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CALANOID COPEPODS FROM THE SHELF AND SLOPE WATERS OFF COCHIN: DISTRIBUTION, BIOMASS AND SPECIES DIVERSITY

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Calanoid copepods off the Cochin coast were studied in relation to hydrographic conditions. Of the 51 species belonging to 14 genera encountered, eleven species were found to be major components. During the period of upwelling, the population density remained high due to the blooming of *Temora turbinata* in the shelf. Species diversity was used as an index of the stability of the environment. Low values at the shelf stations suggest the occurrence of a physically controlled community while higher values at the slope, a biologically accommodated community.

INTRODUCTION

Pelagic copepods of the Indian Ocean are known mainly from the contributions of Sewell (1929; 1948), the neritic and nearshore copepods of the east and west coasts of India from the works of Krishnaswamy (1953a,b,c;1956), Kartha (1959), Prasad and Kartha (1959), Ganapati and Rao (1954), Ganapati and Santhakumari (1961), Kasturirangan (1963) and Saraswathy (1967). The present paper deals with the Calanoid copepods from shelf and slope waters off Cochin collected during 1972.

MATERIAL AND METHODS

Plankton samples off Cochin were collected by oblique hauls with a 20 cm Bongo net of mesh size 0.5 mm (UNDP Progress Report No. 7) during January to December, 1972. Five stations approximately 10 miles apart were worked regularly across the continental shelf. No collections were made in June. The hauls were from 25m. to surface except at the first station where the depth was about 10 m. The biomass values were measured by displacement method and the whole sample was examined for the identification and counts of less dominant species. Aliquots of 10 ml were used to ascertain the dominant species and values for the whole sample were computed per 100 m³. The diversity index values were calculated using the following equation of Fisher *et al.* (1943).

$$S = \alpha \log_e (1 + N/S)$$

where S is the number of species present, N is the total number of individuals in the sample, α the index of diversity. The environmental data was obtained from the Pelagic Fishery Project.

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RESULTS

HYDROGRAPHY

Temperature and salinity at the surface layer and at the depths from which hauls were made (10 m at Stn. 1 and 25 m at other stations) are given in Fig. 1. Surface temperature ranged between 26.7 and 30.7°C. The high value was observed at stn. 1 in April. Another increase in surface temperature occurred during October-November. Low values were noticed in July and August. Temperature at the subsurface layer followed the same pattern. The fall in temperature was well marked in August and September and the lowest values recorded were 22.4, 21.4, 20.7, 19.9 and 23.8°C for stns. 1 to 5 respectively. The difference between surface and subsurface temperature was 6 to 8°C during this period. This sharp decrease in temperature over 25 m. depth and considerable variations found in the first 10 m. suggest that temperature discontinuity starts right from the surface. Comparatively steady conditions prevailed at stn. 5 where amplitude of variation was 3.5°C.

Considerable decrease in salinity was observed only at the first station where it fell to 22.7‰ in July. At the other four stations salinity remained high, never falling below 31‰. Influence of freshwater influx does not seem to extend beyond the first station and there was no evidence of its penetration below the surface. By August, the water column became uniformly saline reaching values of 34‰, except at stn. 1, where it was 30.6‰.

Dissolved oxygen values showed that the surface layers were well oxygenated throughout the year. But the oxygen deficiency layer (< 1 ml/l) extends upto 10 m. during the period of upwelling. Thus, the entire shelf is flooded at the bottom with cold high saline water of low oxygen content. At stn. 5, being more oceanic, such fluctuations were not so well marked, providing a more stable environment.

BIOMASS AND COPEPOD DENSITY

Mean biomass values were high at stns. 2 and 4 (Table 1). The lowest value was noticed at Stn. 1. Low displacement values were recorded during the beginning of the year. Changes in copepod density (Fig. 2) showed similar pattern

Table 1. MONTHLY VARIATIONS IN BIOMASS (ml m⁻³)
FROM JANUARY TO DECEMBER, 1972.

Stations	J	F	M	A	M		
1	0.013	0.076	0.017	0.539	0.214		
2	0.152	0.085	0.063	0.574	0.140		
3	0.132	0.092	0.669	0.373	2.380		
4	0.122	0.510	0.062	2.500	1.029		
5	—	—	0.179	2.794	0.031		
	J	A	S	O*	N	D	Mean.
	0.645	0.052	0.037	0.024	0.017	0.033	0.168
	0.135	0.226	2.426	0.071	0.159	0.039	0.643
	0.009	0.625	1.957	0.255	0.091	0.130	0.549
	1.197	0.603	1.923	0.319	0.007	0.053	0.757
	0.049	1.087	0.133	0.169	0.019	0.043	0.448

No collections in June.

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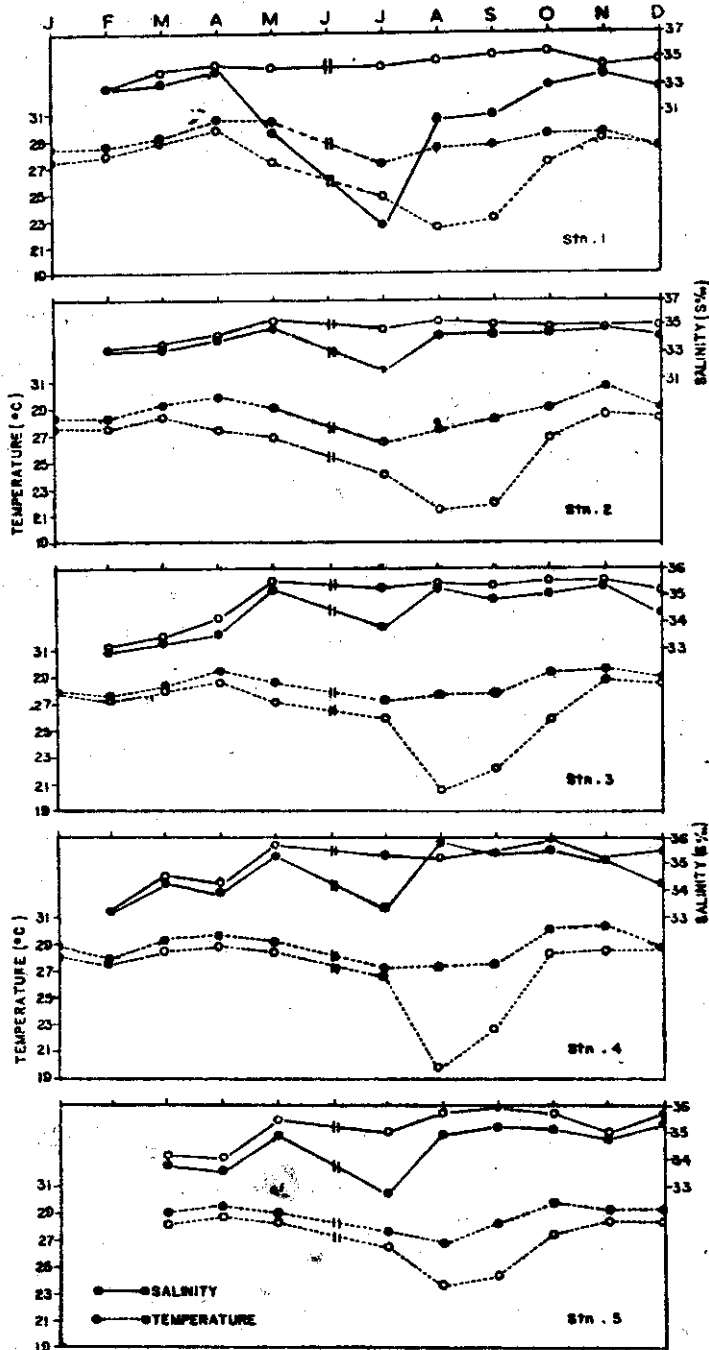


Fig. 1. Salinity and temperature at Stations 1 to 5. Continuous line indicates salinity and dotted line indicates temperature. Solid circles indicate surface and clear circles indicate the values at the depth of sampling

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mainly because the major share in biomass was constituted by copepods. But in September the high displacement volume at stns. 2, 3 and 4 was not accompanied by a corresponding increase in copepod density. During this period blooms of ostracods and sergestids outnumbered the copepods. Copepod number was highest at stn. 3 (50010/100m³) in May. Highest density was encountered in the premonsoon period. During monsoon, copepod numbers decreased considerably but again reached another peak in September remaining more or less steady for the rest of the period.

SPECIES COMPOSITION

51 calanoid species belonging to 14 genera were encountered from this region but not more than 19 species were recorded at a time. *Undinula vulgaris*, *Eucalanus monachus*, *Euchaeta marina*, *E. wolfendeni*, *E. consimilis*, *Centropages furcatus*, *Temora turbinata*, *T. stylifera*, *T. discaudata*, *Candacia discaudata*, *Labidocera minuta*, *L. pectinata* and *L. acuta* were the most abundant forms. *Eucalanus monachus* was the most dominant form and was persistent throughout the year. *Undinula vulgaris*, though numerically abundant was totally absent during August-September. Maximum number for *Temora turbinata* was reached in August-September suggesting that the species might be abundant in the deeper layer and were brought to the surface with the upwelled waters. Smaller forms, mainly *Acrocalanus* spp., *Paracalanus* spp. and *Acartia* spp., were rare in these collections which could be attributed to the larger mesh size of the net used. Oceanic forms like *Pleuromamma indica*, *Lucicutia flavicornis*, *Heterorhabdus papilliger* were found only in the slope region.

SPECIES DIVERSITY

The diversity index (λ) calculated ranged from 0.63 to 2.80 (Fig. 2). To test whether the indices of diversity varies significantly between months and between stations the diversity indices calculated were analysed using analysis of variance table and the results are presented in Table 2. The variations between months and between stations are highly significant ($p < 0.01$, $p < 0.001$ respectively). By forming the least significant difference, the months and stations having higher diversity index were separated. Stn. 5 was having higher diversity index and stn. 1 low diversity index. Stns. 2, 3 and 4 are not significantly different as far as species diversity is concerned.

DISCUSSION

Two major factors influence the shelf waters off Cochin. During monsoon, freshwater influx reduces surface salinity considerably and the effect is persistent throughout the monsoon (Darbyshire, 1967). The effect is maximum in the immediate vicinity of the mouth of the backwater and in the present study also greater influence was noticed at stations nearer to the shore. Upwelling is a feature associated with the monsoon along the west coast of India. Off Cochin, this has been reported earlier by Ramamirtham and Jayaraman (1960). Highly saline cold waters of low oxygen content occupy the shelf waters except for a very thin layer at the surface. In the present survey the effects of upwelling were well manifested at all the stations.

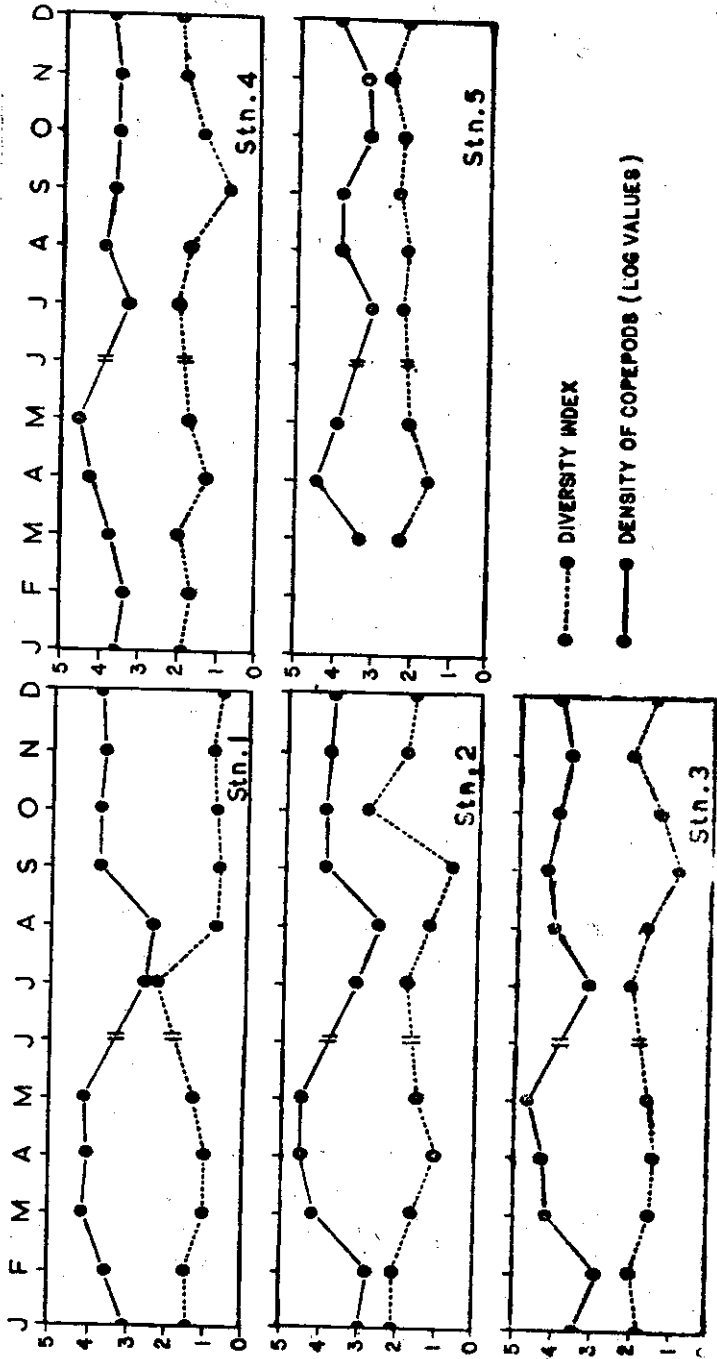


Fig. 2. Diversity index values and copepod numbers/100 m³ in stations 1 to 5.

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The influence of land drainage on the coastal environment was reflected in the lower diversity values of the shelf which was more prominent at stn. 1, being in close proximity to land. The higher diversity index values in July at stns. 1-4 were due to a sudden fall in the density of copepods without a corresponding decrease in the number of species. When the effects of upwelling are well established above 25 m during August and September, most of the dominant coastal species disappear which results in the fall of α values during this period. But the density remained high due to the blooming of a single species namely *Temora turbinata* at all shelf stations. Bowman (1971) studying copepods from Cape Hatteras to Florida reported a seaward gradient in diversity and sought to explain it by stability-time hypothesis of Sanders (1968). Greater number of calanoid copepods in the offshore stations had been reported by Grice and Hart (1962). In the present study highest stability as shown by highest uniform diversity occurred only at the slope station (stn. 5) suggesting the more biologically accommodated nature of the community, whereas a more physically controlled community thrives in the shelf stations.

TABLE 2. ANALYSIS OF VARIANCE TABLE FOR SPECIES DIVERSITY

Source	Sum of squares	Degrees of freedom	Mean square	F
Total	14.8193	52		
Months	4.3303	10	0.43303	3.235**
Stations	5.4021	4	1.35053	10.089***
Error	5.0869	38	0.13387	

** Significant at 1% level.

*** Significant at 0.1% level.

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