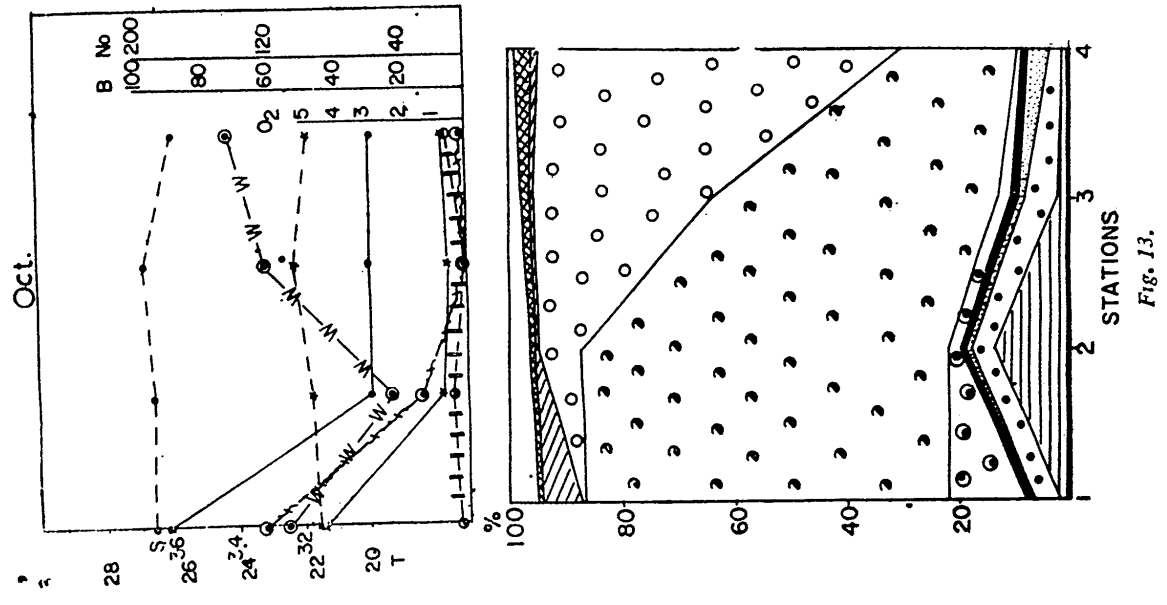


Fig. 13.

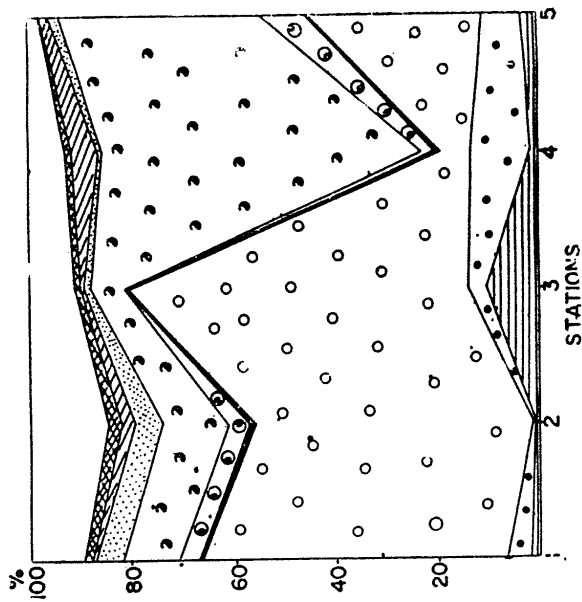
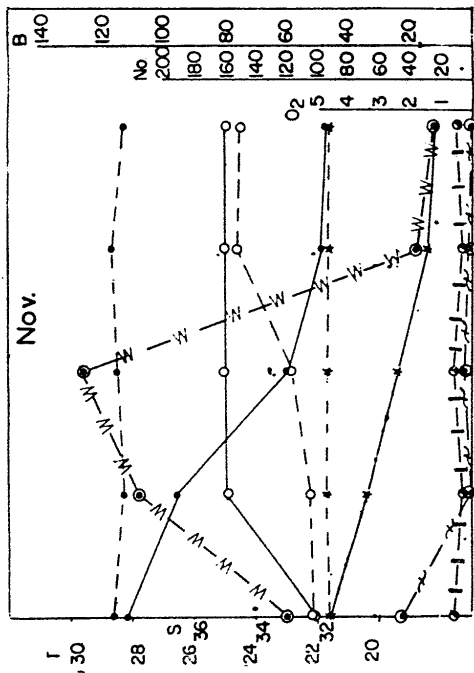


Fig. 14.

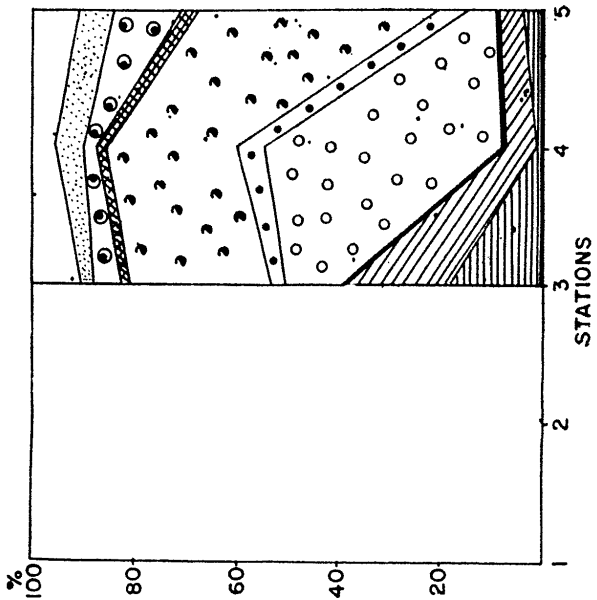
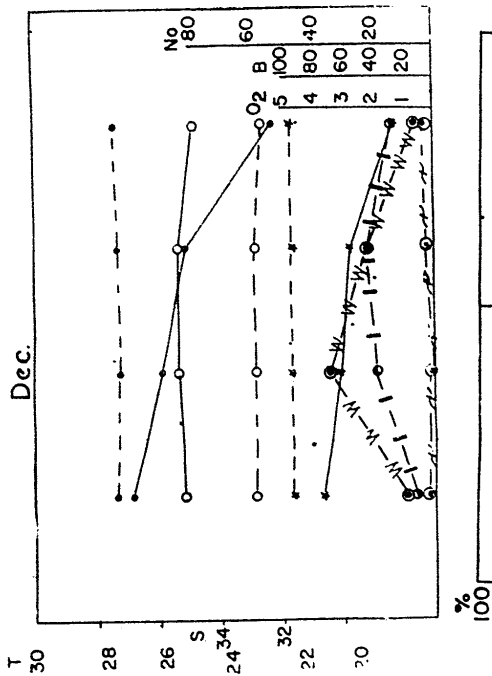


Fig. 1.

George, 1964; George, Raman and Nair, 1968; George, 1970) and presence of decapod larvae in the plankton throughout the year supports this statement.

The role played by siphonophores in the general ecosystem is very important and demands greater attention (Pugh, 1977). Madin and Harbison (1976) stated that salps even when not numerically abundant, were among the most important consumers of nanoplankton in the open ocean. So also groups like Hydromedusae, Ctenophores and Chaetognatha cannot be overlooked (Santhakumari, 1977 and Nair, 1977). These being larger organisms formed a significant portion of the biomass even though occurring in small numbers. Since they are carnivores they also play an important role in the energy transfer in the trophic system.

Peak in the number of fish eggs and larvae observed in the month of August in the Cape Comorin area can be considered as an indication of intense breeding. The outbreak of rains during June-July and the changes in the environment act as a definite stimulus to spawning even in species which are continuous breeders.

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REFERENCES

- Cushing, D. H., 1971. Upwelling and the production of fish. In: *Advances in Marine Biology*, edited by F.S. Russel and C.M. Young, Academic Press, New York, 9: 255-334.
- Daniel, A. and J. T. Jothinayagam, 1977. Newston biomass and variations in abundance of its major zooconstituents in the northern Arabian Sea during the oceanographic expedition on INS *Darshak* (December, 1973-May, 1974). *Proceedings of the Symposium on Warm Water Zooplankton*, Special Publication, UNESCO/NIO, 265-273.
- Gallagher, J. F., 1966. The variability of water masses in the Indian Ocean. *National Oceanographic Data Centre, General Series Publication, G-11: 1-74*.
- George, M. J., 1970. Synopsis of biological data on the penaeid prawn *Metapenaeus dobsoni* (Miers, 1897). *FAO Fishery Report* (57), 4: 1335-1357.
- George, M. J., K. Raman and K. P. Nair, 1968. Observation on the offshore prawn fishery of Cochin. *Indian Journal of Fisheries*, 10: 460-499.
- George, P. C. and M. J. George, 1964. On the location of a possible spawning area for the penaeid prawn *Metapenaeus monoceros* Fabricius off Cochin. *Current Science*, 33: 251-252.
- Kabanova, U. G., 1968. Primary production of the northern part of the Indian Ocean. *Okeanologiya*, 8: 270-278.
- Kasturirangan, L. R., M. Saraswathy and T. C. Gopalakrishnan, 1973. Distribution of Copepoda in the Indian Ocean. In: *Biology of the Indian Ocean*, edited by B. Zeitschel, Springer-Verlag, Berlin-Heidelberg, New York, 3: 231-334.
- Lenz, J., 1973. Zooplankton biomass and its relation to particulate matter in the upper 200 m of the Arabian Sea during NE monsoon. *The Biology of the Indian Ocean*, edited by B. Zeitschel, Springer-Verlag, Berlin-Heidelberg, New York, 3: 239-241.

- Madin, L. P. and G. R. Harbison, 1976. The feeding and growth rates of several species of salps. Paper reviewed at the Joint Oceanographic Assembly, Edinburgh, 13-24 Sept. 1976.
- Menon, M. D. and K. C. George, 1977. On the abundance of zooplankton along the southwest coast of India during the years 1971-75. *Proceedings of the Symposium on Warm Water Zooplankton*, Special Publication, UNESCO/NIO, 205-213.
- Nair, R. V., 1977. Chaetognaths of the Indian Ocean. *Proceedings of the Symposium on Warm Water Zooplankton*, Special Publication, UNESCO/NIO, 169-195.
- Nair, V.R., G. Peter and V.T. Paulinose, 1977. Zooplankton studies in the Indian Ocean: I. From Bay of Bengal during south-west monsoon period. *Mahasagar-Bulletin of the National Institute of Oceanography*, 10: 45-54.
- Panikkar, N.K. and T.S.S. Rao, 1973. Zooplankton investigation in Indian waters and the role of the Indian Ocean Biological Centre. *Handbook to the International Zooplankton Collections*, issued by the Indian Ocean Biological Centre, Cochin, India, 5: 111-162.
- Peter, K.J., H.K. Iyer, S. John and E.V. Radhakrishnan, 1977. Distribution and co-existence of planktonic organisms along the southwest coast of India. *Proceedings of the Symposium on Warm Water Zooplankton*, Special Publication, UNESCO/NIO: 80-68.
- Prasad, R.R., 1958. Plankton Calendars of the inshore waters at Mandapam with a note on the productivity of the area. *Indian Journal of Fisheries*, 5: 172-188.
- Prasad, R.R., 1969. Zooplankton biomass in the Arabian Sea and the Bay of Bengal with a discussion on the fisheries of the regions. *Proceedings of the National Institute of Sciences of India*, 53: 399-473.
- Pugh, P.R., 1977. Some observations on the vertical migration and geographical distribution of siphonophores in the warm waters of the North Atlantic Ocean. *Proceedings of the Symposium on Warm Water Zooplankton*, Special Publication, UNESCO/NIO, 362-378.
- Santhakumari, V., 1977. Distribution of hydromedusae in the Indian Ocean. *Proceedings of the Symposium on Warm Water Zooplankton*, Special Publication, UNESCO/NIO, 69-74.
- Sewell, R.B.S., 1932. Geographic and oceanographic research in Indian Waters: Part VI. Temperature and salinity of the deeper waters of the Bay of Bengal and Arabian Sea. *Memoirs of Asiatic Society of Bengal*, 9: 357-424.
- UNDP/FAO/IFP, 1974. Plankton-fish eggs and larvae studies. Progress Report No. 7, UNDP/FAO Pelagic Fishery Project (IND/593), Bergen/Cochin.
- Warren, B., H. Stommel and J.C. Swallow, 1966. Water masses and patterns of flow in the Somali basin during the south-west monsoon of 1964. *Deep-Sea Research*, 13: 825-860.