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Editors

V.K. Pillai
S.A.H. Abidi
V. Ravindran
K.K. Balachandran
Vikram V. Agadi



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Studies of planktonic ostracoda collected from Arabian Sea and Bay of Bengal

K.J. Mathew, M.Vijayan, M.S. Rajagopalan & P.P. Pavithran

Central Marine Fisheries Research Institute, P.B. No. 1603, Cochin - 682 014

ABSTRACT

General distribution and numerical abundance of planktonic ostracods, as a whole, in the Exclusive Economic Zone of India and nearby seas based on 1086 collections (1985-'88) are discussed. The average density of ostracods in the area investigated was estimated to be 17395/1000 m³. The ostracods occurred far more abundantly in the shelf waters than in the oceanic areas. Samples collected indicated that 95% of the ostracod population occurred off the west coast of India round the year. They were found remarkably high (61168/1000 m³, 63.3%) between 10°N and 15°N off the west coast, while their abundance between 10°N and 15°N off the east coast of India was the lowest (624/1000 m³, 0.65%). The abundance of ostracods was always associated with monsoon when the maximum of 31920/1000 m³ was obtained and this was mainly due to the swarming nature of these organisms. The minimum was observed during the premonsoon period when an average of 1508/1000 m³ ostracods occurred. Comparison of ostracod distribution in the EEZ of India between day and night yielded values of 30.95 and 69.05% respectively, which showed that they are more abundant during night, thereby illustrating pronounced diurnal vertical migration.

INTRODUCTION

Planktonic ostracods contribute significantly to the biomass of marine zooplankton especially of tropical and subtropical oceans. Deevey (1968) found that off Bermuda, they ranked third in abundance after copepods and tunicates with numbers ranging to a maximum of 36/m³ to 11-15/m³, apart from protozoa. In IIOE collections also, ostracods formed a major portion of the zooplankton with maximum occurrence of 12500 specimens per haul (Nair *et. al.*, 1973). Probably the first study on planktonic ostracods from Indian Ocean was based on the *Valdivia* expedition material (Müller, 1906). Later Cannon (1940) gave a list of planktonic ostracods collected during *John Murray* expedition. *Dana* expedition materials were studied by Poulsen (1962, 1965, 1969).

However, until recently a little effort was made to study the ostracods for their quantitative distribution over space and time. It was during the IIOE that such a study was attempted for ostracods in general and for some of the major species. These included the works of George *et. al.* (1975), George & Nair (1980), Nair & Madhupratap (1984). The present study concerns mainly with the general distribution and abundance of planktonic ostracods in the EEZ and contiguous seas of India based on the *FORV Sagar Sampada* collections.

MATERIALS AND METHODS

The material which formed the basis of the study was collected onboard *FORV Sagar Sampada* from the Indian EEZ and contiguous seas (Fig.1) during the period 1985-'88. The gear used was Bongo-60 net of mesh size of 0.33 mm. Hauls were made from 150 m to surface in oblique manner with the ship in motion at 2 knots speed. A precalibrated flow meter was used in most cases. The plankton was preserved in 5% formaldehyde solution. In the laboratory the total volume was determined by displacement method. After removing the macroplankton, a minimum of 5 ml of zooplankton was sorted out into different groups and enumerated. The biomass as well as individual groups were estimated for 1000 m³ of water.

For the purpose of comparisons, the study area was divided into four latitudinal regions namely, region-1: 04°30'N to 10°N; region-2: 10°N to 15°N; region-3: 15°N to 20°N and region-4: 20°N to 23°N. The area west of 77°30'E was considered as eastern Arabian Sea and that east of it as Bay of Bengal. The shelf area mentioned in the paper is the area within the continental shelf and that beyond it is called as oceanic area. The three seasons recognized in the paper are premonsoon (February to May), monsoon (June to September) and postmonsoon (October to January). The samples collected between 0600 and 1800 hrs have been considered as day samples and those collected between 1800 and 0600 hrs as night samples. A total of 1086 zooplankton samples collected during cruises 1-44 have been analysed for the present study.

RESULTS

Quantitative abundance

The general observations made on the occurrence and abundance of the ostracods showed that numerically, they formed one of the major components of the zooplankton. Their average numerical density (no/1000 m³) in the EEZ and the contiguous seas which are under the present investigation has been 17395. While the average density for the eastern Arabian Sea alone was 24144, the average for the Bay of Bengal was 1369 which were equal to 95.36% and 4.64% respectively. When a comparison for the numerical abundance was made between the continental shelf and oceanic waters of the two sea areas separately it was found that though there was vast difference in number of ostracods between the two sea areas, the percentage of abundance in the shelf and oceanic waters was proportionately equal, being around 7:3.

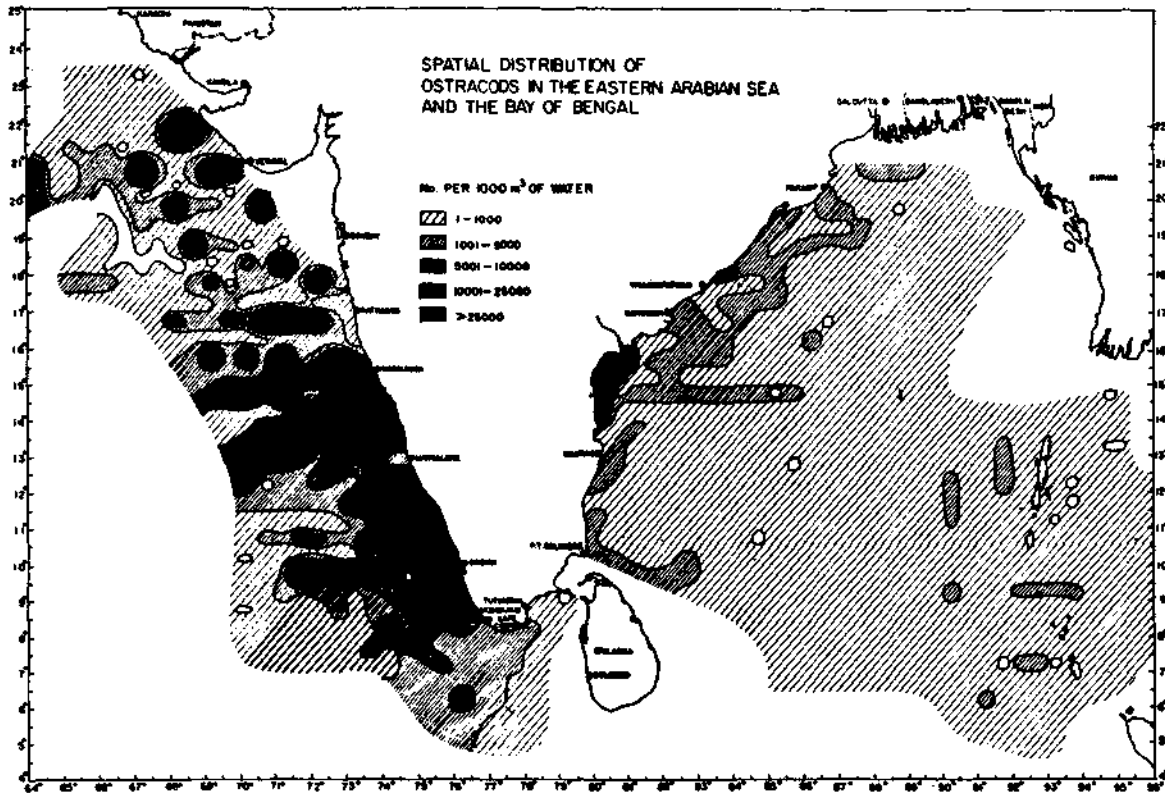


Fig.1- Spatial distribution of pelagic ostracods in the EEZ and contiguous seas of India

Spatial distribution

Considerable variations in the distribution and abundance of ostracods were seen spatially. Figure 1 illustrates the pattern of distribution in the eastern Arabian Sea and the Bay of Bengal. Although ostracods tended to be patchy in distribution in both the sea areas, they were in high densities along the southwest coast of India especially within the shelf area. Such high densities were noticed between Trivandrum and Quilon, Alleppey and Kasaragod and between north of Malpe and Goa. Other areas were not so rich except for small isolated areas off Ratnagiri, Tharapur, Veralval and Dwaraka.

Bay of Bengal was found to be less favourable for the development of ostracod population when compared to the eastern Arabian Sea. With a few exceptions, the abundance was very low and of uniform nature. Moderately high density in the shelf area especially off Krishnapattinam, Machilipatnam and off Kalingapatnam was noticed. The ostracod representation was found to be poor in the Andaman Sea.

Distribution in the shelf and oceanic areas

The ostracods were fairly very abundant in the shelf waters where the occurrence was 35526 which accounted for 79% of the total, whereas the occurrence in the oceanic area was 9446 only, the percentage equivalent of it being 21. Thus in general, a more than three-fold increase was seen in the shelf, which signifies the neritic nature of the ostracods.

There was vast difference in the rate of ostracod abundance in the shelf and oceanic areas of the west and the east coasts. When the shelf waters of the west coast contained ostracods 53059 similar area of the east coast had a population density of 2611 and indicating a 20 times increase for the west coast. Similarly a 17 times increase in the population density was experienced in the oceanic waters of the west coast in comparison to that of the same area in the east coast. The numerical density in the oceanic waters of the west coast was 15749 and for the east coast 924.

Monthly and seasonal variations in numerical abundance

The monthly variations in ostracod abundance worked out for the entire area of investigation (Arabian Sea and Bay of Bengal together) showed that September, with an average number of 61639/1000 m³ of water, accounted for the maximum. Generally speaking the period from June to December yielded the maximum when the number ranged from more than 10000 to around 62000 (Fig.2). The abundance between January and March was rather moderate with the population swinging between 2000 and 3000 individuals.

A monthwise projection of the data obtained separately for the eastern Arabian Sea and the Bay of Bengal is presented in Fig.3. Highest abundance was during September for both the seas, though there was no comparability in density of ostracods between the two (74254 in the Arabian Sea and 6486 in the Bay of Bengal). In general the months of June to December were the best for the ostracods of the eastern Arabian

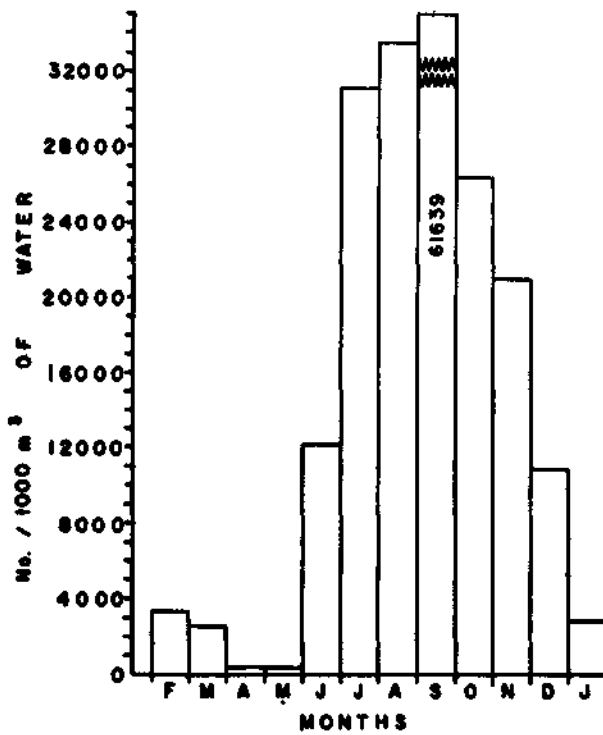


Fig.2 - Monthly variations in the abundance of pelagic ostracods

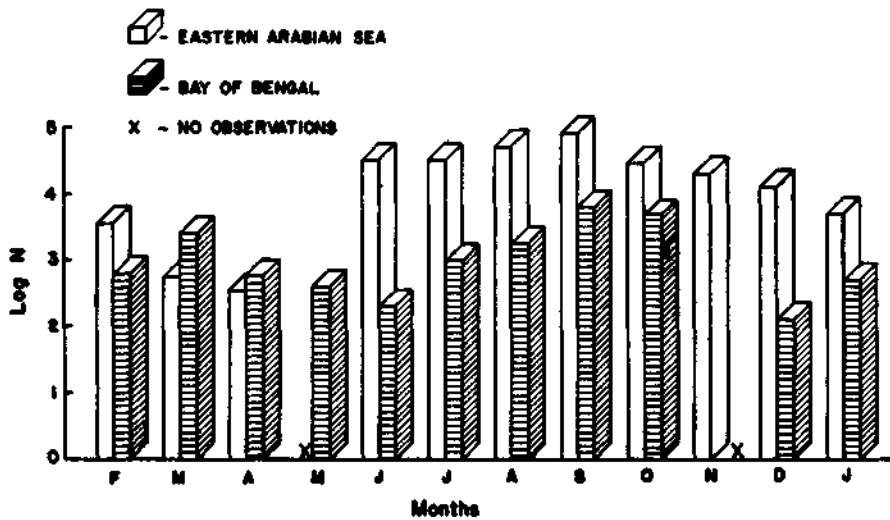


Fig.3 - Monthly coastwise variations in the abundance of pelagic ostracods

Sea whereas March, September and October were the favourable months in the Bay of Bengal. The least abundance off the west coast was during March and April (577 and 345 respectively) while it was during June and December in the Bay of Bengal.

When the 12 months were categorised into 3 seasons it was possible to get the seasonal variations in ostracod abundance. Of all the 3 seasons, the monsoon season with an average number of 33801/1000 m³ ostracods (68.14%) peaked followed by the postmonsoon season with an average of 14320 (28.87%). The least abundance was registered during the premonsoon when only 1482 (2.99%) ostracods were present. The monsoon abundance of ostracods in the Arabian Sea was phenomenal, the mean number being 48466. Relatively this season was the most favourable of the 3 seasons for these planktonic animals, for 73.25% of the total of 3 seasons was represented in this season.

The trend of seasonal variation in the Bay of Bengal was the same as that in the Arabian Sea but for the drastic reduction in the average seasonal values. The highest, of course, was registered during the monsoon period but the number was a mere 2385 (148.50%). The postmonsoon accounted 1956 which was equal to 29.87% of the total. The premonsoon yielded 1059 ostracods which was 21.57% of the total of 3 seasons. On the whole the southwest monsoon period was the best season for ostracods in the Bay of Bengal also. The premonsoon average number for both the sea areas was almost equal though there was marked variations in the percentage of abundance.

In the shelf waters the ostracods in comparison to that of the oceanic waters (Fig.4) during the 3 seasons were 62.58% during the premonsoon, 72.4% during the monsoon and 79% during the postmonsoon. Similarly in the oceanic waters a proportionate decrease in relation to the shelf waters was noticed, the values being 37.42%, 27.6%

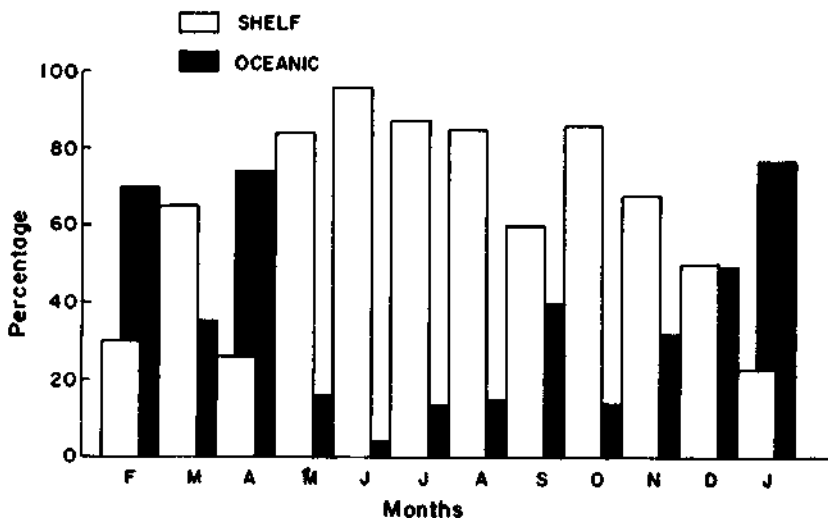


Fig.4 - Shelf and oceanic variations in the abundance of pelagic ostracods

and 21% during the respective seasons. The variations within the shelf during the 3 seasons were also worked out, the values being 2.68% during the premonsoon, 64.63% during the monsoon and 32.69% during the postmonsoon periods. In the oceanic area, the variations among the 3 respective seasons were of the magnitude of 4.48%, 68.78% and 26.75%.

Latitudinal distribution

Along the west coast it was found that the region between 10° and 15° N (Fig.5) was the most productive for the ostracods which had a population density of $61168/1000\text{ m}^3$ and this was 67% of the total ostracods present in the 4 latitudinal regions. The density of population in the other 3 regions was around 1000 with the minimum in region-1. Along the east coast the latitudinal region between 15° and 20° N with a population density of $2449/1000\text{ m}^3$ was the richest and this was equal to 46.13% of the total. The least abundance of 624 was in the second region.

A comparison between the two sea areas showed that the richest latitudinal region in the entire area was between 10° and 15° N in the Arabian Sea which accounted for 63.38% of the total population and that all the latitudinal regions of the Arabian Sea put together claimed 94.48% against the 5.02% in the Bay of Bengal.

Coastwise and regionwise seasonal distribution

To examine which of the 3 seasons contributed the maximum ostracods in the respective sea areas, the ostracod populations in each latitudinal region was further divided into 3 seasons. The results (Fig.6) showed that it was the southwest monsoon

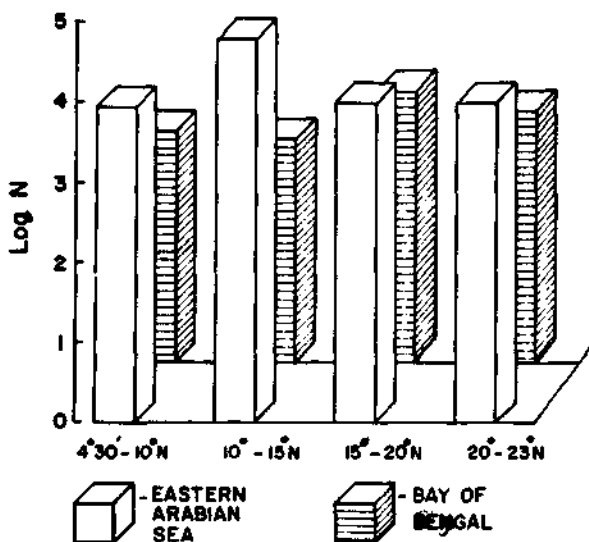


Fig.5 - Coastwise latitudinal variations in the abundance of pelagic ostracods

period which maximised the population density in all the latitudinal regions in both the sea areas except the region between 20° and 23°N. The density in the latitudinal region between 10° and 15°N during the monsoon season was 111564/1000 m³ which was the maximum of all the regions. On the other hand the monsoon maximum in the latitudinal region between 15° and 20°N in the Bay of Bengal was of the order of 7252/1000 m³.

An attempt was also made to understand the exact month in which a particular latitudinal sector contained the maximum number of ostracods. Thus it was found that

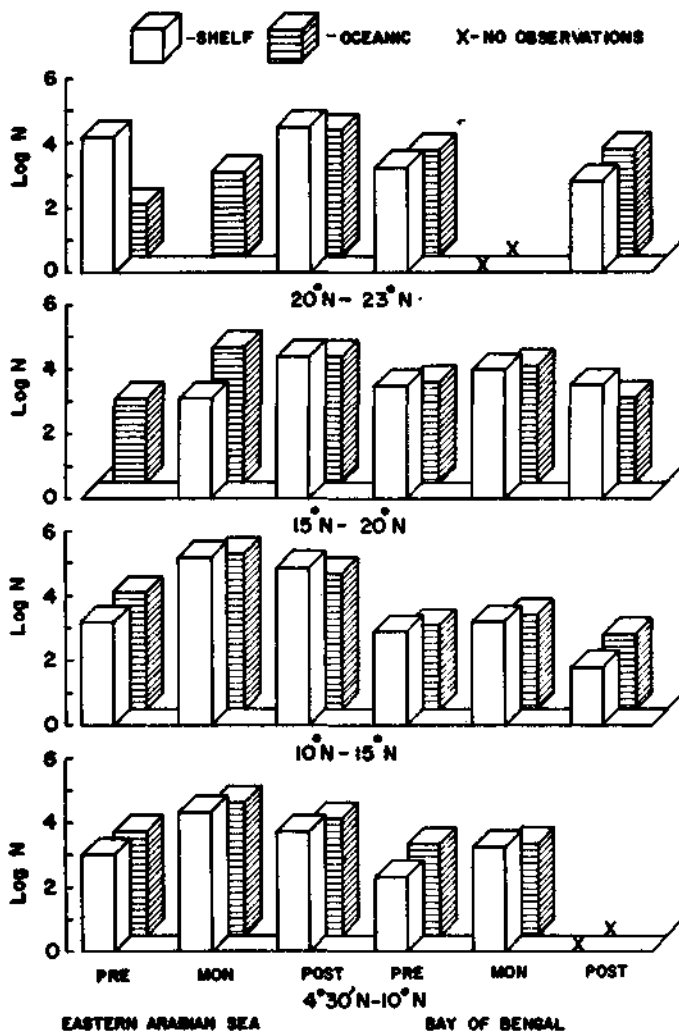


Fig.6 - Coastwise, latitudinal, seasonwise variations of pelagic ostracods in the shelf and oceanic waters

the month of September which is considered here as part of the southwest monsoon season (to say exactly the last month of this season) produced the maximum number, in the 2nd latitudinal region of the eastern Arabian Sea and the occurrence was 217739/1000 m³.

Day-night abundance

In view of the large number of samples during both day (654 samples) and night (427 samples) a comparison between the two for the ostracod abundance became possible for the entire area of investigation and in different situations. While 69.05% of the total ostracods collected was taken during night, the day samples took a share of only 30.95% thereby showing more than double the number of ostracods in the night samples. The result shows that the ostracods exhibit strong diurnal vertical migration in this tropical waters.

A further study of the day-night variations during the different months was carried out (Fig.7). In all the months except August, there was a nighttime abundance. In August 51% of ostracods were present in a day samples maximum nighttime increase by 89.8% was observed during September.

Seasonwise analysis of the day-night variations showed that while 67.1% of ostracods was present in the night samples during the premonsoon, 74.2% was present in the night samples of the monsoon season. However, such a drastic difference between the day and night samples was not observed during the postmonsoon season when the nighttime increase was by 60.1% over the day samples. The trend of nighttime increase was more or less the same in the shelf and oceanic areas, the increase being around 70%. A seasonwise analysis of the day-night variations showed

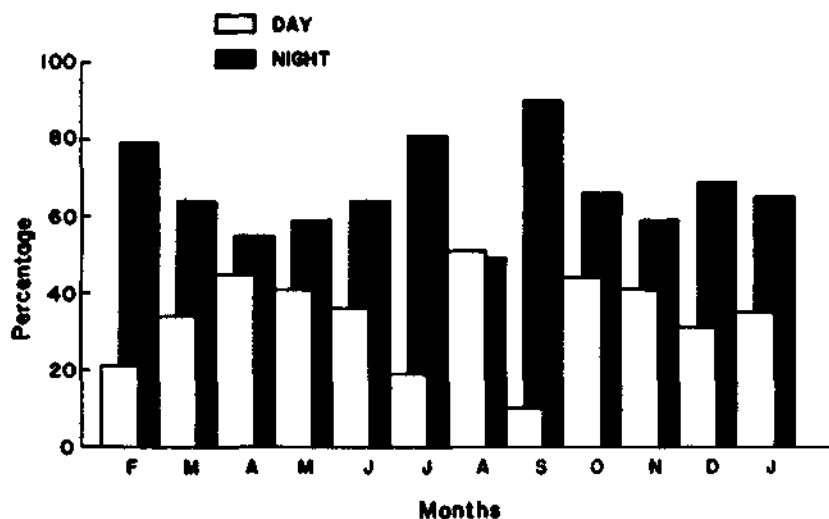


Fig.7 - Monthly day-night variations in the abundance of pelagic ostracods

a nighttime abundance by 67% over the day during the premonsoon season. During the monsoon season there was a 74% increase in the night samples. The night samples of the postmonsoon season contained only 60% of the total ostracods.

The diurnal variations in the 4 latitudinal regions were studied separately for the Arabian Sea and the Bay of Bengal. The most pronounced nighttime increase was noticed in the eastern Arabian Sea in the southernmost latitudinal region where 85% of ostracods was noticed during the night. In the 2nd latitudinal region between 10°-15°N, 65% of the ostracods was in the night samples. In the next northern latitude between 15°-20°N the nighttime increase was only by 57% and in the northernmost latitudes. The day samples contained more ostracods and the increase was by 59%.

Thus a gradual decrease of the nighttime abundance was noticed from south to north culminating in a daytime increase in the northernmost latitude. In the Bay of Bengal, on the other hand a daytime abundance was observed in the 1st, 2nd and the 3rd latitudinal regions. However, 78% of ostracods was present in the night samples in the northernmost latitudinal region.

DISCUSSION

The striking feature noticed during the present study was the uniformly high density of ostracods in all the areas of the eastern Arabian Sea than in the Bay of Bengal. The Arabian Sea accounted for 95% of the total ostracods. This kind of high density in the Arabian Sea, though not to the extent of ostracods, has been established in varying degrees for the zooplankton biomass (Mathew *et al.* 1990a) and for some of the major groups of zooplankters namely mysids, euphausiids, heteropods, pteropods (Mathew *et al.* 1990b,c,d), foraminifers, cladocerans (Naomi *et al.* 1990a,b), chaetognaths (Srinivasan, 1990), amphipods (Revikala *et al.* 1990), lucifer and larval gastropods (Geetha *et al.* 1990a,b). The congenial environmental factors for a high primary production has been attributed to this part of the Arabian Sea. In this sea area, the southwest coast between lat. 10° and 15°N is the richest being influenced by upwelling which is a contributing factor for the very high production at all the levels of the food web.

The swarming nature of ostracods was revealed on many occasions during the present study. Unusually high abundance to the level of a population explosion was noticed especially during September and October at several localities mainly in the shelf waters off the west coast such as between Trivandrum and Quilon, Alleppey and Kasaragod and between north of Malpe and Goa. Such population explosions were not observed in the Bay of Bengal. Similar population explosion of ostracods has been reported by Nair *et al.* (1973) from several localities in the Arabian Sea namely Karachi, Gujarat and Kerala where the numerical density of population exceeded 62500/1000 m³. According to them the number in the Bay of Bengal never exceeded 2500/1000 m³.

A study of the day-night variations in abundance revealed a pronounced vertical migration with these animals, being more in the night samples with a few exceptions in certain localities. Angel & Fasham (1975) who studied the distribution of ostracods of the northeast Atlantic found a slight daytime increase for these plankters. The reason for this could be attributed to the large vertical coverage of the sampling depth which reached up to 2000 m and this might have nullified the effect of the vertical migration which was performed well within the sampling depth and hence a day-night difference was not discernible. However, Louis *et al.* (1976) found that only 67% of the samples collected during the day-night hours contained ostracods compared to 91% during the night and they concluded that the depths sampled recruited more ostracods from greater depths during the night. Nair *et al.* (1973) though observed a nighttime abundance of ostracods in the Indian Ocean in general, a day-night variation in occurrence was not established in the Arabian Sea. However, no mention is made of the number of samples available for the study of diurnal variations in those areas where diurnal variation was not observed.

The month of September contributed the maximum number of ostracods. A significant day-night variation in abundance was noticed, being more in the night samples which once again confirmed the strong vertical up and down movement in the 0-150 m depth zone. More studies are to be made by correlating the ostracod abundance with the hydrographic parameters which could not be made during the present studies for want of data.

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