

PLANKTON COMPOSITION IN THE COASTAL WATERS BETWEEN JAIGARH AND RAJAPUR ALONG WEST COAST OF INDIA

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ABSTRACT

Diatoms dominated the phytoplankton population in the Konkan coastal waters. *Rhizosolenia* spp., *Ceratulinia* sp., *Ditylum* spp., *Navicula* sp. and *Thalassiothrix* spp. were the dominant diatoms observed in this area. Blue-green algae and flagellates were moderately represented in the collections. Dinoflagellates were observed to be poor in this region. The area south of Ganapathipule was relatively rich in zooplankton and the highest biomass recorded off Ratnagiri was 55.6 ml/100m³. Copepoda, Mollusca, Decapoda, Chaetognatha, Tunicata and fish eggs and larvae were the major groups in the zooplankton population. The highest secondary production values were obtained off Ratnagiri and the average production for the Konkan coastal waters was found to be 262.32 mgC/100 m³. Abundance of bivalve and decapod larvae in the coastal waters indicate the potential fishery resources of these groups in the central west coast of India.

INTRODUCTION

Although considerable work on the primary productivity of the Indian coastal waters have been carried out, reports on the distribution of phytoplankton are very few. While Dehdrai and Bhargava (1972) have studied the distribution of phytoplankton in the waters of the central west coast of India, Pant, Bhargava and Goswami (1976) have studied the total phytoplankton and Devassy Bhattathiri and Qasim (1979) have reported the succession of phytoplanktonic organisms following *Trichodesmium* bloom in the coastal waters of Goa. Bhargava, Selvakumar and Singhal (1973) have studied the seasonal abundance of plankton components in the coastal waters of the central west coast of India in relation to ecology. The earlier studies on zooplankton in the Indian waters have been reviewed by Panikker and Rao (1973). Recently, Menon and George (1977), Menon, Gupta, Hariharan, Katti and Shetty (1977), Peter, Iyer, John and Radhakrishnan (1977), Paulinose and Aravindakshan (1977), Nair (1978), Nair, Peter and Paulinose (1978) have studied the zooplankton distribution along the west coast of India. While Qasim (1977) has estimated the biological productivity at different trophic levels in the Indian Ocean, Qasim, Wafar, Sumitra-Vijayaraghavan, Royan and Krishnakumari (1978) have assessed the production at primary, secondary and tertiary levels in the coastal waters of India. The Konkan

coast which contributes a good share to the total fish landings of the west coast of India, has not been studied in detail for primary and secondary productivity. In this paper the phyto- and zooplankton distribution, composition and zooplankton production during the premonsoon season in the coastal waters between Jaigarh and Rajapur are given.

MATERIAL AND METHODS

Observations were made during March-April, 1979 at 5, 10, 15 and 20 m isobaths from 9 transects, namely, Jaigarh, Undi, Tiwri, Ganapathipule, Kalbadevi, Mirya, Ratnagiri, Pavas and Rajapur covering a distance of about 80 km (Fig. 1). Hydrographical parameters such as temperature, salinity and dissolved oxygen content of surface water were estimated at all stations. Phytoplankton samples were collected from surface water, fixed in lugols iodine and preserved in 3% formaldehyde. The sedimented samples were later analysed for phytoplankton composition. A H. T. net (0.25 m² mouth area, 300 μ m mesh) attached with a flow meter was used for surface zooplankton collections. Biomass was estimated as displacement volume and aliquots were analysed for zooplankton composition. The study area has been divided into 4 zones, namely, Zone-1 (Jaigarh), Zone-2 (Undi, Tiwri and Ganapathipule), Zone-3 (Kalbadevi, Mirya and Ratnagiri) and Zone-4 (Pavas and Rajapur) for presenting the hydrographic data and distribution of phytoplankton components. However, the distribution of zooplankton biomass and major groups have been given for the entire area without classifying into zones.

RESULTS

Hydrography

Zone-wise range and average values of temperature, salinity and dissolved oxygen content of surface water are given in Table I. A gradual increase in the distribution of temperature and salinity from north to south was seen. However, at zone-3, these values were slightly higher (31.09°C and 36.09‰ respectively) than in zone-4 (30.7°C and 36.07‰ respectively). In the case of dissolved oxygen content, the highest value (5.39 ml/l) was recorded in zone-2 and the lowest (3.79 ml/l) at zone-1.

Table I. Range of temperature, dissolved oxygen and salinity of surface water in different zones. Figures in parenthesis indicate average values.

Parameters	Zone-1	Zone-2	Zone-3	Zone-4
Temperature (°C)	27.0 (27.0)	27.0-27.5 (27.1)	30.2-32.0 (31.09)	30.0-31.5 (30.7)
Salinity (‰)	35.44-36.54 (35.99)	35.79-35.89 (35.85)	36.05-36.20 (36.09)	36.01-36.15 (36.07)
Oxygen (ml/l)	3.78-3.80 (3.79)	4.87-5.83 (5.39)	4.56-5.47 (4.99)	3.93-4.90 (4.58)

Phytoplankton composition and distribution

Zone-wise distribution of major phytoplankton components are tabulated in Table II (average cell counts or filaments/litre). In general, diatoms dominated the phytoplankton population in all the zones although the blue-green alga, *Trichodesmium erythraeum*, formed a substantial percentage of the total phytoplankton (21.65%, 18,625 filaments/l) in zone-3. A mixed diatom bloom was observed at zone-2, chiefly constituted by *Chaetoceros* spp. (2,03,318 cells/l), *Eucampia* sp. (30,000 cells/l), *Navicula* sp. (13,705 cells/l) and *Rhizosolenia* spp. (13,568 cells/l). In zone-4, on the other hand, a bloom of *Chaetoceros* spp. alone was observed which formed 90.98% (2,96,250 cells/l) of the total phytoplankton population. *Rhizosolenia* spp. was the dominant species of diatom at zone-3 (15,625 cells/l) although some

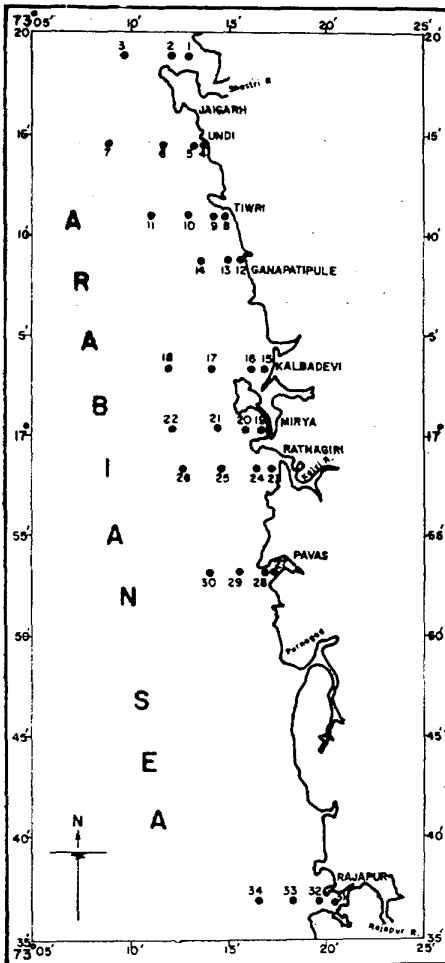


Fig. 1. Map showing station positions.

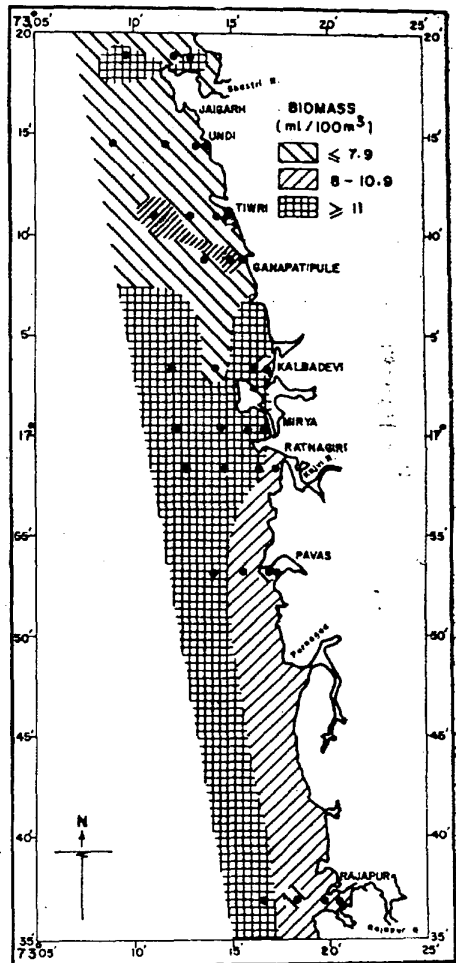


Fig. 2. Distribution of zooplankton biomass.

unidentified species of diatoms formed 40.23% (34,375 cells/l). *Ceratulinia* sp., *Ditylum* spp., *Navicula* sp. and *Thalassiothrix* sp. were the other diatoms distributed in small numbers in this area. Flagellates (green algae) were distributed in moderate quantities at all the zones. *Peridinium* spp. and *Prorocentrum* spp. (dino-flagellates) were poorly distributed in all the zones.

Zooplankton biomass and composition

Based on the zooplankton biomass distribution, the area under investigation could be divided into two distinct areas, namely, a relatively rich area south of Ganapathipule (≥ 11 ml/100 m³) and a poor area north of Ganapathipule (≤ 7.9 ml/100 m³) (Fig. 2). However, the nearshore waters between Ratnagiri and Rajapur fell within the moderate range (8–10.9 ml/100 m³). Isolated patches of moderate and high zooplankton biomass were also observed in the area north of Ganapathipule. The highest biomass value of 55.6 ml/100 m³ was recorded at 20 m station of Ratnagiri transect and the lowest value of 4 ml/100 m³ was at 15 m station of Undi and Ganapathipule transects. Copepoda, Decapoda, Chaetognatha, Mollusca, Tunicata, fish eggs and larvae were the major groups constituting the zooplankton population.

Copepoda—This was the most dominant group in all the samples. Their distribution in the area north of Ganapathipule was generally moderate (10,000–49,999/100 m³). However, a large patch of high and poor distribution was also seen in this area. They sustained high density in area south of Ganapathipule

Table II. Average counts (cells or filaments/l) of dominant phytoplankton components at different zones. Figures in parenthesis indicate percentage to the total count of the respective zone.

Phytoplankton components	Zone-1	Zone-2	Zone-3	Zone-4
<i>Ceratulinia</i> sp.	—	2182 (0.69)	750 (0.87)	—
<i>Chaetoceros</i> spp.	750 (7.62)	203318 (64.02)	1500 (1.75)	296250 (90.98)
<i>Coscinodiscus</i> spp.	1333 (13.55)	2386 (0.75)	1375 (1.60)	656 (0.20)
<i>Ditylum</i> spp.	166 (1.70)	682 (0.21)	—	—
<i>Eucampia</i> sp.	—	30900 (9.50)	—	—
<i>Navicula</i> sp.	1166 (11.90)	13705 (4.34)	875 (1.02)	3750 (1.15)
<i>Nitzschia</i> spp.	1417 (14.40)	9682 (3.06)	3063 (3.58)	1781 (0.54)
<i>Rhizosolenia</i> spp.	166 (1.70)	13568 (4.30)	15625 (18.28)	3188 (0.97)
<i>Thalassiothrix</i> sp.	1083 (11.04)	1500 (0.47)	—	—
Other diatoms	1000 (10.16)	30409 (9.63)	34375 (40.23)	4219 (1.29)
<i>Peridinium</i> spp.	417 (4.23)	750 (0.23)	2063 (2.41)	2063 (0.63)
<i>Prorocentrum</i> spp.	166 (1.70)	68 (0.02)	1063 (1.24)	281 (0.08)
Other dinoflagellates	166 (1.70)	68 (0.02)	750 (0.87)	750 (0.23)
Flagellates	2000 (20.33)	8727 (2.76)	4125 (4.82)	10031 (3.13)
<i>Trichodesmium erythraeum</i>	—	—	18625 (21.65)	1500 (0.46)
Other green and blue-green algae	—	—	1438 (1.68)	1125 (0.35)

($\geq 50,000/100\text{ m}^3$) (Fig. 3). Their maximum number was observed at station 19 (4,41,748/ 100 m^3) and minimum at station 7 (6,460/ 100 m^3).

Decapoda—Decapod larvae were distributed in moderate quantities (1000–4,999/ 100 m^3) around Jaigarh. The area south of Jaigarh to Kalbadevi was observed to be comparatively poor in decapod larvae while south of Kalbadevi they occurred in large numbers ($\geq 5,000/100\text{ m}^3$) (Fig. 4). Station 26 recorded their highest number (49,722/ 100 m^3) and station 4 recorded their lowest number (60/ 100 m^3).

Chaetognatha—This group sustained relatively higher density between Rajapur and Mirya ($\geq 1000/100\text{ m}^3$), moderate between Mirya and Tiwri (500–999/ 100 m^3) and poor north of Tiwri ($\leq 499/100\text{ m}^3$) (Fig. 5). Their occurrence, however, was less in the nearshore waters between Pavas and Kalbadevi. A large patch of higher

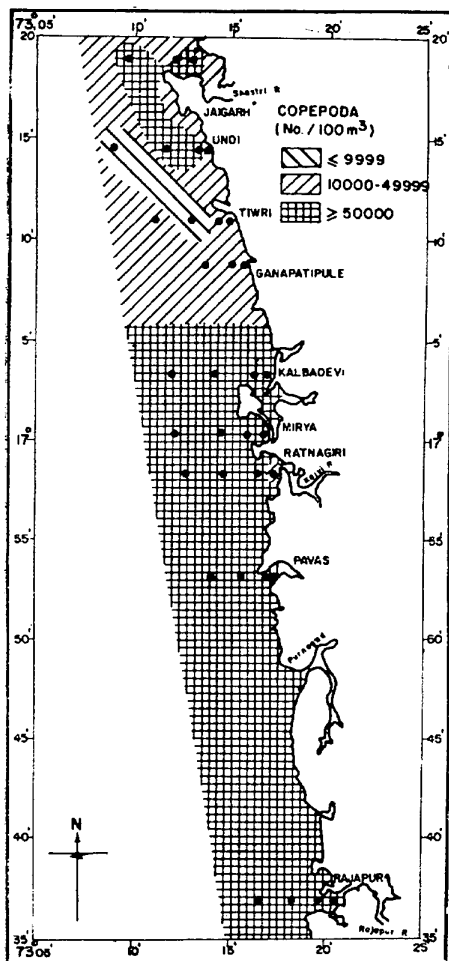


Fig. 3. Distribution of Copepoda.

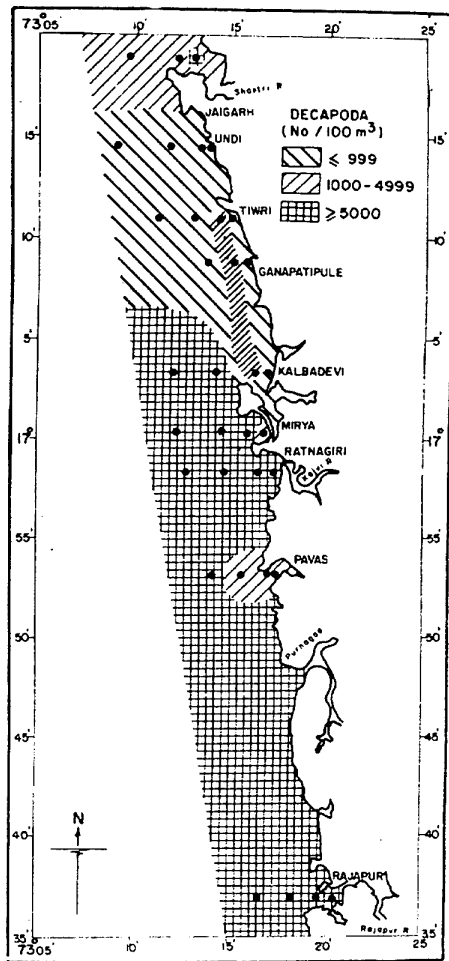


Fig. 4. Distribution of Decapoda.

abundance was noted in Jaigarh area, and incidentally, Station 3 recorded their maximum number (12,838/100 m³). Their lowest recorded number was 27/100 m³ at Station 4. *Sagitta enflata* and *S. bedoti* were the dominant species and *S. robusta* was distributed in small numbers at a few stations.

Mollusca—This group was chiefly constituted by juveniles of bivalves. The other representatives of this group were a few pteropods and juveniles of gastropods. They formed the second abundant group of zooplankton after Copepda in the present study. They occurred abundantly ($\geq 5,000/100\text{ m}^3$) in the nearshore waters between Undi and Mirya. They were moderately abundant (1,000–4,999/100 m³) in the offshore waters north of Mirya. Nevertheless, isolated patches of low density ($\leq 999/100\text{ m}^3$) were also observed in this region (Fig. 6). Their maximum

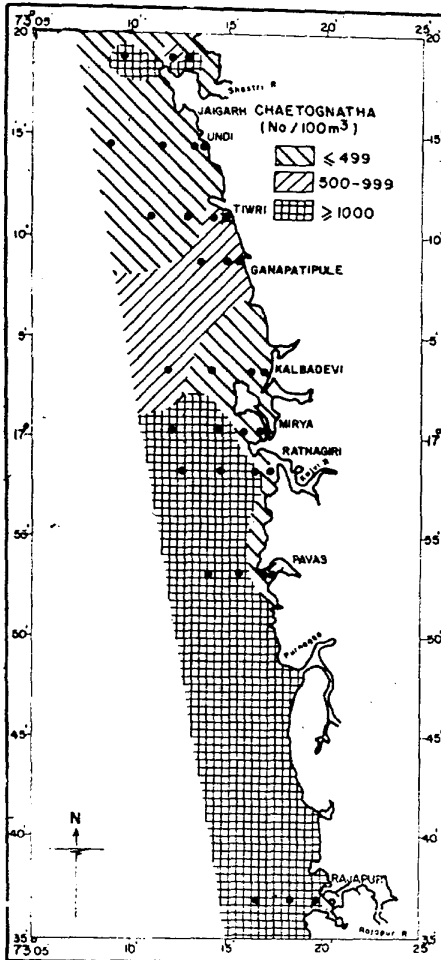


Fig. 5. Distribution of Chaetognatha.

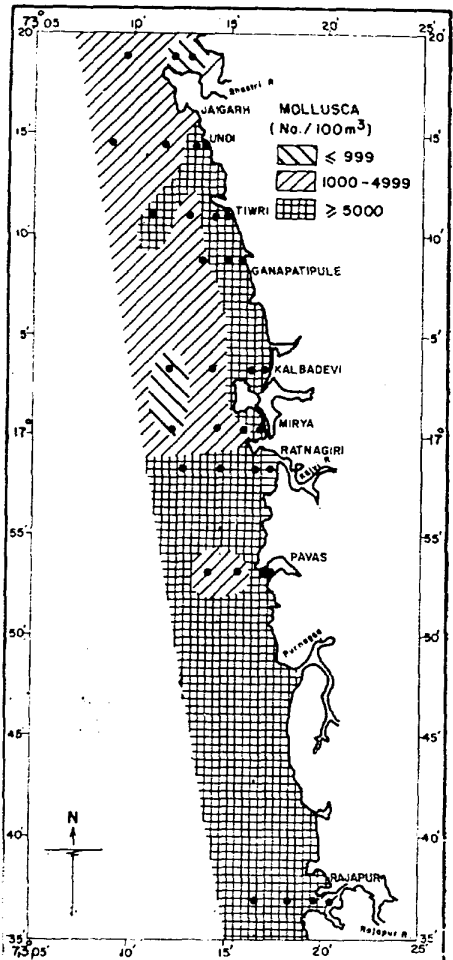


Fig. 6. Distribution of Planktonic Mollusca.

number was recorded at station 26 ($1,49,167/100\text{ m}^3$) and minimum at station 22 ($500/100\text{ m}^3$).

Fish eggs and larvae—Their number was very less in the samples. However, the area south of Kalbadevi sustained relatively higher density (Fig. 7). Between Kalbadevi and Ratnagiri, their distribution towards the coast was either poor ($\leq 99/100\text{ m}^3$) or moderate ($100-499/100\text{ m}^3$). A prominent patch of higher abundance was seen at Jaigarh area ($\geq 500/100\text{ m}^3$) and poor representation was observed around Undi transect.

Tunicata—Pelagic tunicates (copelates, doliolids and salps) were also present in small numbers. Their relatively higher abundance ($\geq 500/100\text{ m}^3$) was noted between

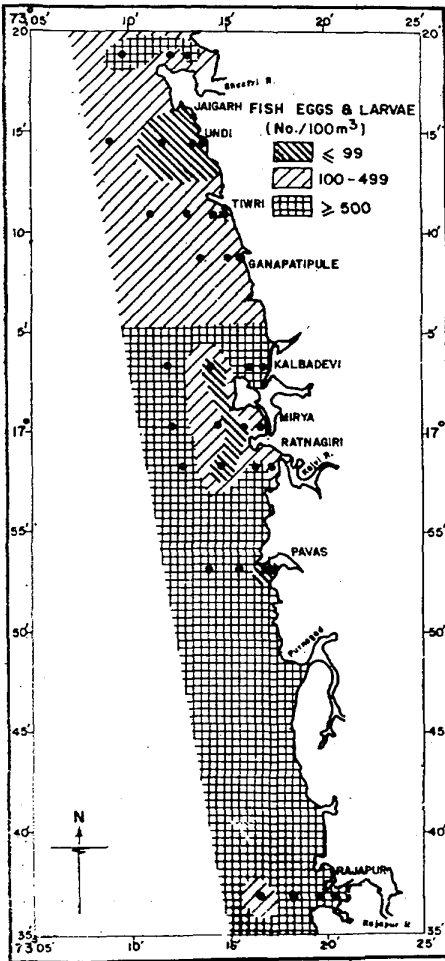


Fig. 7. Distribution of fish eggs and larvae.

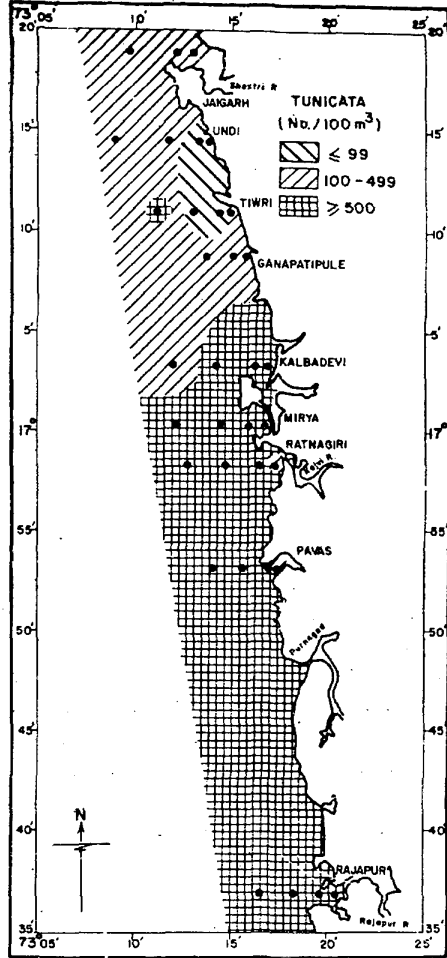


Fig. 8. Distribution of pelagic tunicates.

Kalbadevi and Rajapur and were moderate ($100-499/100\text{ m}^3$) in the area north of Kalbadevi (Fig. 8).

Other groups—Polychaetes, cladocerans, cirripede nauplii, euphausiids, mysids, stomatopods, ostracods, amphipods, isopods, hydromedusae and ctenophores together formed only a small percentage of the total zooplankton population. Of these, cladocerans and cirripede nauplii were present only in zones-3 and 4. In zone-3, cladocerans formed 5.23% ($11,440/100\text{ m}^3$) of the total zooplankton count.

Zooplankton production

Zooplankton production ($\text{mg C}/100\text{ m}^3$) of each transect was calculated from the average biomass ($\text{mg dry wt}/100\text{ m}^3$) (Nair, 1980) and tabulated in Table III. It could be seen from the table that the highest zooplankton production was observed at Ratnagiri ($604.36\text{ mg C}/100\text{ m}^3$) followed at Jaigarh ($328.85\text{ mg C}/100\text{ m}^3$) and the lowest production at Undi ($113.20\text{ mg C}/100\text{ m}^3$). The average zooplankton production for the coastal waters of Konkan coast was found to be in the order of $262.32\text{ mg C}/100\text{ m}^3$.

Table III. Mean zooplankton volume, dry weight and carbon content in different regions of the Konkan coast.

Area	Volume ($\text{ml}/100\text{ m}^3$)	Dry. wt. ($\text{mg}/100\text{ m}^3$)	Carbon content ($\text{mg}/100\text{ m}^3$)
Jaigarh	15.4	953.26	328.85
Undi	5.3	328.07	113.20
Tiwri	9.0	557.10	192.20
Ganapathipule	6.6	408.54	140.95
Kalbadevi	10.9	677.85	233.86
Mirya	13.8	854.22	294.71
Ratnagiri	28.3	1751.77	604.36
Pavas	10.6	656.14	226.37
Rajapur	10.6	656.14	226.37

DISCUSSION

The present investigation was carried out during the premonsoon season when the environmental parameters of the coastal waters of the west coast of India are known to have high values and stability. There was an increase in temperature and salinity values towards the southern part of the study area although oxygen values did not follow any particular pattern.

The phytoplankton population was dominated by diatoms in this area. A mixed diatom bloom observed in zone-2 (Table II) was almost similar to the one reported from the coastal waters of Goa during this season (Devassy, Bhattathiri and Qasim, 1979). A bloom of the diatom *Fragilaria oceanica* has also been reported from the coastal waters of Mangalore during the premonsoon season (Devassy, 1974). But these diatoms blooms were of a higher magnitude in nature than the present one. *Trichodesmium erythraeum* which is reported to be an important phytoplankton component of the coastal waters of west coast of India and manifest to bloom situation during the premonsoon season (Devassy,

Bhattathiri and Qasim, 1978), occurred in large numbers only in zone-3 and was completely absent in the first two zones.

Attainment of high zooplankton biomass in the coastal waters of central west coast of India during the late premonsoon season coincides with the temperature peak (Bhargava, Selvakumar and Singhal, 1973). The present result is also in agreement with this. However, they did not observe any relationship between phyto and zooplankton population and suggested that the diatom population may be succeeded by zooplankton population.

A direct relationship has been established between zooplankton biomass and pelagic fisheries of the Indian coastal waters (Prasad, 1969; Nair, Peter and Paulinose, 1978). The present findings are in agreement with the above observation as the pelagic fish landings of the Konkan coast is high where zooplankton was also found to be rich.

Abundance of bivalve juveniles in the zooplankton population in the in-shore waters between Undi and Mirya and almost the entire area south of Mirya is an indirect evidence of their potential fishery resources in this area. This may also indicate their intense spawning activity during this period.

Cladoceran swarms are known to have a positive influence on the mackerel fishery of nearby areas (Selvakumar, 1970). Incidentally, the region between Kalbadevi and Ratnagiri (zone-3) is a rich mackerel ground where the cladoceran population was found to be relatively high (11,440/100 m³, 5.23%).

Species diversity of chaetognatha was very less in the coastal waters of the Konkan coast. Of the three species encountered, only *S. enflata* and *S. bedoti* were distributed relatively abundantly and *S. robusta* was observed only at a few stations in very small numbers.

Meroplanktonic groups such as decapod crustacean larvae and molluscan juveniles form a very dominant component of zooplankton population of the coastal waters of the Konkan coast. In other words, the zooplankton biomass of this region is to a large extent, depending on the abundance of meroplanktonic groups which in turn is an indication of the fishery potential of these groups in this area.

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