

RELATIVE ABUNDANCE AND DIEL VARIATION OF ZOOPLANKTON FROM SOUTH WEST COAST OF INDIA

V. SANTHAKUMARI AND K.J. PETER

National Institute of Oceanography, Regional Centre, Kochi - 682 018, Kerala.

ABSTRACT

Relative abundance and diurnal variations of zooplankton from six anchor stations along Kerala coast, were investigated. Samples were collected during April - May 1988 at three hour intervals from depths varying between 15 m and 40 m from the traditional fishing grounds of Kerala coast. Average biomass values ranged from 45-95 ml 100/m³. Increase in zooplankton at night was discernible at most of the stations and the highest biomass noticed was 131 ml 100/m³. Copepods formed the most abundant group, of which calanoids predominated. A swarm of the hydromedusan species, *Aequorea conica*, (181/m³) was seen at night. Quantitative and qualitative variations of various zooplankton groups from six stations in relation to selected physico chemical factors are discussed. Maximum fish larvae was observed in the night samples. Relatively high abundance of sardines, carangids and flat fish larvae in the collections is in agreement with the predominance of fish catch from the area of study.

INTRODUCTION

The levels of nutrients and primary & secondary productivity ultimately determine the sustainable harvest of fish resources (Cushing, 1971). Information on plankton standing stock can conveniently be used to the prediction of fishery potential. Further, zooplankton are often an important link in the transfer of energy from producers to carnivores. Biomass estimates of zooplankton indicate their importance as part of the herbivore link in the marine food chain. The south west coast of India is a very productive area and sustains a rich and abundant planktonic life and is significant because of its rich fishery. Information on diel variations from coastal waters of India is meagre (Mathew *et al.* 1977), while distributional studies of zooplankton from west coast of India have been carried out by several authors (Nair *et al.* 1978; Menon and George, 1977; Peter *et al.* 1977, Nair and Peter 1980; Madhupratap *et al.* 1990 and Santhakumari, 1993). The present paper gives information on the relative abundance and diel variation of zooplankton community from the traditional fishing grounds of Kerala along the south west coast of India.

MATERIAL AND METHODS

Zooplankton samples were collected on board R.V. Gaveshani from six anchor stations between 8° and 13°N lat: (Fig.1) during April-May 1988. Vertical hauls were made with W.P. net (mouth area 0.25 m² and mesh width 300 µm) equipped with a calibrated flow meter. They were taken at three hours intervals for 24 hours from depths ranging from 15-40 m. All samples were preserved in 4% formaldehyde solution. Biomass of zooplankton was estimated as displacement volume after removing the larger gelatinous organisms. Subsamples were taken from larger samples using a Folsom plankton splitter. Aliquots or whole samples were analysed and groups of zooplankton were enumerated using a counting chamber. Zooplankton biomass and counts were transformed to numbers per unit volume using flow meter data. Water samples analysed for estimation of hydrographic parameters by chemical oceanographic section of this centre has been made use of in this paper. The time of observations for water quality parameters are different from that of biological collection.

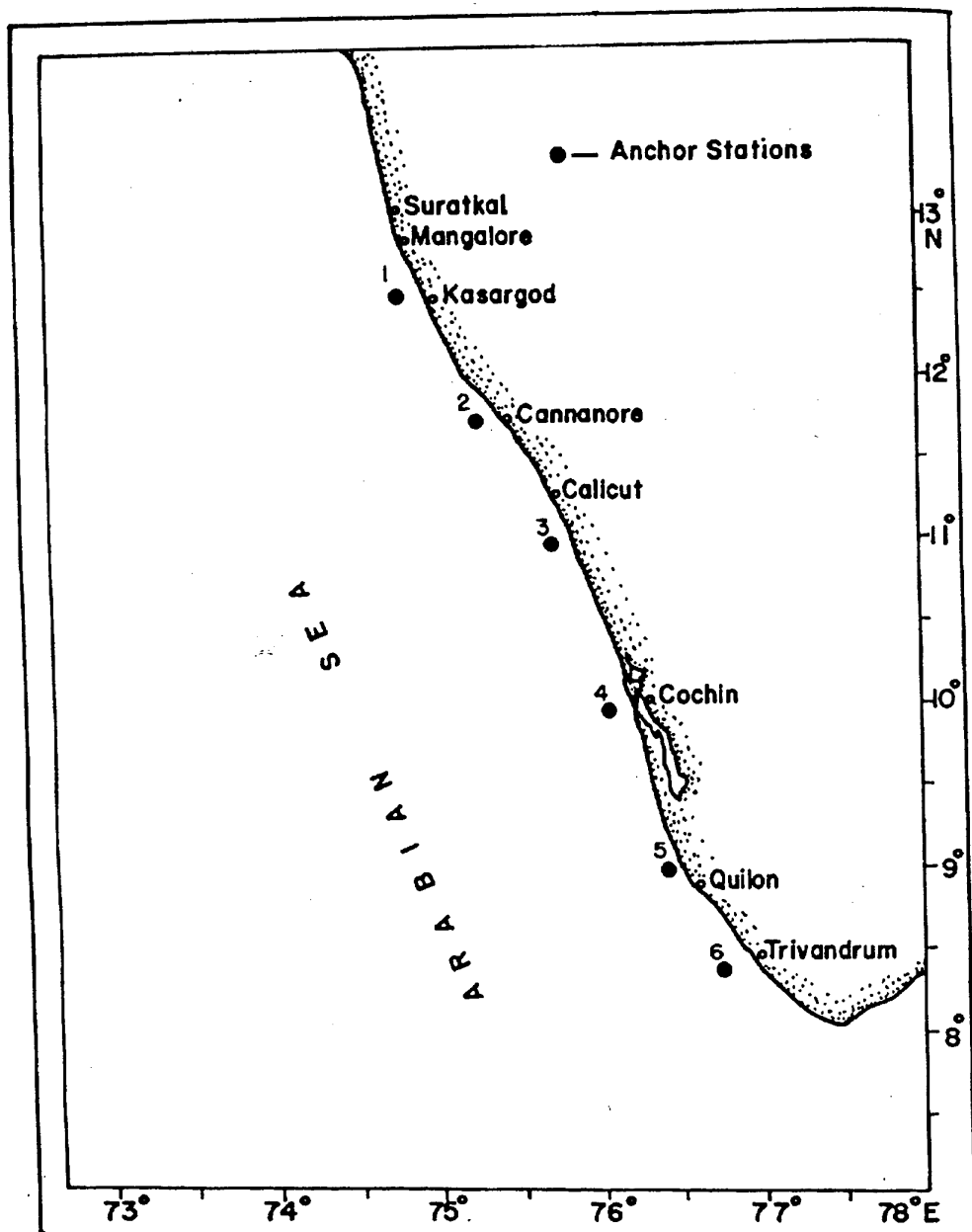


Fig. 1 : Map showing the station locations.

RESULTS AND DISCUSSIONS

Environment

Variations in physico-chemical parameters for different stations are given in Table 1. Temperature in the area attained values upto 31.81°C . The difference in temperature from surface to bottom was about $1-2^{\circ}\text{C}$. Minimum variation in salinity and dissolved oxygen was found from station 3, off Calicut and pH variation was not marked in any of these stations. Minimum range in $\text{NO}_3\text{-N}$, $\text{NH}_4\text{-N}$, $\text{PO}_4\text{-P}$, SiO_4 was obtained at this station. Maximum variation in SiO_4 and minimum range in salinity was noticed off Quilon (Station 5) while $\text{NH}_4\text{-N}$ maximum and DO minimum was seen off Trivandrum. Minimum variation in $\text{NO}_3\text{-N}$ and $\text{PO}_4\text{-P}$ was recorded off Kasargod.

Biomass :

Density and pattern of variation in zooplankton biomass is depicted in Figs 2-7. The highest biomass of $131 \text{ ml}/100 \text{ m}^3$ was from station 5, off Quilon and copepods constituted the most numerically abundant group (Fig. 6) and the lowest value was noticed at station 1, off Kasargod. (Fig.2) The station off Calicut showed a relatively steady and higher biomass than other stations (Fig.4). Copepods and cladocerans, when present in swarms, contributed to high biomass but gelatinous organisms like medusae, tunicates and siphonophores even when numerically less abundant formed a very significant part of the sample. These regions maintained an average value ranging from 45 to $95 \text{ ml}/100 \text{ m}^3$, except at Kasargod where the minimum value noticed was $10 \text{ ml}/100 \text{ m}^3$. High biomass at Cochin during day time was contributed by heteropods and siphonophores.

Relative abundance and diel variation :

Copepods dominated in all samples except in the night collection off Kasargod (Fig.2). The maximum numerical abundance amounting to $2645/\text{m}^3$ was observed off Quilon. A second

peak was obtained off Calicut at dawn. *Temora turbinata*, *Undinula vulgaris* were common in some of the collections while the genera *Candacia*, *Temora* and *Centropages* were present in most of the samples.

Chaetognaths were represented in almost all stations and the highest density, $451/\text{m}^3$ was encountered during night off Calicut. They contributed much to the biomass value and were second to Copepoda in abundance. Commonly occurring species in the collection were *Sagitta enflata* and *S. bedoti*. *S. pacifica* and *S. robusta* were also obtained in few numbers. Maximum percentage (27.8) was recorded during day off Kasargod.

Two species of cladocerans, *Evadne tergestina* and *Penilia avirostris*, were present in most of the samples. *E. tergestina* was found to be more abundant. Highest density of cladocerans, $1173/\text{m}^3$ was noticed off Quilon at 1800h (Fig. 6). Low values of temperature and $\text{NO}_3\text{-N}$ were discernible at this station. A second peak of $776/\text{m}^3$ was observed off Kasargod at 2100h (Fig.2) In this particular sample cladocerans dominated the population. At Kasargod *P. avirostris* population was more than *E. tergestina*. Most of them carried either eggs or embryos. $\text{PO}_4\text{-P}$ concentration was highest off Kasargod. In general inverse relationship between medusae and cladocerans was observed.

In the case of decapods a maximum density of $384/\text{m}^3$ was recorded off Trivandrum during night. Compared to other stations the lowest values of temperature and DO were recorded at this station. Relatively higher densities were obtained from most of the collections off Trivandrum (Fig.7). In general, decapoda were found more at night than day samples. Decapod larvae represented in samples belonged to Penaeidae, Alpheidae, Sergestidae and Porcellanidae. Lucifers were represented by the single species, *L. hasseni* and it was observed in most of the collections while the genus *Acetes* was represented mainly by *Acetes indicus* and were few in number.

Table 1 : Physico-chemical data collected from anchor stations off Kasargod, Cannanore, Calicut, Cochin, Quilon and Trivandrum.

Stations	Time	Temp.	Sal. (‰)	pH	DO (ml/l)	NO ₃ -N (μmol/l)	NH ₄ -N (μmol/l)	PO ₄ -P (μmol/l)	Si O ₄ (μmol/l)
Off Kasargod (Station 1)									
	0800	31.81	--	8.15	4.49	1.53	--	1.01	2.01
	1100	29.79	--	8.15	3.40	0.95	--	0.89	1.20
	1400	30.20	--	8.21	4.12	1.95	1.05	0.45	2.76
	1700	30.54	--	8.15	4.12	1.60	2.90	0.26	2.76
	2000	30.45	--	8.22	4.27	1.50	0.81	0.36	3.22
	2300	30.10	--	8.27	4.19	1.38	0.34	0.36	2.07
	0200	30.20	--	8.23	3.51	4.83	4.85	0.39	1.72
	0500	30.30	--	8.27	4.49	1.75	1.95	0.29	2.59
Off Cannanore (Station 2)									
	1930	30.08	34.80	8.15	3.11	2.36	--	0.48	1.72
	2230	30.91	--	8.19	3.11	0.02	0.95	0.18	0.40
	0130	30.35	--	8.20	4.64	0.49	2.90	0.02	2.24
	0430	30.21	33.38	8.16	4.56	0.53	0.00	0.46	4.54
	0730	30.82	34.49	8.16	4.31	0.23	0.95	0.20	4.65
	1030	31.21	34.89	8.24	4.17	0.98	2.09	0.53	2.93
	1330	30.21	--	8.20	4.38	1.08	0.00	0.24	3.62
	1630	29.62	--	8.21	4.44	0.09	0.00	0.12	3.79
Off Calicut (Station 3)									
	0230	31.20	34.82	8.21	4.12	0.04	1.90	0.28	1.49
	0530	31.21	35.85	8.23	4.33	0.34	0.00	0.29	1.90
	0830	31.40	34.46	8.18	1.32	0.05	1.54	0.29	1.03
	1130	31.20	34.18	8.22	4.36	0.09	1.66	0.11	0.69
	1430	30.91	33.79	8.19	4.67	0.96	1.06	0.16	0.29
	1730	31.40	35.19	8.25	4.49	0.09	1.14	0.17	0.58
	2030	31.31	34.82	8.27	4.63	0.71	0.38	0.15	1.89
	2330	31.30	33.93	8.27	4.90	--	1.33	0.22	1.49
Off Cochin (Station 4)									
	2030	30.41	35.00	8.24	4.76	1.16	1.38	0.29	2.41
	2330	30.61	34.19	8.25	3.36	--	--	0.03	--
	0230	30.30	34.65	8.30	3.98	0.28	2.14	0.41	3.22
	0530	30.80	35.49	8.32	4.41	0.26	0.00	0.17	--
	0830	30.61	35.49	8.31	4.46	0.09	0.33	0.23	0.80
	1130	30.40	34.33	8.24	4.70	--	--	--	--
	1430	30.31	34.76	8.26	4.81	0.54	--	0.29	1.49
	1730	30.70	34.80	8.28	4.80	0.19	0.38	0.16	2.29
Off Quilon (Station 5)									
	0400	30.50	33.90	8.21	4.35	0.27	0.00	0.23	4.54
	0700	31.10	33.50	8.20	4.21	0.44	4.09	0.07	3.90
	1000	30.20	33.50	8.12	4.14	0.17	3.85	--	1.78
	1300	30.30	33.50	8.14	4.18	0.22	4.28	0.16	1.26
	1600	29.77	33.50	8.19	4.04	1.28	4.18	0.38	5.57
	1900	30.41	33.50	8.21	4.33	0.74	5.09	0.18	3.45
	2200	30.00	33.90	8.17	3.79	1.28	1.53	0.18	4.77
	0100	30.31	33.50	8.12	4.36	0.29	1.38	0.19	3.79
Off Trivandrum (Station 6)									
	0600	29.00	33.90	8.13	3.84	2.91	0.52	0.21	0.63
	0900	28.40	33.90	8.09	3.60	2.93	5.37	0.20	2.53
	1200	28.40	35.20	8.11	3.90	1.85	1.35	0.27	3.22
	1500	28.00	35.24	8.15	3.57	1.87	0.56	0.24	2.30
	1800	27.50	34.40	8.09	3.41	1.59	0.66	0.43	--
	2100	29.30	35.24	8.15	3.95	0.15	3.23	0.18	2.87
	2400	28.20	34.81	8.16	3.68	0.21	0.57	0.30	0.97
	0300	28.10	35.65	8.13	3.63	3.34	0.00	0.27	0.86

Maximum density of fish eggs of $296/\text{m}^3$ was observed at 0600h off Trivandrum (Fig.7) and it was found in all collections from this station. Stationwise order of abundance of fish eggs was found off Quilon, Cochin, Calicut, Cannanore and Kasargod. Fish eggs were noticed more at night than the day collections.

Highest density $256/\text{m}^3$ of fish larvae was recorded at night off Quilon with comparatively high representation from this station (Fig.6). Of these carangid larvae were more at this station. A few flat fish larvae also were present at this location. Myctophid larvae were seen off Cochin and Calicut. Representation of clupeid larvae were more from Kasargod, Cannanore and Calicut areas.

Eventhough numerically not abundant, volumetrically medusae contributed much to the biomass value. Maximum density of medusae, $264/\text{m}^3$, was found off Calicut. Relatively uniform high density was observed off Cochin. An instance of a swarm of *Aequorea conica* ($181/\text{m}^3$), was observed off Cannanore at night which coincided with high values of $\text{PO}_4\text{-P}$. Hydromedusan species like *Liriope tetraphylla*, *Aglaurea hemistoma*, *Eirene ceylonensis*, *Aequorea conica*, *Solmundella bitentaculata*, *Phialidium brunescens* and *Cytaeis tetrastyla* were found in abundance at most of the stations. Larvae of scyphomedusae were noticed from many stations with the maximum occurrence off Cochin. Congregation of gelatinous organisms were found to be more at Cochin. Nair *et al.* (1983) observed a similar phenomenon at Bombay.

Siphonophore was represented in most of the stations. Though they are numerically less abundant they play an important role in the food web as pure carnivores and contribute to a major share of the biomass. The highest population density was $64/\text{m}^3$ from Trivandrum but they were totally absent off Kasargod. At Cochin the high biomass value was due to this group during day time.

Maximum density of mollusca noticed was

$264/\text{m}^3$ from Calicut during night. Gastropod larvae occurred in large numbers at Calicut and Cochin. Swarms of the pteropod, *Creseis acicula*, was noticed off Cochin and contributed for the high biomass value during day. Meroplanktonic gymnosomes and cephalopod juveniles were observed in few numbers.

The occurrence of ctenophore, *Pleurobroachia globosa*, was sporadic with maximum concentration noticed off Quilon. A few specimens of *Beroe* were present only off Calicut and Cannanore. Salps and doliolids also occurred at a few stations with the highest concentration recorded off Cochin. Appendicularians were more at the stations off Calicut with a maximum density of $188/\text{m}^3$. Mysids and cumaceans were comparatively very less in the collections.

It is worth mentioning that off Calicut a bloom of *Noctiluca miliaris* was noticed. The green colouration to *Noctiluca* was due to the presence of a small green flagellate, *Protoeuglena noctiluca* found inside and the whole water in the area appeared as green carpet. During this period the average value of chlorophyll *a* was $36.44\text{ mg}/\text{m}^3$ during day and $22.26\text{ mg}/\text{m}^3$ during night off Calicut.

Kerala coast is influenced by two watermasses, a low saline coastal water mass and a high saline oceanic water mass (Wyrki, 1973). During the premonsoon season, this high saline water is traceable up to 40 m depth. The low saline coastal water mass is found to occupy the inshore waters of coastal area from surface to bottom and spreads at the surface level extending to the offshore region. In majority of the stations the depth was only up to 20 m except at off Cochin where the depth was 40 m. The seasonal change in the overall oceanographic conditions of the area appeared to be similar every year and upwelling which occurs during the summer monsoon is the most important process for fishery. Most of the environmental parameters did not show much diel variation. pH was around 8 at all stations. High values of DO indicated the prevailing healthy

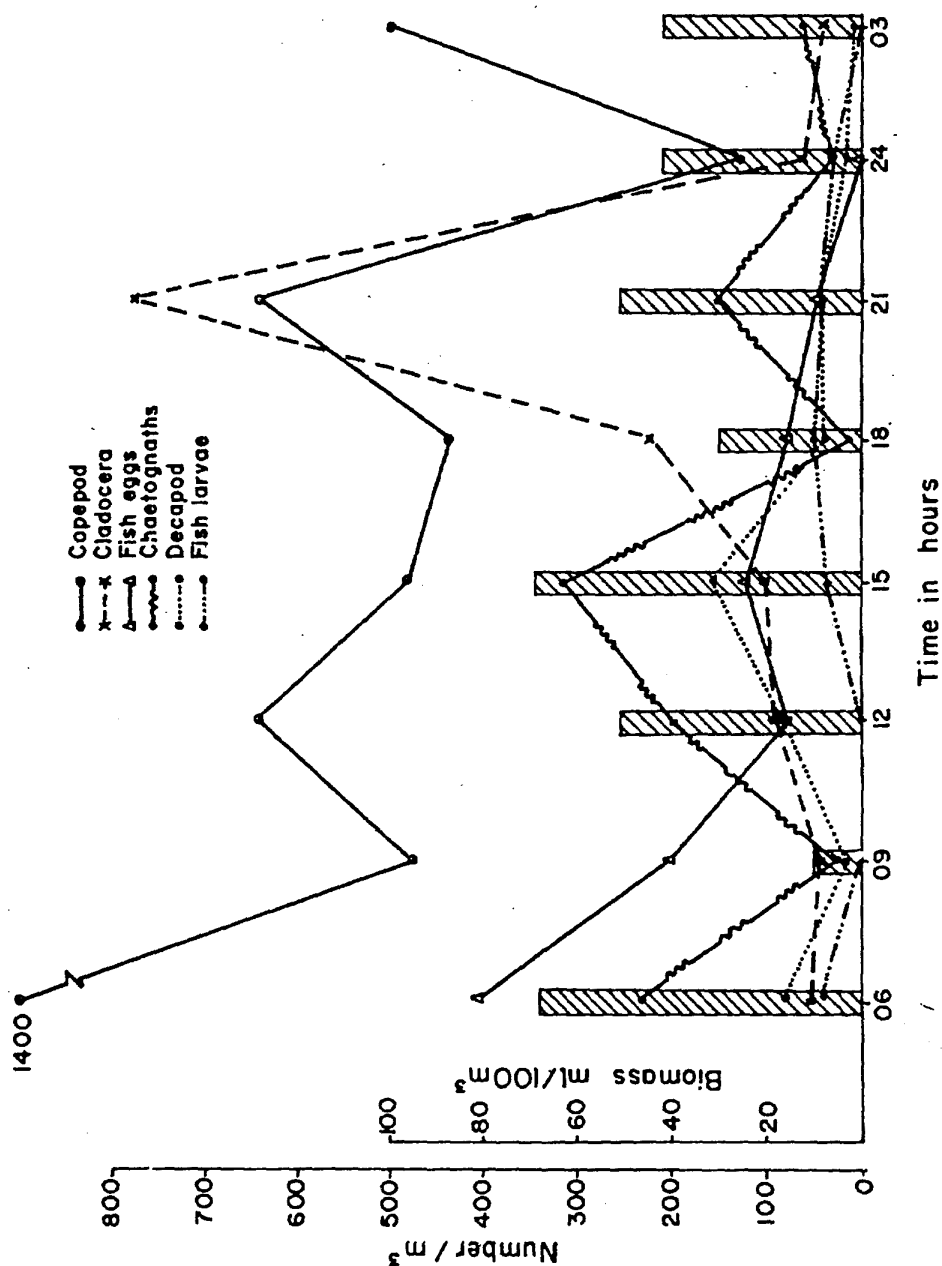
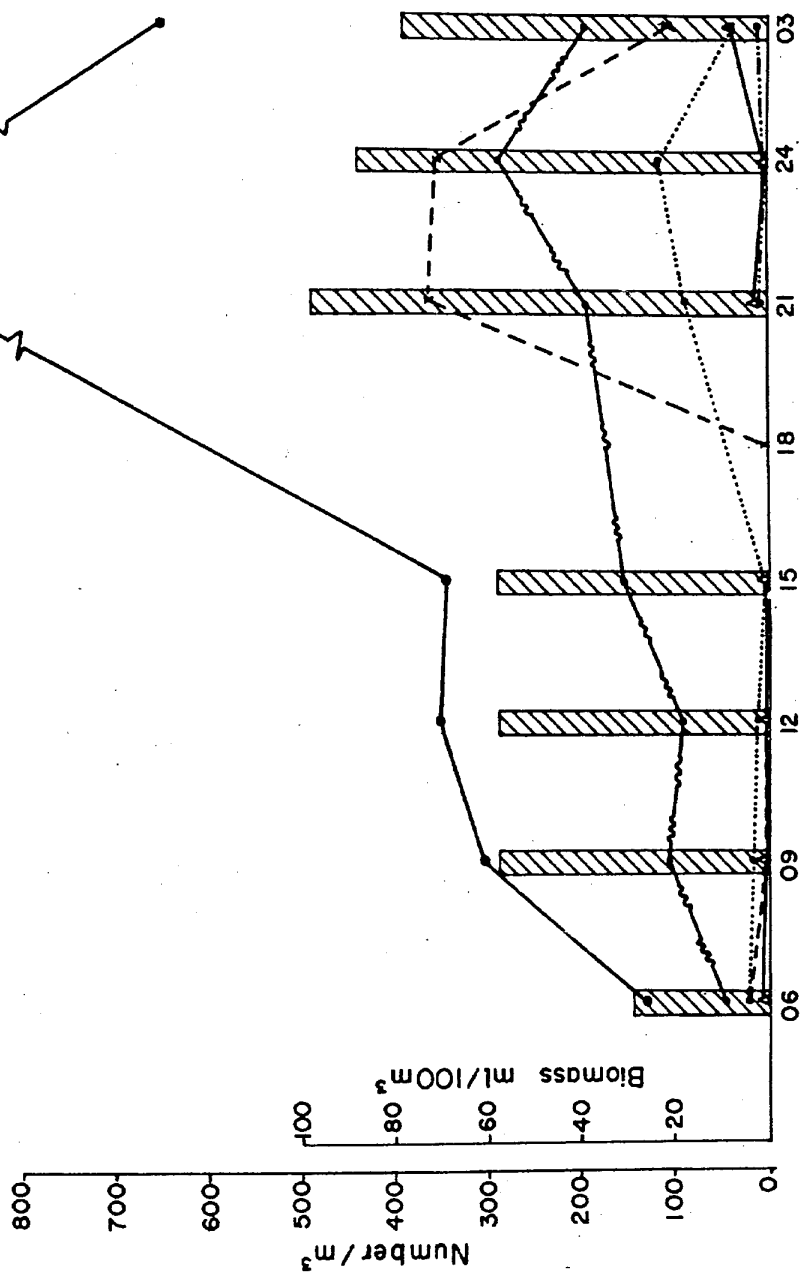


Fig. 2 : Off Kasargod

Fig 2 to 7 : Biomass is shown as bar diagram and common groups as graphs for off Kasargod, (Station 1), Cannanore (Station 2), Calicut (Station 3), Cochin (Station 4), Quilon (Station 5), and Triyandrum (Station 5). Symbols given under Fig : 2 is applicable to all graphs



Time in hours

Fig. 3 : Off Cannanore

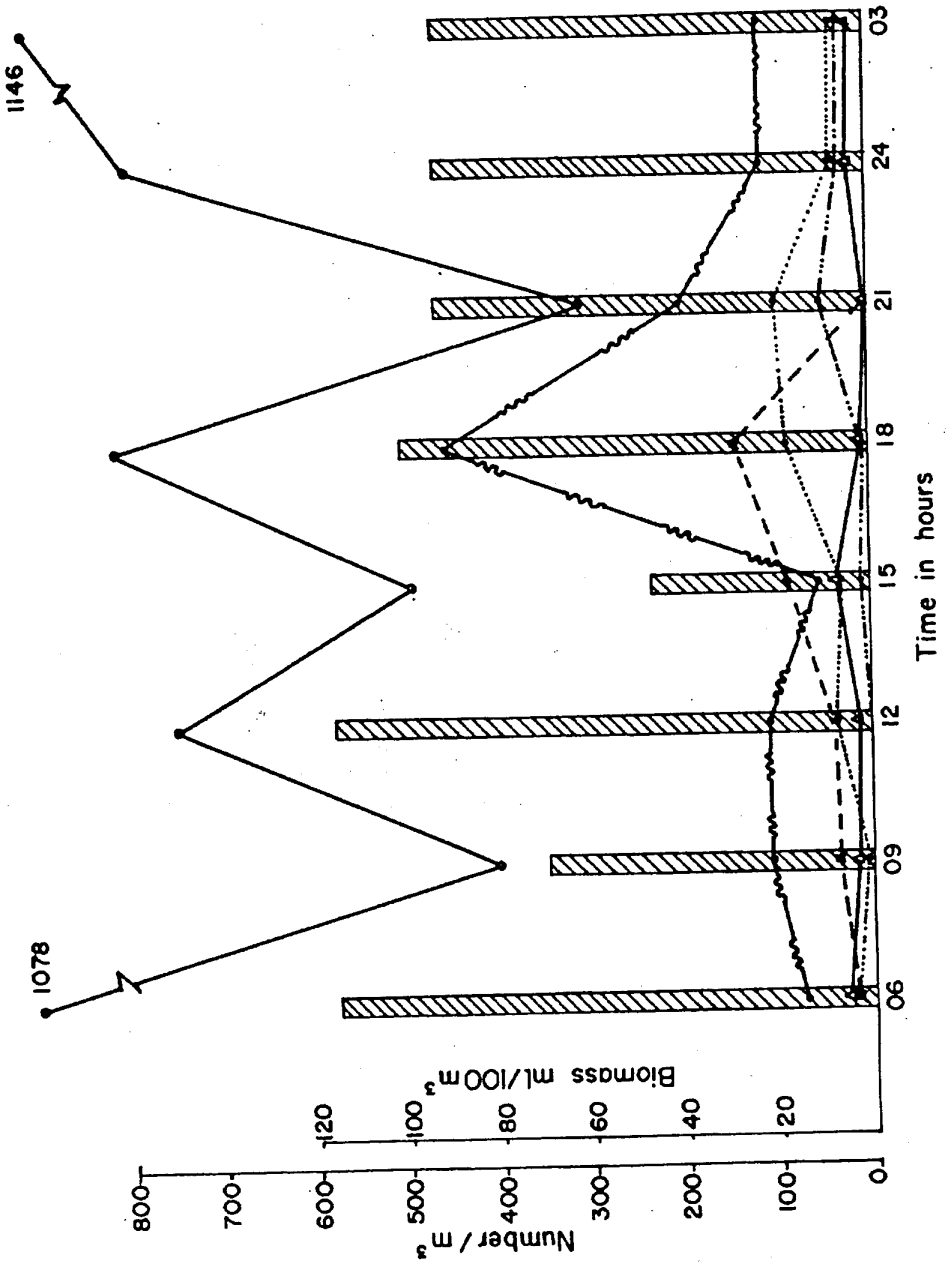


Fig. 4 : Off Calicut

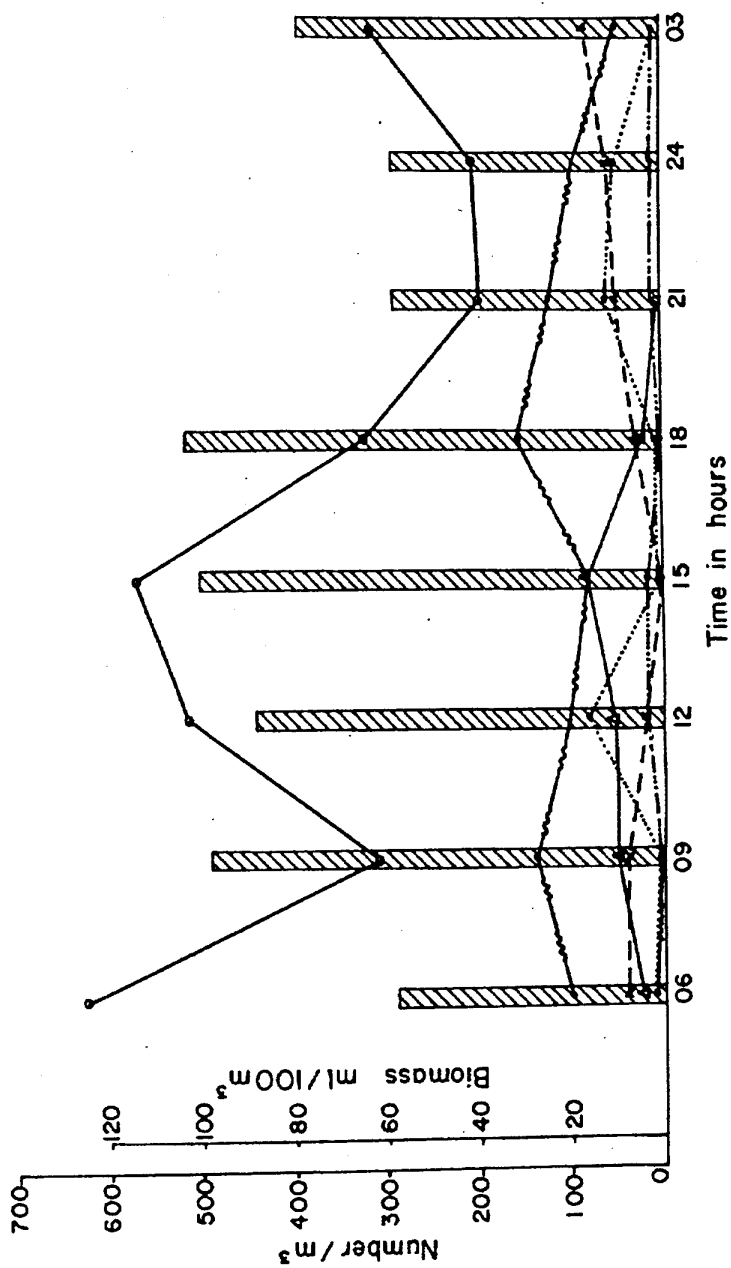


Fig. 5 : Off Cochin

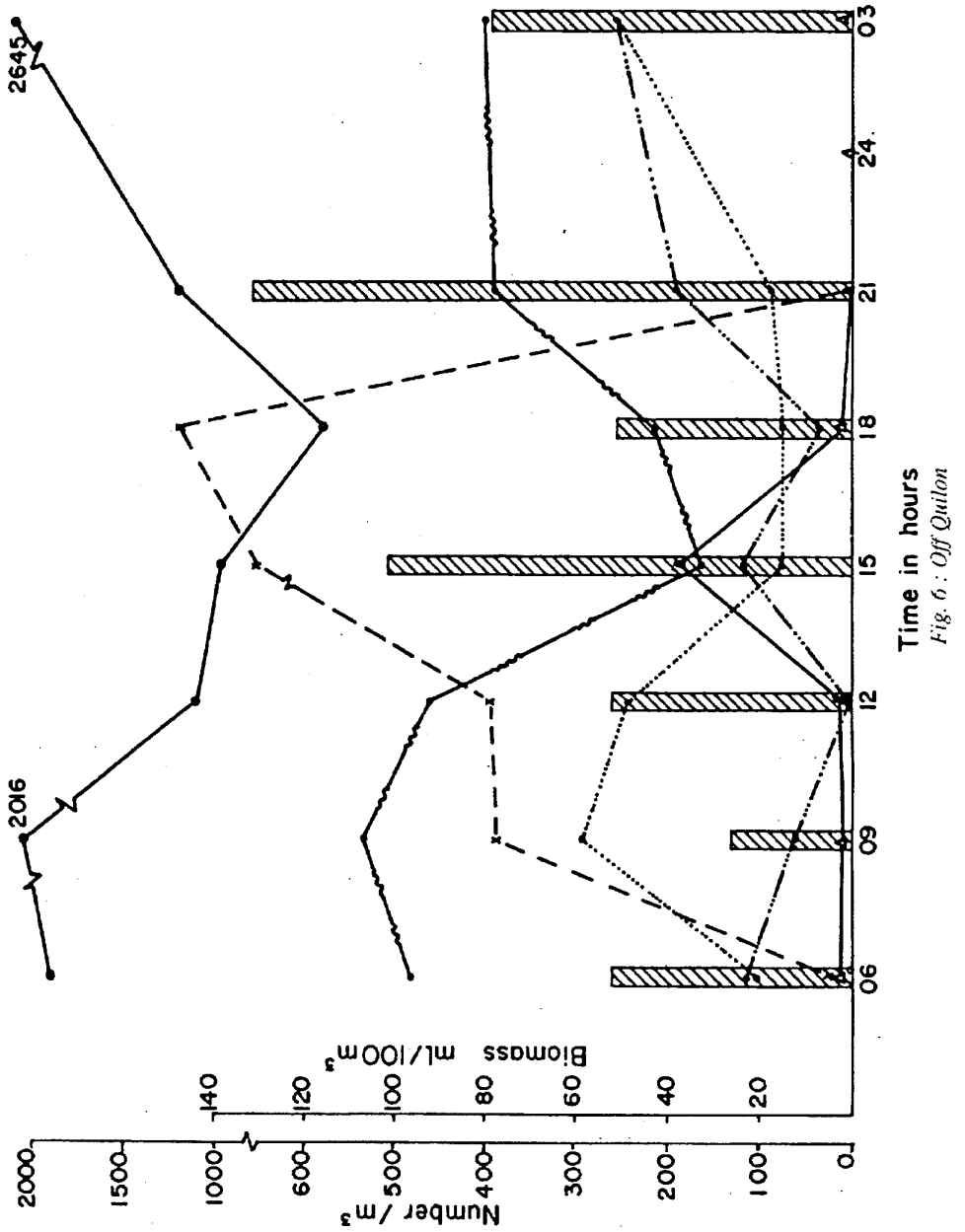


Fig. 6 : Off Quilon

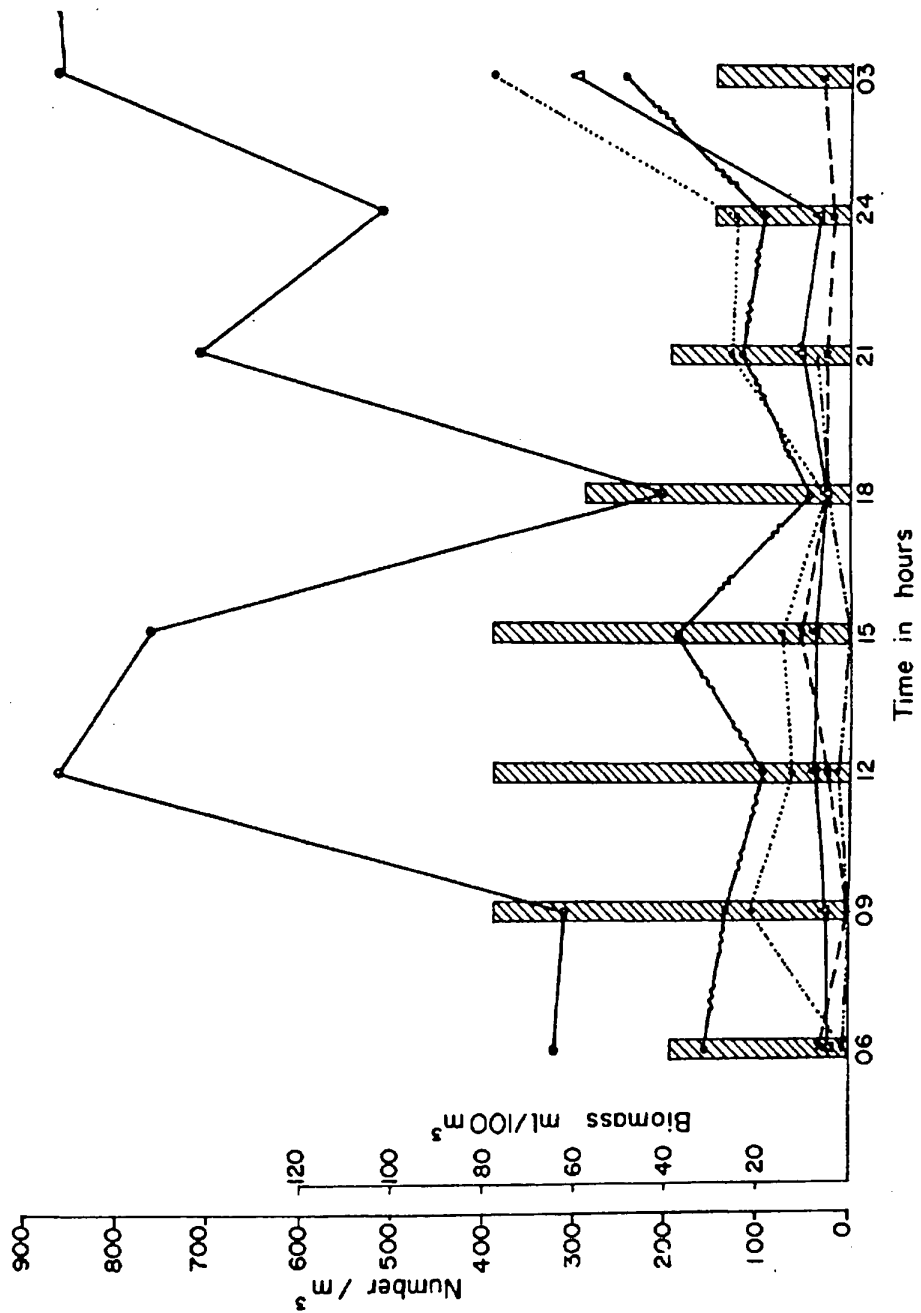


Fig. 7 : Off-Trivandrum

environmental conditions. Relatively higher concentration of DO found during day than night might be due to the photosynthetic activity during day. The divergence near the bottom between 20 and 30 m depth along the coast, north of Quilon, produce vertical acceleration with the resultant lifting of bottom waters. Tranter (1973) points out that, in tropics, where nutrients are in short supply, a significant correlation between zooplankton and nutrients is largely the result of a direct cause and effect relationship by way of zooplankton excretion and remineralisation of nutrients. The enrichment of waters by nutrients especially phosphates and nitrates associated with the fall in temperature and salinity results in high production of phytoplankton (Gopinathan, 1972). Copepods feed on phytoplankton and ciliates and thus in normal productive areas they dominate. In the present study it is seen that the maximum biomass was obtained off Quilon area and it was mainly due to the abundance of copepods. In general, copepods formed the dominant group in majority of the collections. The highest biomass value as well as the high density of zooplankton recorded in the samples were always found either at night or dawn. But a strict diel variation was not discernible at certain stations. The abundance of zooplankton at night cannot be attributed to the vertical migration alone, as there is every chance of migration of zooplankton from deeper waters to shallow regions due to other factors also. Further, the current in the area can influence the movement of deeper water to the shallow region. Mathew *et al.* (1977) also supports this view.

The presence of larvae of sardines, anchovies, carangids, bothids etc. in the collections in reasonably good numbers, indicates the existence of their fishery, as evidenced by records of the fish catch of Kerala coast. The sardine fishery of these regions is mainly constituted by *Sardinella longiceps* which contribute to 44% of the total marine fish catch, in addition to the lesser sardines. Carangid fishery is supported by *Megalaspis cordyla*, *Decapterus russelli* and species of *Caranx*, *Chorinemus* etc. The planktivore fish mackerel,

Rastralliger kanagurta, abundantly occur in this region.

ACKNOWLEDGEMENTS

The authors are thankful to the Director, National Institute of Oceanography, Goa, and to Scientist-in-Charge, Regional Centre of N.I.O., Cochin, for the facilities and encouragement.

REFERENCES

- Carmer, J.D. and Marzolf, G.R. 1970. Selective predation of zooplankton by gizzard shad. *Trans. Amer. Fish. Soc.*, **99** : 320-332.
- Cushing, D.H. 1971. Upwelling and the production of fish. *Advances in Marine Biology*, **9** : 255-334.
- Gopinathan, C.P., 1972. Seasonal abundance of phytoplankton in the Cochin backwater. *J.mar. biol. Ass. India*, **14** : 568-577.
- Madhupratap, M., Nair, S.R.S. Haridas P. and Gadi Padmavati. 1990. Response of zooplankton to Physical changes in the environment : Coastal upwelling along the central west coast of India. *J. Coast. Res.*, **6**: 413-426.
- Madhupratap, M. and Rao, T.S.S. 1979. Tidal and diurnal influence on estuarine zooplankton. *Indian J. mar. Sci.*, **8** : 9-11.
- Mathew, K.J. Gopinathan, C.P. Rao, D.S., Raghunathan, A. and Murthy, A.V.S. 1977. Diurnal variations in the distribution of zooplankton in relation to currents and other ecological parameters of the mud bank of Alleppey, Kerala. *Proc. Symp. Warm. Water, Zoopl. Spl. Publ. UNESCO/NIO* : 250-263.
- Menon, M.D. and George, K.C. 1977. On the abundance of zooplankton along the south west coast of India during the year 1971-75. *Proc. Symp. Warm Water Zoopl. Spl. Publ.*

UNESCO/NIO : 205-213.

UNESCO/NIO : 80-86.

Nair, V.R., Peter, G. and Paulinose, V.T. 1978. Zooplankton studies in the Indian Ocean. II. From the Arabian Sea during the postmonsoon period. *Mahasagar - Bull. nat. Inst. Oceanogr.*, **11** : 35-43.

Nair, V.R. and Peter, G. 1980. Zooplankton from the shelf waters off the west coast of India. *Mahasagar - Bull. nat. Inst. Oceanogr.*, **13** : 61-65.

Peter, K.J. Iyer, H.K. John, S., and Radhakrishnan, E.V. 1977. Distribution and coexistence of planktonic organisms along the south west coast of India. *Proc. Symp. Warm Water Zoopl. Spl. Publ.*

Santhakumari, V. 1993. Zooplankton standing stock and community structure and along Karnataka coast, west coast of India. *J. Indian. Fish. Ass.*, **21** : 21-30.

Tranter, D.J. 1973. Seasonal studies of pelagic ecosystem (Meridian 110°) In : *The Biology of the Indian Ocean*, Zeitzschel, B. (Ed.), Springer-Verla, Berlin, Vol. 3. Heidelberg, New York. 487-525.

Wyrski, K. 1973. Physical Oceanography of the Indian Ocean. In : *The Biology of the Indian Ocean*, Zeitzschel B (Ed.) Vol. 3. Springer-Verl, Berlin, Heidelberg, New York. 18-16.