

**Proceedings of the
FIRST WORKSHOP ON SCIENTIFIC RESULTS OF
FORV SAGAR SAMPADA**

5-7 June, 1989, Cochin

Sponsored by

**DEPARTMENT OF OCEAN DEVELOPMENT
&
INDIAN COUNCIL OF AGRICULTURAL RESEARCH
NEW DELHI**

Organized by

**CENTRAL MARINE FISHERIES RESEARCH INSTITUTE
&
CENTRAL INSTITUTE OF FISHERIES TECHNOLOGY
COCHIN**

OCTOBER, 1990

Published by

Dr. P.S.B.R. JAMES

DIRECTOR

Central Marine Fisheries Research Institute

COCHIN - 682 031

Edited by

Dr. K.J. MATHEW

Central Marine Fisheries Research Institute

COCHIN - 682 031

STUDIES ON THE OCCURRENCE AND ABUNDANCE OF PLANKTONIC GASTROPODS OTHER THAN PETROPODS AND HETEROPODS FROM THE EEZ OF INDIA AND ADJOINING SEAS

GEETHA ANTONY, T. S. NAOMI AND K. J. MATHEW

Central Marine Fisheries Research Institute, Cochin - 682 031

ABSTRACT

The observations made during 1985- '88 between 4°30'N and 23° N lat. and 65°E and 96° E long. in the eastern Arabian Sea and the Bay of Bengal on the distribution and abundance of planktonic gastropods, other than pteropods and heteropods, at 1,086 stations sampled by FORV *Sagar Sampada* during her cruises 1-44 showed that they were present in 83% of the samples at an average density of 877 (number per 1000 m³). Their population density in the eastern Arabian Sea (1,137) was more than double that in the Bay of Bengal (489) and was distinctly higher in the shelf (1,059) than in the oceanic waters (797). The concentration of pelagic gastropods observed between 14° N and 20° N lat. in the eastern Arabian Sea was high, and that (1,65,349) encountered in a half degree square in the oceanic region off Karwar was the highest. The abundance was comparatively high from September to December in the eastern Arabian Sea and from February to March and during August in the Bay of Bengal. A comparison of the planktonic gastropod content in the samples collected during day with those taken at night showed that they were more abundant in the latter (1,290) than in the former (609) with an increase of 8% and 233% respectively in the shelf and oceanic waters.

INTRODUCTION

Marine gastropods, the largest and the most successful of all molluscs, have a thriving fishery in the seas around India and are much valued, for their ornamental shells, in religious rituals, in indigenous medicine, for the manufacture of lime and for the meat used as bait and to a very limited extent as food. The developmental stages of these benthic gastropods as well as a few isolated holoplanktonic gastropod genera other than pteropods and heteropods form occasionally a significant part of the plankton of the warm tropical seas around India. These planktonic gastropods were found to be an important food item for the planktivorous fishes (Rao, 1962; Kagwade, 1967; Desai, 1971).

Natarajan (1957) reviewed the information on the eggs and larvae of marine gastropods from the world oceans and studied the breeding season and larval development for 32 species of prosobranchs from the Palk Bay and the Gulf of Mannar. Prasad (1954), Mahadevan and Nayar (1966) and Siraimetan and Marichamy (1988) studied the seasonal occurrence of gastropod larvae in the Gulf of Mannar. Achuthankutty *et al.* (1980) estimated the numerical abundance of this planktonic fauna from 47 stations in the western Bay of Bengal. In the eastern Arabian Sea, the seasonal occurrence of

planktonic gastropods from the inshore waters of Karwar (Naomi, 1986), Calicut (Mukundan, 1967), Colachel (Suscelan *et al.*, 1985) and Vizhinjam (Rani Mary *et al.*, 1981) has been reported. Distribution map of meroplanktonic Gastropoda (IOBC, 1971) based on 1,548 samples from the Indian Ocean is the only available work with a wide coverage on the seasonal and spatial variations.

The planktonic gastropods other than the holoplanktonic pteropods and heteropods can be said to be the least studied component of the zooplankton compared to the wealth of information available on the distribution of adult gastropods along the Indian coasts (Jones, 1970; Rao, 1973; Nayar and Mahadevan, 1973; Nayar *et al.*, 1985; Sundaram, 1974; James, 1988; Devaraj and Ravichandran, 1988). The present study based on material from 1,086 stations collected by FORV *Sagar Sampada* in the shelf and oceanic waters of the eastern Arabian Sea, the Bay of Bengal and the Andaman Sea was undertaken to highlight the salient features of the spatial and temporal distribution of planktonic gastropods other than pteropods and heteropods.

MATERIALS AND METHODS

The studies were based on 1086 plankton samples collected since January, 1985 to March, 1988

in the area within 4° 30' N to 23° N lat. and 75°E to 95°E long. by oblique tows from 150 m to surface using a Bongo- 60 net (mesh aperture 0.33 mm), equipped with a calibrated flow meter. The average No. /1000 m³ per half a degree square pooled for 1985 - '88 was taken as the index of abundance with reference to area and time.

The faunal content of the eastern Arabian Sea (65° to 77° 30' E long.) is compared with that of the Bay of Bengal (77° 30' to 95° E long.). Latitudinal variations of the fauna between region I (from 4° 30' N to 10° N lat.), region II (10° N to 15° N lat.), region III (15° to 20° N lat.) and region IV (beyond 20° N upto 23° N lat.) in the eastern Arabian Sea and Bay of Bengal are compared. The Shelf region of the eastern Arabian Sea or the Bay of Bengal is compared with the respective oceanic region. Premonsoon (Feb. - May), Monsoon (June - Sept.) and postmonsoon (Oct. - Jan.) were the periods identified for comparing the variations between seasons. Samples collected from 0600 to 1800 hrs were taken as day samples and 1800 to 0600 hrs as night samples for studying the day - night variations in distribution.

OBSERVATIONS

Spatial distribution

The planktonic gastropods were present in 83% of the samples with an average density of 877 from the seas around India.

The fauna was found distributed as patches of varying densities over the area investigated with the greatest concentrations in the northern half of the eastern Arabian Sea between 14°N and 20°N latitude (Fig. 1). The mean concentration of this pelagic fauna encountered in a half degree area in the oceanic waters of Karwar was the highest (1,65,349). Their abundance was observed to range between 33,254- 59,487 in the high density pocket observed off Bombay. The group occurred in a continuous stretch from Karwar to Cape Comorin along the outer shelf spilling over to the adjacent oceanic waters with dense pockets off Mangalore, Calicut, Cochin, Alleppey and Vizhinjam-Cape Cormorin extending down to 5°N lat. A patch of fairly high density was observed in the region between 8°30'N and 11°N lat. around Lakshadweep.

In the Bay of Bengal, the density (11,356) observed at the head of the Bay was the highest. A similar dense area was observed off Tuticorin

(10,703) and comparatively high production occurred in the waters of the Gulf of Mannar. Fairly high density pockets were also encountered at the mouths of River Krishna (5,884) and Cauvery (2,191). Except for a narrow belt of moderate concentration off Andhra and Orissa coasts and a few isolated patches in the oceanic waters, their density was of low order in the central Bay.

In the Andaman Sea, moderate abundance of planktonic gastropods was observed with pockets of denser areas (2,500-2,800) between 9°N and 10°30'N lat. and to the west of the Great Nicobar Island.

Regionwise distribution in the eastern Arabian Sea and the Bay of Bengal

The population density of planktonic gastropods was higher in the four latitudinal regions of the eastern Arabian Sea than the corresponding regions of the Bay of Bengal (Fig. 2) with the maximum variation in their densities observed between 15°N and 20°N latitudes (1,731 and 501 respectively).

In the eastern Arabian Sea it is highly significant that a progressive increase in the number of planktonic gastropods was observed from the southern (mean density of 759 and 882 in the region from 4°30'N to 10°N lat. and from 10°N to 15°N lat. respectively) to the northern latitudes (mean density of 1,423 in the region from 20°N to 23°N lat.) with the major concentration confined between 15°N and 20°N latitudes (1,731).

In the Bay of Bengal the highest concentration of planktonic gastropods was observed in the northernmost region beyond 20°N lat. (1,171). A drastic reduction in their population density was observed south of 20°N lat. (501 in the region from 20°N to 15°N lat. and 323 in the region from 15° to 10°N lat). However, their abundance between 10°N and 4°30'N lat. (554) was highest than those of the regions between 20°N and 10°N latitudes.

Monthly variations in the seas around India

The monthly variations in abundance for the total area surveyed showed that the fauna was present throughout the year in the seas around India (Fig. 3). From the lowest number (171) observed in July, their abundance increased steadily from August to reach the maximum number (4,580) in November. Their abundance was moderate from January (515) to May (493).

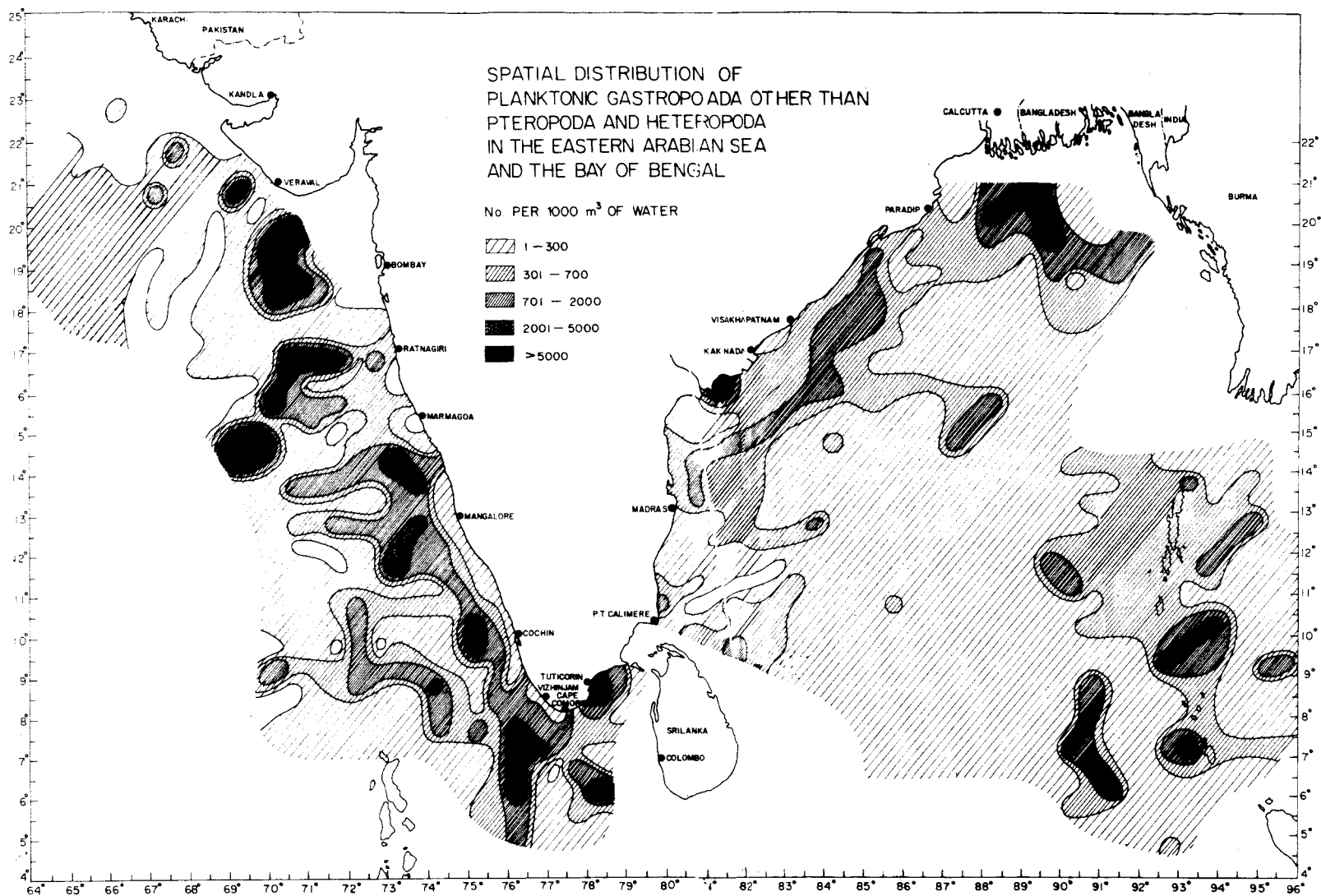


Fig. 1. Spatial distribution of planktonic Gastropoda other than Pteropoda and Heteropoda in the eastern Arabian Sea and the Bay of Bengal.

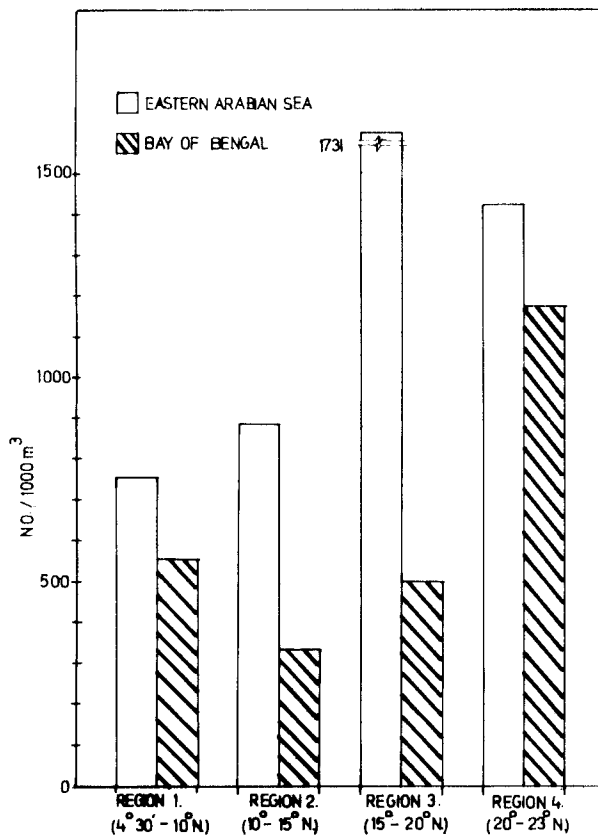


Fig. 2. Regionwise distribution in the abundance of planktonic gastropods other than pteropods and heteropods in the eastern Arabian Sea and the Bay of Bengal.

Monthly variations in the eastern Arabian Sea and the Bay of Bengal

The density of planktonic gastropods was observed to be 40% more in the eastern Arabian Sea than in the Bay of Bengal, (Fig. 4) with an average concentration of 1,137 and 489 respectively.

In the eastern Arabian Sea the numerical abundance of gastropods which showed a steady increase from September reached the maximum in November while in the Bay of Bengal the primary peak noticed in March was followed by a secondary peak in August. The least abundance of the group was observed in April in the eastern Arabian Sea and in June in the Bay of Bengal.

It was observed that in the eastern Arabian Sea the abundance of planktonic gastropods started to increase as the intensity of the southwest monsoon decreased and attained the maximum during the postmonsoon season. In the Bay of Bengal, their concentration which was observed to increase as the

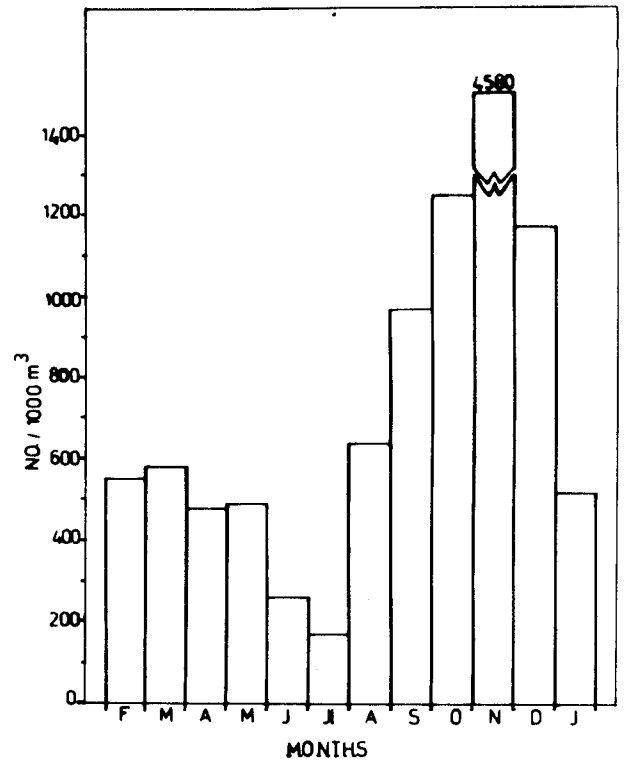


Fig. 3. Monthly variations in the abundance of planktonic gastropods other than pteropods and heteropods in the seas around India.

intensity of the northeast monsoon decreased reached the maximum soon afterwards. The increased abundance observed in August was just after the peak of the southwest monsoon.

Monthly variations in the shelf and oceanic areas of the seas around India

Planktonic gastropods were found to be more abundant in the shelf (1059) than in the oceanic waters (797) with a 14% increase in their density in the shelf over that of the oceanic waters (Fig. 5).

It may be seen that in the shelf waters the increase in their abundance from August reached the maximum in October (2,549) whereas in the oceanic waters an unprecedented population outburst (5,769) occurred in November in contrast to their sparse distribution (< 574) observed during the rest of the months.

In the shelf as well as the oceanic waters, the abundance of planktonic gastropods was the maximum during the postmonsoon season while a lowering of their number was evident during the monsoon season.

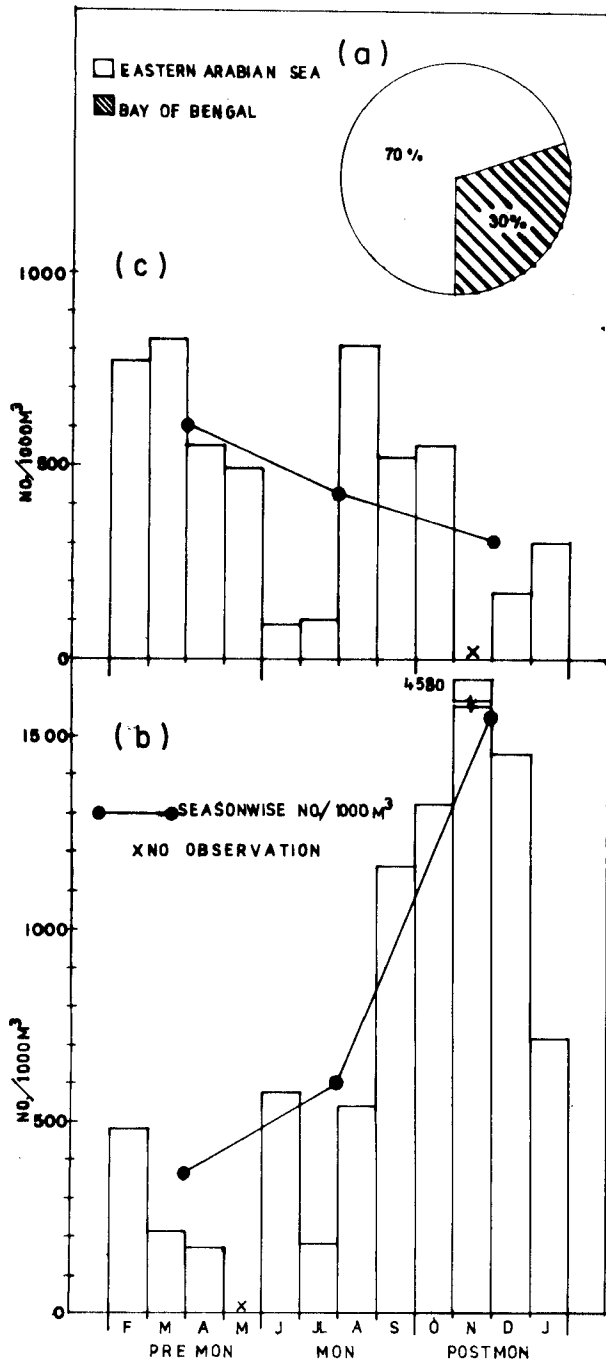


Fig. 4. Abundance of planktonic gastropods other than pteropods and heteropods in the eastern Arabian Sea and Bay of Bengal (a) Relative abundance, Monthly and seasonal variations in (b) the eastern Arabian Sea and (c) the Bay of Bengal.

Monthly variation in the shelf and oceanic waters of the eastern Arabian Sea and the Bay of Bengal

In the eastern Arabian Sea greater abundance of the pelagic fauna occurred during September

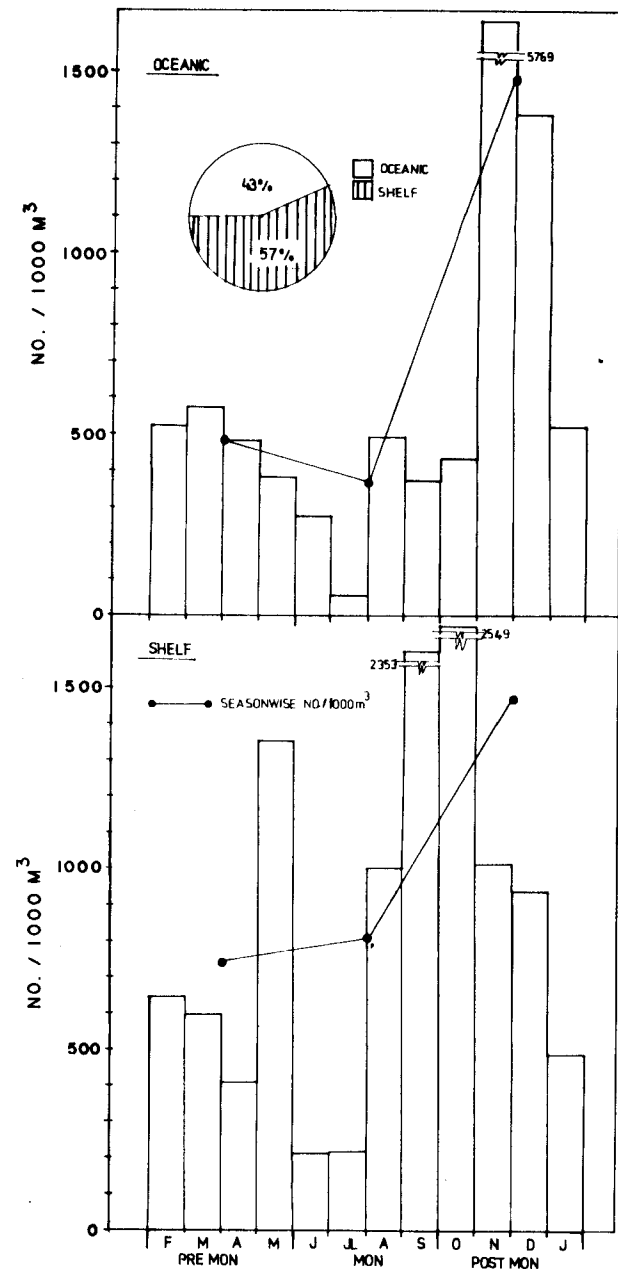


Fig. 5. Monthly and seasonal variations in the abundance of planktonic gastropods other than pteropods and heteropods in the shelf and oceanic waters of the seas around India.

(3,636) - October (3,267) in the shelf waters (Fig. 6). A population outburst of the group occurred in November (5,770) in the oceanic waters, where increase in abundance was also observed during December and June. For the remaining part of the year there was not much variation in their concentration between the shelf and the oceanic waters.

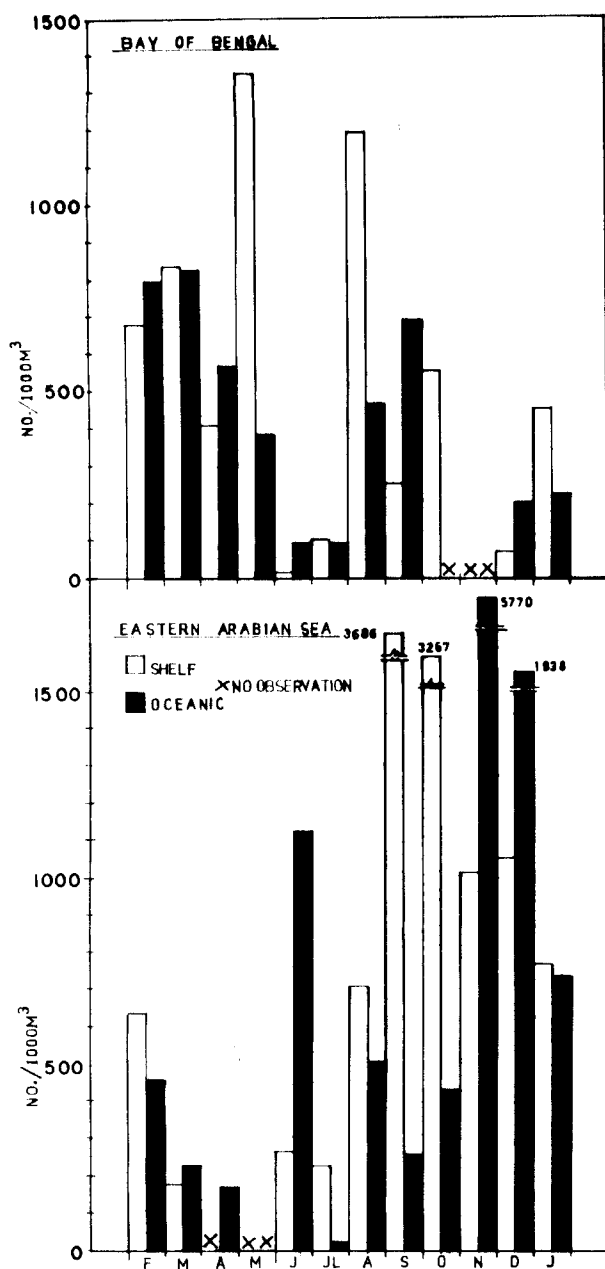


Fig. 6. Monthly variations in the abundance of planktonic gastropods other than pteropods and heteropods in the shelf and oceanic waters of the eastern Arabian Sea and the Bay of Bengal.

In the Bay of Bengal, variations in the abundance of planktonic gastropods between the shelf and the oceanic waters were discernible only during May and August when their concentration fluctuated between 1,352 and 384, and 1,196 and 467 respectively.

Latitude-wise seasonal distribution in the shelf and oceanic waters of the eastern Arabian Sea and the Bay of Bengal

A comparison of the population densities of planktonic gastropods between the shelf and oceanic waters in the eastern Arabian Sea (mean number 1,268 and 1,072 respectively) and the Bay of Bengal (mean number 667 and 426 respectively) showed that they were 18.3% more in the shelf than in the oceanic waters in the eastern Arabian Sea whereas in the Bay of Bengal their concentration was 56.6% more in the shelf than in the adjacent oceanic waters (Fig. 7). In the eastern Arabian Sea, variation in the density of the fauna between the shelf and the oceanic waters increased from south to north and was found most significant beyond 20°N lat., where the density of the fauna was 90% more in the shelf waters than the adjacent oceanic waters whereas in the Bay of Bengal this variation was considerable only in the region between 4°30'N and 10°N lat. where the shelf fauna was 70% more than the oceanic fauna.

In the eastern Arabian Sea, throughout the four latitudinal regions, the planktonic gastropods observed in lesser abundance during the premonsoon season, increased during the monsoon season to reach the maximum during the postmonsoon season. During the premonsoon season, the abundance of the fauna was found to decrease from the south to the north in the four latitudinal regions (mean number of 1,096, 892, 193 and 105 respectively observed in the shelf together with the adjacent oceanic waters). Their abundance in the shelf was higher than that of the oceanic waters in the four latitudinal regions. During the monsoon season, even though there was a shift in the increased abundance from the shelf to the oceanic waters between 4°30'N and 15°N lat., an increasing trend in abundance in the four latitudinal regions from the south to the north was evident (mean number of 912, 963, 2,160 and 1,794 respectively in the shelf together with the adjacent oceanic waters), the highest concentration confined in the region between 15°N and 20°N latitudes in the shelf waters (1,987). The increase in abundance from south to north was most significant during the postmonsoon season when the density of planktonic gastropods observed in the shelf together with the adjacent oceanic waters between 4°30'N and 10°N lat. 2,565 increased to 3,288 between 10°N and 15°N lat. and to 3,928 between 15° and 20°N lat. reaching the

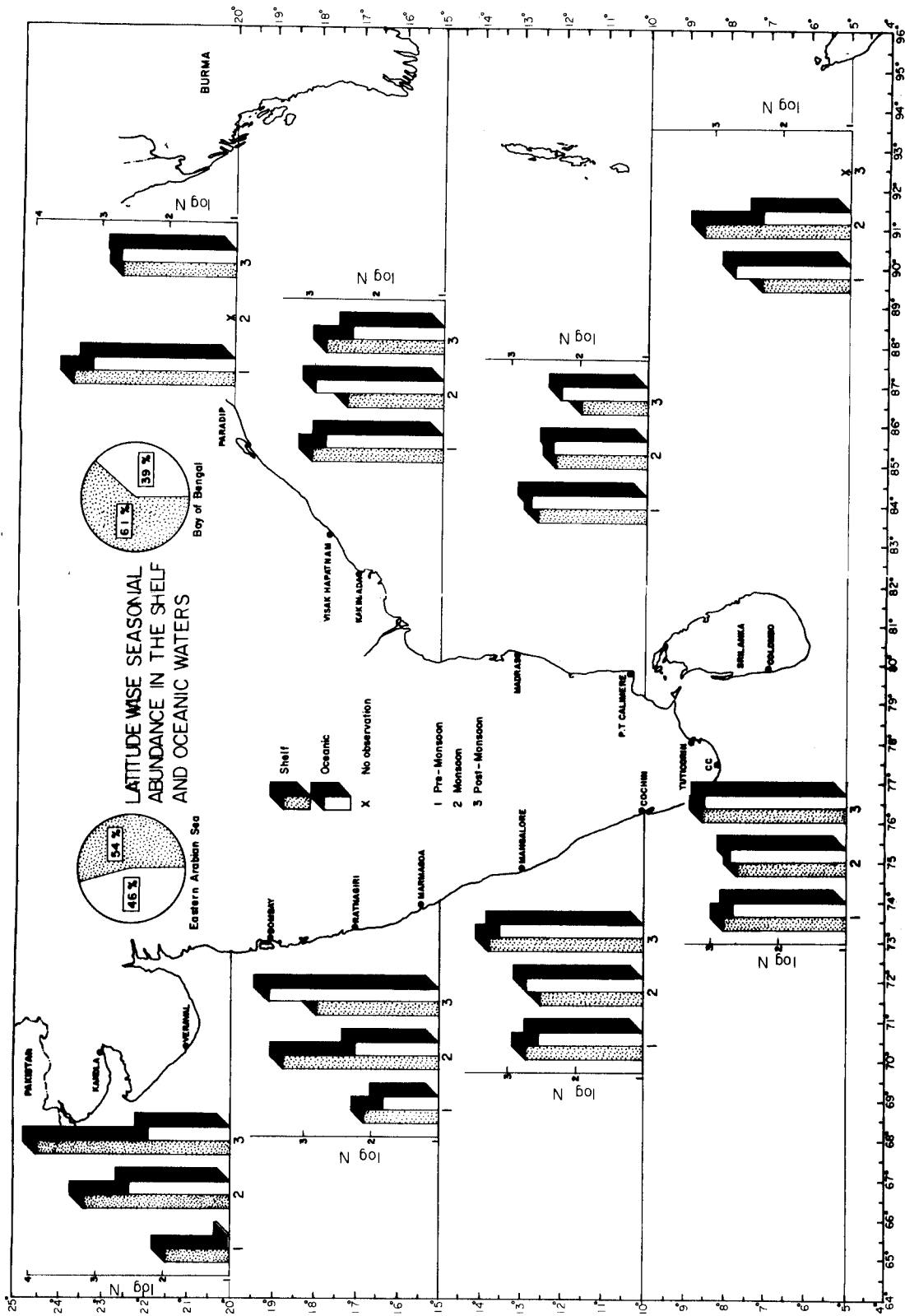


Fig. 7. Latitude-wise seasonal abundance of planktonic gastropods other than pteropods in the shelf and oceanic waters of the eastern Arabian Sea and the Bay of Bengal.

maximum of 7,614 beyond 20°N lat. During the postmonsoon season the fauna was found more in the shelf than in the oceanic waters in the three latitudinal regions other than the region between 15°N and 20°N lat., where the concentration encountered was more in the oceanic than in the adjacent shelf waters.

In the Bay of Bengal, planktonic gastropods was observed in high abundance during the pre-monsoon season in the latitudinal regions above 10°N increasing from the south to the north (895 and 1,408 in the shelf together with the adjacent oceanic waters between 10°-15°N and 15°-20°N lat. respectively) with the maximum concentration above 20°N lat. (3,683). While the abundance of the fauna was found moderate during the monsoon season between 20°N-15°N lat. and 15°N-10°N lat. (1,030 and 459 respectively), their concentrations in these regions (755 and 272 respectively) as well as in the region above 20°N lat. (972) was considerably reduced during the postmonsoon season, the least numbers being observed in the shelf waters between 15°N and 10°N lat. (91). In the region between 10°N and 4°30'N lat. the abundance of planktonic gastropods was found high during the monsoon season (1,587) than the premonsoon season (667) with higher concentrations in the shelf (1,397) than the adjacent oceanic waters (190).

Day - night variations in abundance

The number of stations sampled for this study in the area investigated during the day time was 659 and in the night 427. The mean number of planktonic gastropods observed in the day samples was 609 and in the night samples 1,290 (32 and 68 % respectively) thereby showing an increase of 112 % in their density at night than during day (Fig. 8 a). In the eastern Arabian Sea, the number of stations sampled during day and night were 392 and 258 with a mean concentration of 761 and 1,743 respectively (30 and 70 %) thereby showing an increase of 129 % in their abundance during night than during day (Fig. 8 b). In the Bay of Bengal, the mean number of planktonic gastropods observed from 267 samples during day was 361 and from 169 samples at night was 693 (34 and 66 % respectively) thus showing a 92 % increase in their occurrence in the night samples than the samples collected during day time (Fig. 8 c).

Monthly variations in the area investigated showed that the planktonic gastropod content of the

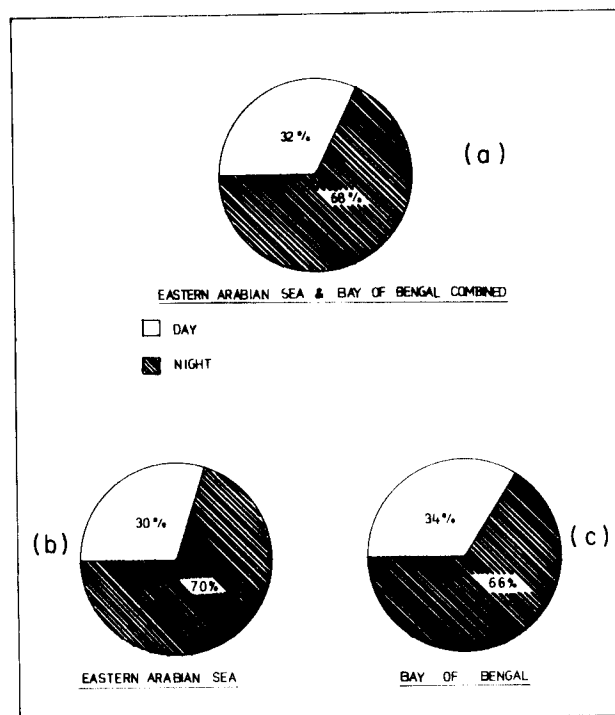


Fig. 8. Variations in the abundance of planktonic gastropods other than pteropods and heteropods during day and night.

night samples was higher than that of the day samples in all the months except September (Fig. 9a). The maximum day-night variation was observed during November when 82.7% of the total gastropods was present in the samples collected during night time.

While a marginal increase in abundance in the day samples was observed than that in the night samples (550 and 529 respectively) during the monsoon season (Fig. 9 b) their abundance in the samples at night was higher than at day during the post-monsoon (2,478 and 848 respectively) and the premonsoon (753 and 375 respectively) seasons.

The concentration of planktonic gastropods collected during day and at night from the oceanic waters in the seas around India (mean number of 408 and 1,358 from 446 and 309 stations sampled during day and night respectively) showed an increase of 233 % in their density at night than during day whereas in the shelf waters (mean number of 1,113 and 1,029 from 118 night and 213 day stations sampled respectively) the increase in the abundance at night was only 8 % more than that during the day (Fig. 10 a).

The variation in monthly abundance of planktonic gastropods collected during day and night in

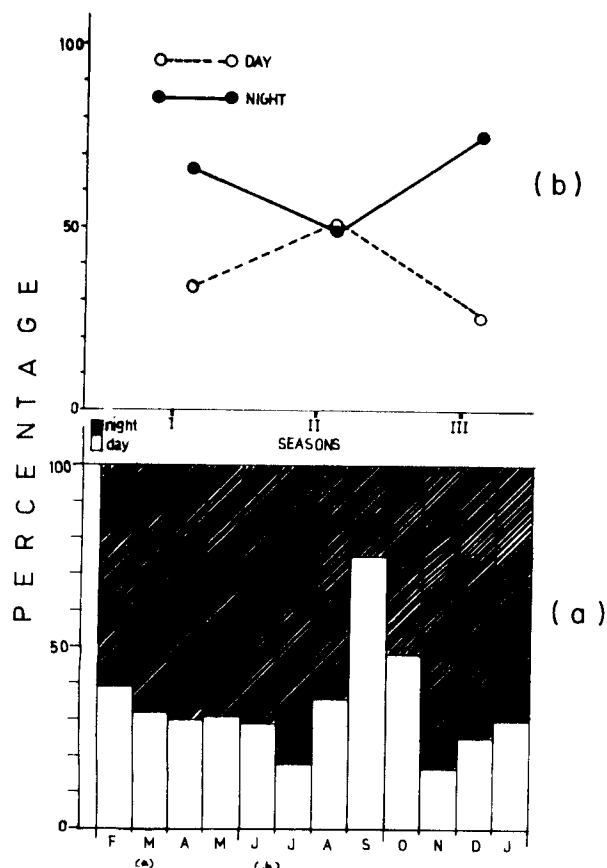


Fig. 9. Monthly and seasonal variations during day and night in the abundance of planktonic gastropods other than pteropods and heteropods in the area investigated.

the shelf and oceanic waters (Fig. 10 b) shows that the concentration of these animals collected during the night time was markedly higher in the oceanic waters from September to January with the maximum variation observed in December (mean number of 3,039 and 360 in the day and night samples respectively) and in the shelf waters from March to August and in November with considerable variation observed in May (2,381 and 322) as well as in November (1,813 and 214). Their abundance in the samples collected in the day was more than that at night during September and December (98 % and 57 % of the total respectively) in the shelf waters and in July (66 % of the total) in the oceanic waters.

Seasonal variation in the abundance of planktonic gastropods during day and at night in the shelf and oceanic waters of the seas around India (Fig. 10c) shows that the concentration of these organisms far exceeded in the night time than at day during the premonsoon and postmonsoon seasons. While the concentration of the fauna was distinctly higher in

the night time than at day in the shelf waters during the premonsoon season, (1,451 and 363) the difference was not as conspicuous as during the postmonsoon season in the oceanic waters (2,880 and 533). During the monsoon, higher concentration was observed in the samples collected in the day time (904) than at night (634) from the shelf whereas in the oceanic region their abundance in the samples of the night time (465) showed marginal increase than those of the day (302).

DISCUSSION

Estimates of the numerical abundance of planktonic gastropods from the seas around India

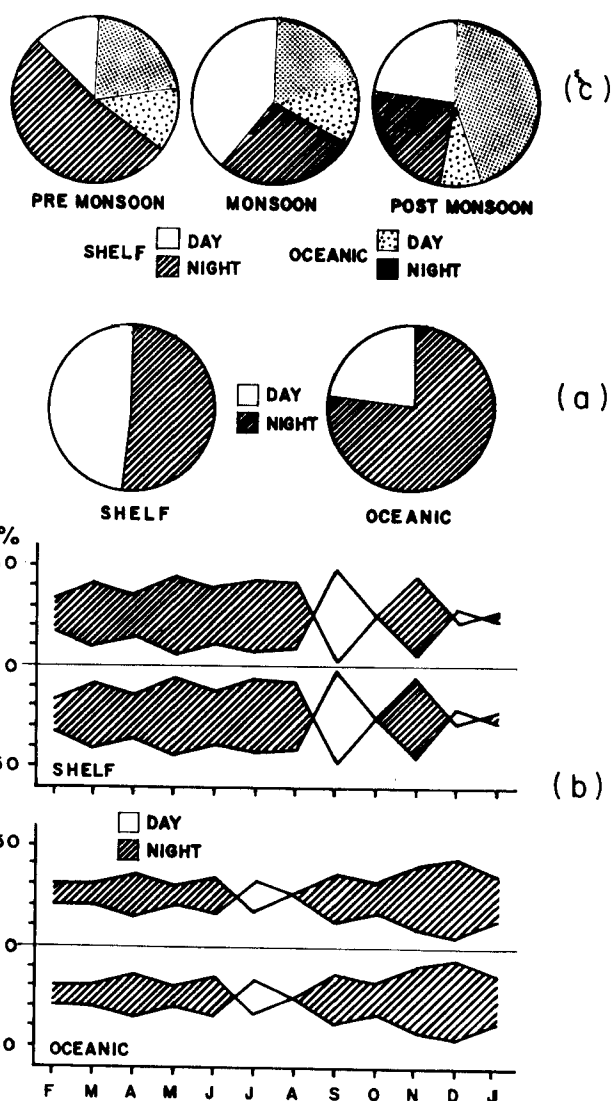


Fig. 10. Day - night abundance of planktonic gastropods other than pteropods and heteropods in the shelf and oceanic waters a) In the seas around India b) Monthly variations c) Seasonal variations.

show considerable patchiness in the faunal distribution (Fig. 1), in conformity with earlier reports (IOBC, 1971; Panikkar and Rao, 1973). The present study shows that the population density of planktonic gastropods was distinctly higher in the eastern Arabian Sea than in the Bay of Bengal with the maximum abundance occurring between 14°N and 20°N latitudes. Though the abundance of this pelagic fauna was reported to be high along the whole of the southwest coast of India (Rao, 1973) during the present investigations they were found to be concentrated more along the outer shelf and the adjacent oceanic waters (Fig. 1), whereas in the Bay of Bengal, the density of these larvae was very high in the shelf waters between 20°N and 21°N latitude and in the Gulf of Mannar waters. It was moderately high at the river mouths of Krishna and Cauvery and also in small pockets around the Andaman Sea. Dense occurrence of planktonic gastropods had been reported in the Gulf of Mannar (Prasad, 1954), at the head of the Bay (Rao, 1973) and between Pondicherry and Point Calimere (Achuthankutty *et al.*, 1980).

Planktonic gastropods were found throughout the year in the seas around India, with definite seasonal fluctuations in abundance (Fig. 2). The marine gastropods are known to have a protracted breeding period in the warm seas (Raymont, 1983) with specific period of intense activity (Natarajan, 1957; Mahadevan and Nayar, 1966; Rajagopal *et al.*, 1981).

In the eastern Arabian Sea, the planktonic gastropods flourished during September - December with the peak abundance occurring in November but were in small numbers during March- April and July (Fig. 4). In general, gastropod larvae were less abundant in the premonsoon season throughout the four latitudinal regions but the shelf always contained more of these organisms particularly in the region between 4°30'N and 10°N lat. (Fig. 7). During the monsoon season, the population density of the group increased more both in the shelf and the contiguous oceanic areas and the concentration observed was the highest in the former between 15°N and 20°N lat. The overall abundance of the pelagic fauna reached the maximum during the postmonsoon season especially in the shelf waters around 20°N lat. and the oceanic area between 15°N and 20°N lat. was also densely populated during the same season. Reports on the seasonal abundance of the larval gastropods in the coastal waters

of the eastern Arabian Sea indicate that the fauna abound in the waters off Calicut during the summer months (Mukundan, 1967), off Trivandrum from December to April (Prasad, 1954), off Vizhinjam during February, August and November (Rani Mary *et al.*, 1981), off Colachel in March and December (Suseelan *et al.*, 1985) and off Karwar during March, May and December (Naomi, 1986).

In the Bay of Bengal, planktonic gastropods occurred in large number during February- March and August and the least was observed during June- July and December (Fig. 4c). Figure 7 shows that while the concentration north of 10°N lat. was the highest in the shelf waters during the premonsoon season (February - May) with the maximum concentration occurring beyond 20°N lat., the abundance was high during the monsoon season (June - September) in the region south of 10°N lat. In the Gulf of Mannar, Prasad (1954) reported the occurrence of gastropod larvae throughout the year with two peak spawning seasons, one in March-April and the other around August. Natarajan (1957) observed peak breeding for most of the groups during January-March and July- August. In the same region, Siraimetan and Marichamy (1988) observed that the larval gastropods exhibited two distinct modes; the first during February- April and the second during September- December and that in certain years the fauna was prominent during June - July also.

The present studies reveal that the density of planktonic gastropods is rather low during the warmest months as well as at the peak of the monsoons in the eastern Arabian Sea and the Bay of Bengal. However, soon after the peak of the monsoon, the lowering of salinity probably triggers spawning in many species of gastropods with the result that the spawned products were found in increased abundance during the latter half of the monsoon to reach the peak abundance noticed during the postmonsoon season. The dominance of veligers during the period of low salinity had been reported off Goa by Goswami and Selvakumar (1977).

The regions remarkable for the dense concentration of the gastropod larvae as observed in the eastern Arabian Sea, Andaman Sea and in the western Bay of Bengal excluding the northern Bay beyond the Godavari river mouth are well known for their rich fishing grounds of the adult gastropods (Jones, 1970; Rao, 1973; Nayar and Mahadevan,

1973; Nayar *et al.*, 1985; Sundaram, 1974; Devaraj and Ravichandran, 1988; James, 1988). Planktonic gastropods are reported to be feeding mainly on microalgae (Richter, 1987). Areas of higher concentrations of planktonic gastropods in the seas around India are also regions enriched by upwelling or land drainage followed by high phytoplankton productivity as reported for the high abundance of euthecosomatous gastropods in the Indian Ocean by Sakthivel (1969).

Qasim (1977) observed that the Arabian Sea is far more productive than the Bay of Bengal and that the regions of maximum primary production are along the southwest coast of India. In the eastern Arabian Sea, upwelling starts in May, continue through the southwest monsoon and reach the peak in August/September (Anon., 1976). The standing crop of phytoplankton is reported to be high along the coast off Trivandrum from January onwards and the maximum is attained in May, and at Calicut and further north it is during July- August (Subrahmanyam, 1973). Sukhanova (1962 a, b) recorded regions of fairly high concentrations of phytoplankton between 15° and 19°N lat. and 70°-75°E long. during the north east monsoon and Zernova and Ivanov (1964) reported rich phytoplankton in the northwest Indian Ocean north of 12°N lat. during October - December.

At different centres of north western Bay, upwelling had been reported to occur during January - June (La Fond, 1954; Varadachari and Sharma, 1967; Sankaranarayanan and Reddy, 1968) and the maximum standing crop of phytoplankton during February - April (Ganapati and Murty, 1955; Ganapati and Subba Rao, 1958) whereas in the southern part of the Bay of Bengal, phytoplankters are rich during the southwest monsoon, about 2 - 2.5 times more than that of the northeast monsoon (Sukhanova, 1964). Nair *et al.*, (1973) observed higher values of primary production in the inshore waters of the Gulf of Mannar and the palk Bay region during June - July.

It is observed that the seasonal fluctuations in the abundance of planktonic gastropods (Fig. 7) clearly follow the primary maxima of the phytoplankton production, which is reported to move from north (in February) to south (in June) direction along the east coast and from south (in January) to north (in September) along the west coast (Nair and Copinathan, 1981).

The larval gastropods were found to be more abundant in the shelf waters than in the oceanic waters (Fig. 5). Thorson (1940) is of the opinion that the pelagic development of the prosobranchs of the world oceans is restricted to the shelf and it was found to be the highest in the shelf areas of the tropics. Mahadevan and Nayar (1974) attributed great significance to the presence of a large amount of food materials and calcium content in the surrounding waters for the growth of chank larvae. The increased concentration of planktonic gastropods in the continental shelf may be due to the increased productivity of the shelf as already discussed.

It may be seen that an unprecedented population outburst occurred in the oceanic waters during November- December (Fig. 5 a & b) in the eastern Arabian Sea. Legendre and Demers (1984) suggested that the zooplankton maxima need not be the result of *in situ* grazing and growth but can be due to physical transport and behavioural aggregation. Menon and George (1977) reported that along the west coast of India, north of Kasaragod (12°30'N), the biological cycle is influenced not only by upwelling alone but also due to the influence of the environmental regime in the northern Arabian Sea, particularly the current system. Investigations of the Pelagic Fishery Project indicated the existence of a convergence zone, where the heavier Arabian Sea water sinks below the north flowing low salinity equatorial surface water during the early part of the northeast monsoon. The position and intensity of the convergence zone showed large variations from year to year and was located in 1974 between Karwar and Ratnagiri (Anon., 1976). Thorson (1950) was of the view that many tropical macroplanktonic species have long planktonic life and refers (Thorson, 1961) to certain gastropods of which the larvae grow into relatively large veligers with greatly hypertrophied lobes that appears to be truly adapted for trans-oceanic passage. Natarajan (1957) has observed in the Gulf of Mannar many gastropod veligers with well developed velum and having a long planktonic phase. Mileikovskiy (1966), Scheltema (1968) and Scheltema and Williams (1983) have reported meroplanktonic larvae of many gastropod spp. transported over long distances by currents. It seems logical to conclude that the presence of very high density pockets of planktonic gastropods observed in the eastern Arabian Sea between 14°N and 20°N latitudes may be due to

transport by currents, further leading to a mechanical concentration in the convergence zones as suggested by Vinogradov and Voronina (1962).

The planktonic gastropod content in the samples collected at night far exceeded that of the day time in the eastern Arabian Sea and in the Bay of Bengal (Fig. 8). Monthly variations showed that this pelagic fauna was abundant throughout the year in the night samples except in September and the maximum encountered at night was in November (Fig. 9). The day- night variation in the abundance was marginal in the shelf waters but was conspicuous in the oceanic area (Fig. 10 a). Though the figure shows only a marginal variation in the shelf waters, Fig. 10 c shows that during the premonsoon season their abundance at night was distinctly higher than in the day. In the oceanic region the gastropod content in the night samples was higher than that of the day almost all through the year and a remarkable increase was observed during the postmonsoon season with the maximum occurring in December (Figs. 10 b & c).

The distinct variations in the abundance of the samples collected during day and at night indicate that the planktonic gastropods undergo vertical migration and avoid surface layers during day time. It is highly significant that the only variation noticed in this vertical migration was during September in the shelf waters when a greater percentage of these organisms was present in the day samples. Gastropod veligers being voracious phytoplankton feeders, their ascend at night may be for feeding on phytoplankton generally most abundant at 75 m (Humphrey and Kerr, 1969). The very high surface productivity in the shelf waters during September may be the reason for the higher concentration of the fauna in the day time.

ACKNOWLEDGEMENTS

We are thankful to Dr. P. S. B. R. James, Director, CMFRI for his keen interest shown in this work. Our thanks are also due to Dr. K. S. Scariah and Shri P. P. Pavithran for the help rendered in the computer analysis of the data.

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