

PLANKTON BIODIVERSITY OF DHARAMTAR CREEK ADJOINING MUMBAI HARBOUR.

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ABSTRACT : Marine biodiversity is highest in the coast rather than the open sea as there is a greater range of habitat near the coast. Contemplating on this the phytoplankton and zooplankton diversity of Dharamtar creek, a vital system adjoining the Mumbai harbour were assessed to obtain baseline information. A total of 58 genera of phytoplankton were encountered from the area which included 46 diatoms, 6 dinoflagellates and 6 other algae. Variation in phytoplankton cell count was enormous ($17-5980 \times 10^3 l^{-1}$) with an average cell count of $266 \times 10^3 l^{-1}$. The phytoplankton community was dominated by diatoms (97.6%) followed by dinoflagellates (2%) and other algae (0.4%). Blooms of *Skeletonema* and *Peridinium* were respectively observed during October – November and December. Shannon and Weaver's diversity index H' ranged from 0.29 - 3.6 (av. 2.42) while Margalef's D varied from 1.4-4.93 (av. 2.96).

Zooplankton population density varied between 3091 & 1723786/100m³ (av. 126986/100m³). Copepods formed the largest group of zooplankton population (71.9%) comprising 46 species belonging to 23 genera. Calanoid copepods were the predominant species. Diversity index H' for copepods ranged between 0.4 and 3.4 (av. 2.54) whereas D varied from 0.35 to 2.09 (av. 1.13). Decapods largely constituted by larval stages formed the second largest group of zooplankton (11.4%). Brachyuran larvae predominated among the decapods. Swarming of *Lucifer* was observed in November at outer zone. Chaetognaths contributed 8.3% to the zooplankton population. 3 species of chaetognaths were found in the area and *Sagitta bedoti* was the true inhabitant. Other groups of zooplankton formed 8.4% of the zooplankton population and were represented by coelenterate medusae, siphonophores, ctenophores, platyhelminths, polychaetes, cladocerans, ostracods, mysids, cumaceans, isopods, amphipods, stomatopods, crustacean naupli, pygogonids, molluscs, echinoderms, tunicates, fish eggs and fish larvae.

In general, Dharamtar creek sustains a rich plankton community. However, recent industrial development along the banks of creek may pose the problem due to waste disposal into this creek system. Losses of marine life diversity are largely the results of conflicting uses, in particular coastal habitat which leads to degradation of habitats. The best way to conserve biodiversity is to protect habitat diversity which requires periodic monitoring of this creek system in order to compare with the baseline for checking the loss of biodiversity.

Key Word : Plankton biodiversity : dharamtar creek

INTRODUCTION

Information on plankton biodiversity around the coast of Mumbai is meagre. Variation in seasonal composition of plankton for the Mumbai harbour was reported by Gonzalves (1947). Earlier studies on zooplankton are mostly confined to Mumbai harbour. The study of plankton from polluted and unpolluted environment included a few locations off Bombay (Gajbhiye, 1982; Ram, 1985). Later an extensive study of plankton from Mumbai harbour – Thana – Bassein system was carried out by Lodh (1990). Dharamtar creek, the estuarine complex of Amba river is a major estuarine system opening into the southern limits of Mumbai harbour. The contribution of the creek system in terms of plankton to the bioproductivity potential of the near shore waters of Mumbai is significant. The present study gives an account of biodiversity with reference to phytoplankton and zooplankton and provides baseline information for future monitoring of the system considering the industrial growth around the creek.

MATERIALS AND METHODS

Five stations were selected within a stretch of about 30 Km from Mumbai harbour to Dharamtar located between lat $18^{\circ}42' 11'' - 18^{\circ}51' 52''$ N and long $72^{\circ}51' 29'' - 73^{\circ}01' 42''$ E (Fig. 1). This covers the outer zone (stns. 1 and 2) located in the open sea off the creek where influence of rain water is negligible and the inner zone (stns. 3-5) located towards the upper reaches of the creek predominantly influenced by the tide. Depth of the water column varied from 2.5 to 14 m. Sampling was done monthly (September 1984 – November 1985) covering intermediate phase of the tide to avoid tidal effect if any. Water samples for selected physicochemical parameters and phytoplankton were collected from the surface and bottom using clean plastic bucket and Niskin water sampler respectively. The physicochemical parameters of water (temperature, pH, salinity, DO, BOD, PO_4 -P, NO_2 -N, NO_3 -N and NH_3 -N) were estimated using standard methods (Carlberg, 1972; Strickland & Parsons, 1972; Grasshoff *et al.*, 1983). Qualitative and

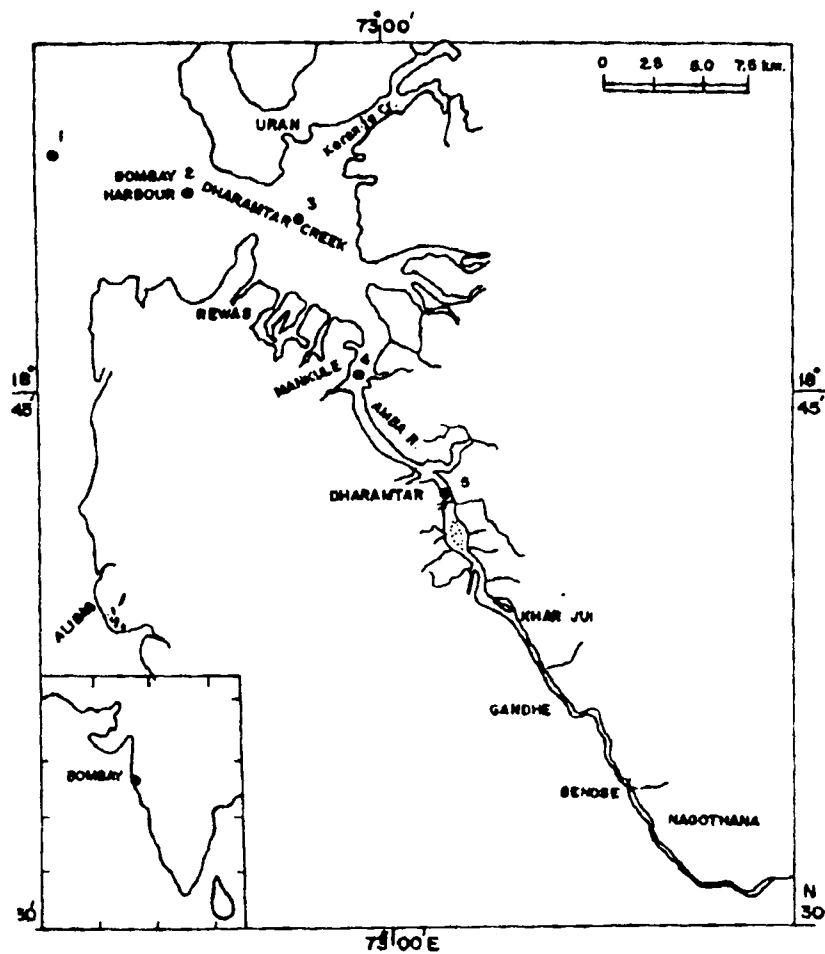


Fig. 1 :Map showing location of stations.

Table 1 – Variations in different physicochemical parameters of surface and bottom waters. (Mean values represented in parentheses).

	Stations				
	1	2	3	4	5
Temperature (°C)	24.7-31.5 (27.6)	23.6-32.0 (27.7)	24.0-32.2 (27.8)	24.0-32.4 (28.1)	24.4-33.6 (27.9)
pH	7.5-8.3 (7.8)	7.5-8.2 (7.8)	7.5-8.4 (7.8)	7.5-8.3 (7.7)	7.5-8.3 (7.7)
Salinity ($\times 10^{-3}$)	23.6-36.6 (32.8)	8.1-36.9 (31.6)	1.7-36.5 (27.7)	0.2-37.2 (23.9)	0.1-38.0 (21.2)
DO (ml l^{-1})	3.1-6.3 (4.1)	3.4-5.4 (4.3)	3-5.3 (4.4)	3.1-5.3 (4.2)	3-5.2 (4.3)
BOD (ml l^{-1})	0.2-3.8 (1.4)	0.2-3.4 (1.3)	0.4-2.9 (1.3)	0.4-3.3 (1.4)	0.2-2.9 (1.4)
$\text{PO}_4\text{-P}$ ($\mu\text{g. at l}^{-1}$)	0.6-3.4 (1.9)	0.6-3.5 (2)	0.6-3.1 (1.7)	0.4-3.6 (1.8)	0.6-3 (1.7)
$\text{NO}_2\text{-N}$ ($\mu\text{g. at l}^{-1}$)	0.2-3.1 (1.1)	0.1-1.9 (0.7)	0.2-2.2 (0.9)	0.2-2.3 (0.8)	0.2-2.8 (0.9)
$\text{NO}_3\text{-N}$ ($\mu\text{g. at l}^{-1}$)	5.1-21.8 (13.7)	1.0-33.9 (15.1)	3.6-24.3 (16.1)	3.9-30.6 (17.9)	4.2-42.4 (18.8)
$\text{NH}_3\text{-N}$ ($\mu\text{g. at l}^{-1}$)	0.2-6.6 (1.5)	0.1-6.8 (1.5)	0.1-5.1 (1.2)	0.1-4.9 (1.5)	0.1-5.6 (1.7)

quantitative enumeration of phytoplankton was carried out adopting Lugol's iodine technique (UNESCO, 1978). Cell count was done using a Sedgwick Rafter counting chamber. Identification of phytoplankton was done as per Subramanyan (1948), Desikachari (1959) and Nair (1959). Phytoplankton diversity indices Shannon and Weaver (1963) H' and Margalef (1968) D were calculated. Evenness (E) was also worked out (Pielou, 1966). Zooplankton was collected by oblique haul using HT net (mesh 0.3mm, mouth area 0.25m²) fitted with TSK flowmeter. Biomass (ml/100m³) was measured by displacement method and population density (no/100m³) was determined by analyzing aliquots of 25-50% of the sample for common forms and the entire sample for rare groups.

RESULTS AND DISCUSSION

Physicochemical parameters

Variations in water quantity parameters were within the expected levels for a tropical estuary indicating that area was free from any environmental perturbation. Tides and monsoon were main factors influencing the temporal and spatial variations of some of the parameters (Table 1). Though temperature varied from 23.6 to 33.6 °C (av. 27.8 °C), the difference between surface and bottom temperature was insignificant (0.5°C) indicating lack of vertical stratification. The pH variation was in the range of 7.48 – 8.37 (av. 7.76). Relatively low values were obtained during monsoon due to influence of riverine flow. Marked variation in salinity was observed ranging from 0.07×10^{-3} to 37.99×10^{-3} (av. 27.37×10^{-3}). The entire water column was homogeneous during premonsoon period due to limited influence of freshwater and the creek was completely tide dominated. With the onset of the monsoon the creek became fresh water dominated due to influx of fresh water from Amba river. Salt wedge formation was also noticed near the mouth during peak monsoon period when salinity at Stns. 4 and 5 decreased to almost freshwater condition. During postmonsoon period the stratification was broken as the creek became tide dominated. Fairly high level of DO (3.02 – 6.32 ml l⁻¹, av. 4.25 ml l⁻¹) and low BOD (0.22-3.6 ml l⁻¹, av. 1.34 ml l⁻¹) indicated effective assimilation of organic load. Nutrients in Dharamtar creek indicated seasonal variations with maximum concentration during the monsoon period (Tiwari, 1990). In general the range in nutrients showed comparable values at all stations though the levels of nitrate were higher at the interior locations.

Phytoplankton diversity

Phytoplankton cell count showed enormous variation ($17\text{-}598 \times 10^3 \text{ l}^{-1}$) with an average cell count of $266 \times 10^3 \text{ l}^{-1}$. The overall distribution of phytoplankton indicated a bimodal pattern with population maximum during September-October followed by a secondary peak in April. Outburst of phytoplankton during monsoon period synchronized with low salinity and high nutrients values,

similar to the observations made from Cochin backwaters (Gopinathan, 1972). In general, the area between stns. 1 – 3 showed peak phytoplankton production during monsoon period while at stns. 4 and 5, peaks were restricted to monsoon season. The interior most locations of Dharamtar creek showed very low salinity during monsoon season and almost freshwater dominated the area. Probably this would have led to the shifting of population maximum for the post monsoon period along the interior part of the creek.

A total of 58 genera of phytoplankton were recorded from the area of which 46 belonged to diatoms, 6 to dinoflagellates and 6 to other algae. Diatoms were represented by *Amphiprora*, *Amphora*, *Asterionella*, *Bacteriastrum*, *Biddulphia*, *Campylodiscus*, *Cerataulina*, *Coscinosira*, *Cyclotella*, *Denticula*, *Detonula*, *Diploneis*, *Ditylum*, *Eucampia*, *Fragilria*, *Grammatophora*, *Guinardia*, *Gyrosigma*, *Hemidiscus*, *Hyalodiscus*, *Lauderia*, *Leptocylindrus*, *Licmophora*, *Melosira*, *Navicula*, *Nitzschia*, *Pinnularia*, *Planktoneilla*, *Pleurosigma*, *Rhabdonema*, *Rhizosolenia*, *Skeletonema*, *Streptotheca*, *Surirella*, *Synedra*, *Thalassionema*, *Thalossiosira*, *Thalassiothrix*, *Triceratium* and *Tropidoneis*. The dinoflagellates encountered were *Ceratium*, *Dinophysis*, *Goniaulax*, *Noctiluca*, *Peridinium* and *Prorocentrum*. Other algae included *Anabaena*, *Gloeothece*, *Nodularia*, *Oscillatoria*, *Phaeocystis* and *Spirulina*.

The average contribution of diatoms, dinoflagellates and other algae to phytoplankton was respectively 97.6, 2.0 & 0.4%. *Thalassiosira* exhibited the maximum percentage contribution (av. 34.5%) to the phytoplankton community followed by *Skeletonema* (22.2%). *Coscinodiscus*, *Nitzschia*, *Thalassiosira* and *Thalassiothrix* were encountered at all the stations throughout the period of study. *Biddulphia*, *Cerataulina*, *Navicula*, *Pleurosigma*, *Rhizosolenia*, *Surirella* and *Synedra* were the other genera occurring very frequently in the area. The most common genera of dinoflagellate were *Peridinium* and *Dinophysis*. A bloom of *Skeletonema* occurred during October – November which was more prevalent in the interior creek stations (stns 2-5). In October '84 it formed 96.8% of phytoplankton population. Curl & McLeod (1961) deduced the optimum salinity range for *Skeletonema* as $15 - 20 \times 10^{-3}$ whereas Nakanishi & Monsi (1965) reported 18×10^{-3} as the optimum salinity. The highest peak of *Skeletonema* observed in the present study coincided with a salinity range of $20.23 - 21.7 \times 10^{-3}$. Gonzalves (1947) also reported increase in number of *Skeletonema* during September – October from Mumbai waters. Dinoflagellate *Peridinium* led to a bloom in December accounting for 76% of the total phytoplankton count at stn .4 .

Shannon's diversity index H' varied in the range of 0.29 – 3.61 while Margalef's D ranged from 1.14 to

4.93 (fig. 2). The lowest value of H' and D coincided with either the bloom or with the minimum number of genera. The average diversity index H' for the outer zone was 2.45 and that for the interior zone was 2.41. The respective D values were 3.05 and 2.9. Reduction in the number of species and species diversity and an increase in the number of *Skeletonema costatum* are some of the changes associated with the domestic and industrially polluted environment (Patrick, 1967). Occurrence of *Skeletonema* bloom in October '84 in the present study appears to be a recurring phenomenon as it was repeated in October '85. Hendey (1977) classified marine habitat on the basis of species diversity as severely (0-1), moderately (1-2) and slightly (2-3) polluted. Considering the mean diversity indices (H' : 2.42 and D : 2.96), it can be concluded that Dharamtar creek sustained fairly healthy phytoplankton community. Relatively higher diversity indices in the outer zone may be attributed to higher salinity and contribution of immigrant population from the offshore waters.

Zooplankton diversity

While zooplankton biomass varied from 1.12 to 135.33 ml / 100m³ (av. 30.28 ml / 100m³) population density range was between 3091 and 1723786 / 100m³ (av. 126986 / 100m³). A clear cut increase in biomass and population was noticed from the outer to the inner zone (Fig. 3) and the respective average values were 24.97 ml / 100m³, 81755 / 100m³ & 33.84 ml / 100m³; 157040 / 100m³. Positive and very significant correlation was found between zooplankton biomass and population. High standing stock of zooplankton very often synchronized with phytoplankton abundance indicating a direct relationship (Tiwari, 1990) though individual samples did not always show a proportionate correlation probably due to variation in composition of flora and fauna or grazing by zooplankton.

Abundance of various zooplankton in the estuary fluctuated in accordance with salinity regime. Copepods, decapods and chaetognaths which formed the major part of zooplankton were studied in detail while remaining groups were clubbed as other taxonomic group.

Copepods : Copepods formed the largest group of zooplankton contributing 71.8% with a population density ranging from 731 to 1686611 / 100m³ (av. 109252 / 100m³). Peak in copepod population was observed during August-October. A total of 46 species belonging to 26 genera were encountered in the collections (Table 2). Calanoid copepods formed the largest share (98.7%) followed by cyclopoids (1.1%) and harpacticoids (0.2%). The most common species were *Acartia spinicauda*, *Acrocalanus sp.*, *Eucalanus pileatus* and *A. centrura*. *A. spinicauda* was the dominant species in the outer zone while the *Acrocalanus sp.* was predominant in the creek area. Shannon and Weaver diversity index H' ranged between 0.44 and 3.4 (av. 2.54) and Margalef's D varied

from 0.35 to 2.09 (av.1.13). Interior creek area showed relatively lower diversity than that of the outer zone (fig. 4). *Paracalanus parvus*, *Euchaeta wolfendeni*, *Euchaeta sp.*, *Centropages tenuiremis*, *Centropages sp.*, *Temora discaudata*, *Pontella securifer*, *Microsetella sp.*, and *Corycaeus sp.* were restricted exclusively to stn.1 while *Heliodyptomus sp.*, *Neodyptomus sp.*, *Pseudodyptomus annandalei*, *P. sewelli*, *P. tollingeriae*, *Temora sp.*, *Acartiella gravelyi*, *Miracia sp.* and *Mesocyclops sp.* were observed only during the monsoon months suggesting their preference to very low saline or limnetic conditions. *Pseudodyptomidae* and *Acartiidae* were the most successful copepods in Dharamtar creek.

Decapods : This group was largely constituted by larval stages and formed the second largest group of zooplankton. Their population varied between 151 and 80217/100m³ (av. 7508/100m³) with average contribution of 11.44 % to the total zooplankton population. Highest density (80082/100m³) was recorded in January at stn 4 which was associated with an outburst of crab zoeae . Seasonally, postmonsoon period sustained higher population than other seasons. Twenty six forms of planktonic decapods belonging to Penaeidae, Sergestidae, Caridea, Scyllaridae, Stenopidae, Thalassinidae, Anomura and Brachyura were encountered in the present collections. On an average brachyuran larvae formed major part of the decapod population throughout except at stn. 1 where the members of Sergestidae outnumbered them. Penaeidae was represented by protozoeae and mysid stages of *Metapenaeus*, *Parapenaeiopsis* and *Penaeus* with the first dominating all over. Larvae of *Penaeus* were observed only at stns. 1 and 2. Sergestidae was represented by *Sergestes*, *Acetes*, *Lucifer hansenii*, *Lucifer typus* and protozoeae of *Lucifer* and *Acetes*. An outburst of *Lucifer* was observed at st.1 in November '85 with population density of 28504 and 3455/100m³ respectively for *L.hansenii* and *L.typus*. Caridean larvae belonged to the families Pasipheidae, Pandalidae, Hippolytidae, Processidae, Alpheidae and Palaemonidae. While Alpheidae was dominant at stn. 1, Palaemonidae dominated at the remaining stations. Scyllaridae, represented by phyllosoma larvae, was restricted only to the outer zone of the creek. Stenopidae larvae were confined to stn. 1. Thalassinidae was represented by members of families Axiidae and Upogebidae. Porcellanid and pagurid larvae were the representative of Anomura. Zoea, megalopa and glaucothoeae of crabs represented Brachyura which dominated over other decapods.

Occurrence of epiplanktonic species of *Lucifer* and *Acetes* which form a major diet of shore fishes and larger shrimps, and those of palaemonid carideans and brachyuran larvae in good numbers is an indication of non-penaeid prawn and crab resources of the Dharamtar creek.

Chaetognaths: The group contributed 8.3% of total zooplankton population forming the third largest group of zooplankton. Variation in chaetognath population was from 0 to 40818/100m³ (av. 5373/100 m³). *Sagitta bedoti* was common at all stations while *S.enflata* was largely noticed towards the lower reaches. *S. oceania* was more abundant at the interior region than the outer zone. At stns. 1 and 2 with salinity ranging from 8 to 36.9 x 10⁻³, chaetognaths were fairly abundant throughout with peaks recorded in September and November. At stn. 5 their population rose to a peak only in May coinciding with the maximum salinity of 37.8 x 10⁻³. During monsoon months when freshwater dominated the estuary, chaetognaths were either absent or very sparse.

Other groups : Many other groups were also represented in the collections whose occurrence and abundance were sporadic, even though they collectively dominated zooplankton at times. Medusae were common in the area except during June to August at the interior zone. Population density of hydromedusae fluctuated between 10 to 1670, 10 to 500 and 10 to 6660/100m³ in the monsoon, premonsoon and postmonsoon respectively. 26 species belonging to 21 genera of hydromedusae were obtained from this estuarine system. They included Anthomedusae: *Euphysora bigelowi*, *Hybocodon forbesi*, *H.unicus*, *Baugainvillia fulva*, Leptomedusae, *Obelia spp*, *Phialidium hemisphaericum*, *Phialidium brunescens*, *P.globosum*, *P.simplex*, *Blackfordia virginica*, *Eucheilota menoni*, *Helgicirra malayensis*, *Phialucium condensum*, *Octophialucium indicum*, *Phialella fragilis*, *Eutima mira*, *E.commensalis*, *Amphinema rugosum*, *Aequorea tenueis*, *A.conica*, *A.pensilis*; Limnomedusae: *Ostroumovia inkermanica*; Trachymedusae: *Aqlaura hemistoma*, *Liriope tetraphylla*, *Gerionia proboscidalis* and Narcomedusae: *Solmundella bitentaculata*. High density of hydromedusae at the outer zone was the result of high number of holoplanktonic species like *Liriope tetraphylla*, *Solmundella bitentaculata* and *Aqlaura hemistoma* which are also indicative of high saline waters evident at stns. 1-3. In general, a downward trend in species richness was discernible towards the upper reaches of the estuary. The numbers of species recorded at stns. 1 to 5 were respectively 20, 18, 13, 9 and 5. Siphonophores also were more abundant at stns. 1- 3 than the remaining locations. Eventhough ctenophores were well represented in the creek, the population density was low during the monsoon period. Planktonic platyhelminths, a rare group was represented solely by marine flukes. Polychaetes were more frequent at stn. 1. *Evadne* and *Moina* contributed to the cladoceran community. During June-July freshwater *Moina* became abundant at the interior part of the creek. It formed the most dominant group at stn. 5 in June contributing 56.2% to total zooplankton population. *Cypridina dentata* was the single ostracod species rarely found in the collections. Mysids were common at all stations and were represented by *Mesopodopsis zeylanica* and *Lycomysis*

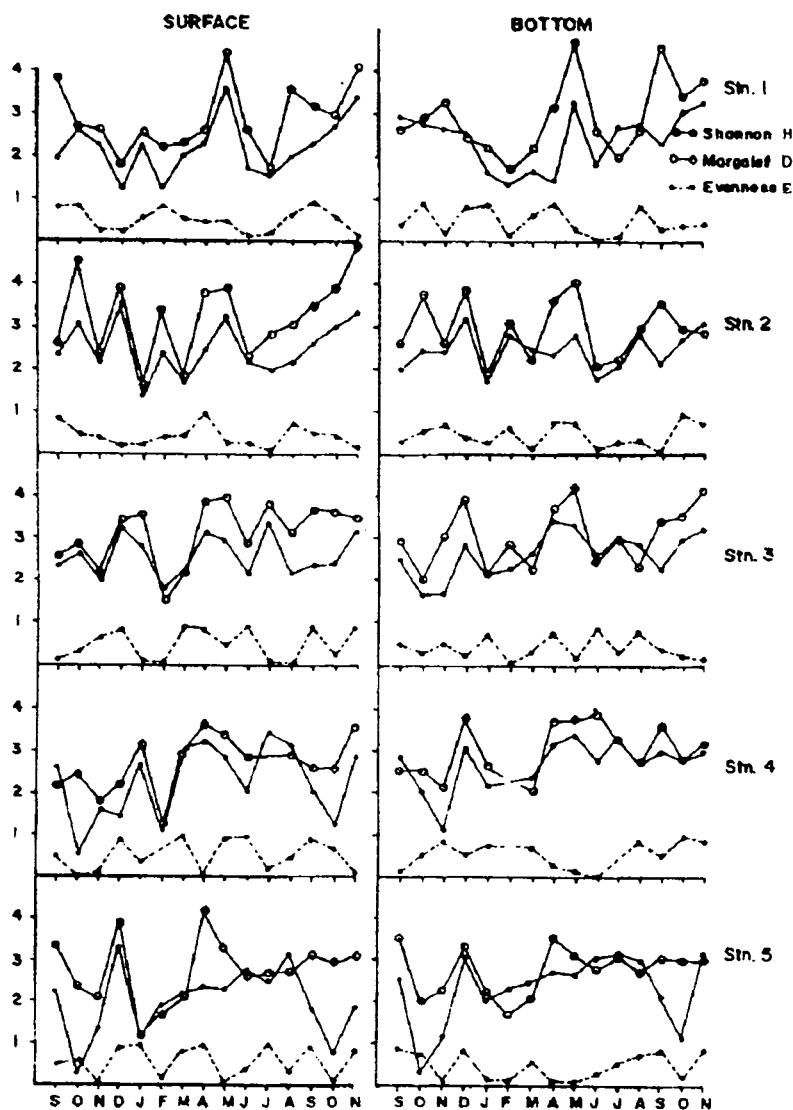


Fig. 2: Trend in diversity indices of phytoplankton at different stations during 1984-85.

platycauda. Cumaceans, pycnogonids and echinoderm larvae were rare in the area while isopods and amphipods were found in fairly large numbers. Naupli of crustaceans and alima larvae contributed in fairly large proportion to the total zooplankton population. Planktonic gastropods and bivalves were common at all stations, the latter being less frequent as compared to gastropods. However, at st 2 in November '85 bivalves became the second largest group contributing 23% to the total zooplankton community. Copelates were more common towards the outer zone. Salps and doliolids were sparsely represented towards the creek mouth.

Fish eggs were commonly found at all stations and occasionally found in large numbers. They occurred less frequently at stn. 5. Their maximum population (739/100m³) was recorded from stn. 3 in December. Fish larvae constituted another very common group in Dharamtar creek. Their population maximum (6031/100m³) was encountered at stn 5 during August. On an average the outerzone sustained relatively higher population of fish eggs and larvae than the interior zone. This is in contrary to the assumption that the interior creek area are more congenial for the development of these larvae. The possibility of predation of fish eggs and larvae by carnivores like medusae leading to depletion of fish eggs and larvae can not be ruled out. In

this context, higher population of medusae towards the interior part of the creek coinciding with lower population density of fish eggs and larvae is significant. However, the occurrence of fish eggs and larvae within the entire creek system in fairly good number suggests the existence of breeding ground of fishes in the vicinity of this creek.

CONCLUSION

It is an accepted fact that the greatest levels of marine diversity are found in tropical countries and this assumption is true for Dharamtar creek system. Losses of biodiversity are largely the result of conflicting uses of the near shore environment which leads to degradation, fragmentation and losses of habitats due to human interference. Considering the industrial development along the banks of this creek system, periodic monitoring of the fauna and flora is required in order to check the variation in diversity, if any.

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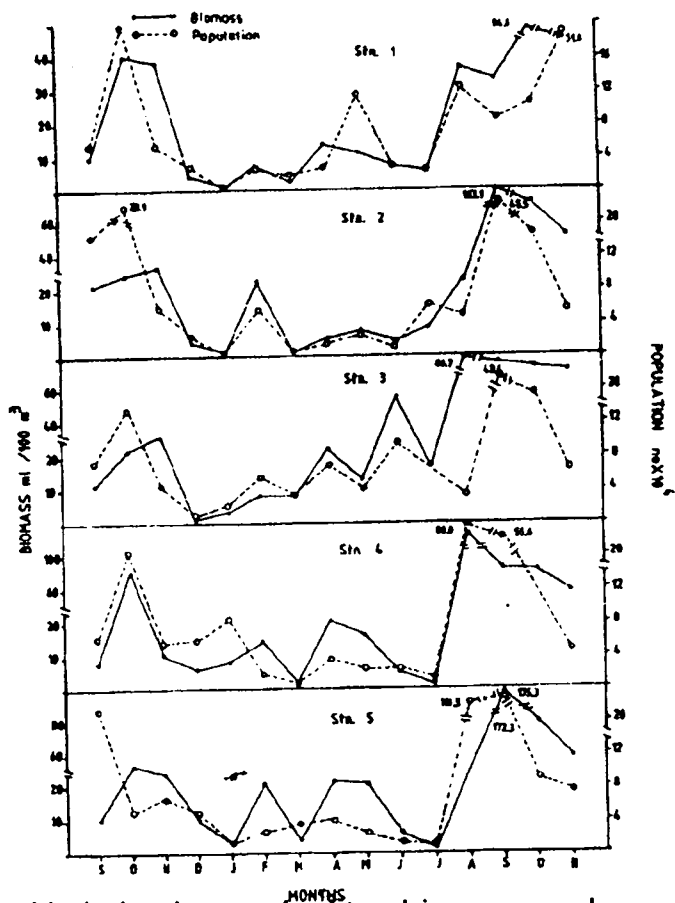


Fig. 3: Variation in zooplankton biomass and population at different stations during 1984-85.

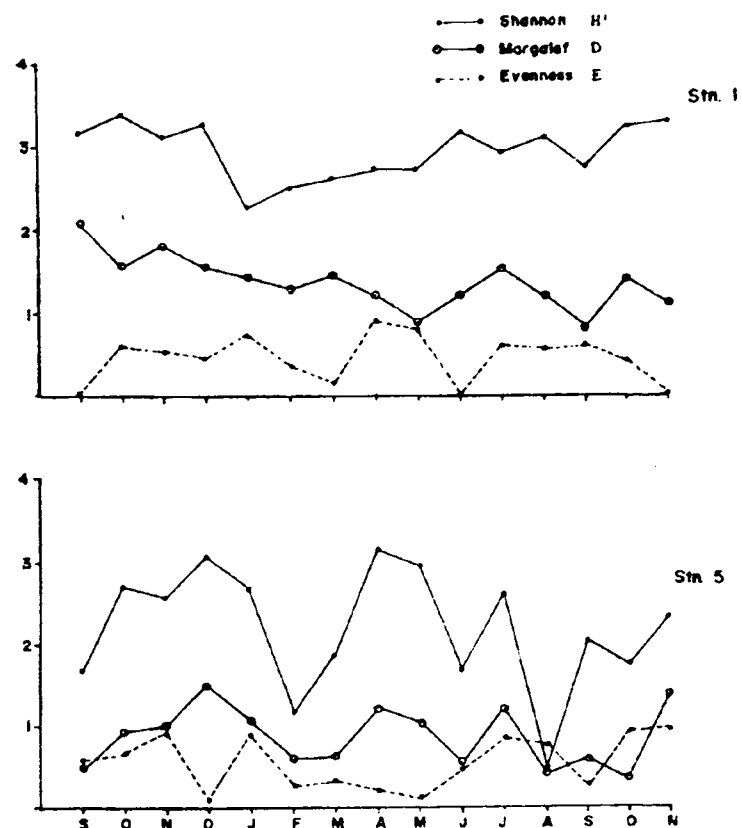


Fig. 4: Variation in diversity indices of copepods at different stations during 1984-85.

Table 2 : List of copepod species recorded from stations 1 to 5. (+ indicates occurrence of species)

Name of species	Station 1	Station 5	Name of species	Station 1	Station 5
Calanus sp.	+	+	Temora sp.	-	+
Canthocalanus pauper	+	+	Labidocera pectinata	+	+
Eucalanus crassus	+	+	Labidocera sp.	+	+
E. pileatus	+	+	Pontella securifer	+	-
E.subcrassus	+	+	Pontella sp.	+	+
Paracalanus aculeatus	+	+	Acartia centrura	+	+
P.parvus	+	-	A. pacifica	+	+
Acrocalanus sp	+	+	A. plumosa	+	+
Euchaeta marina	+	+	A.spinicauda	+	+
E.wolfendeni	+	-	Acartia sp.	+	+
Euchaeta sp.	+	-	Acartiella gravelyi	-	+
Centropages dorispinatus	+	+	A.keralensis	+	+
C.tenuiremis	+	+	A.sewelli	+	+
Centropages sp.	+	-	Tortanus barbatus	+	+
Heliodiaptomus sp.	-	+	T.gracilis	+	+
Neodiaptomus sp.	-	+	Microsetella sp.	+	-
Pseudodiaptomus annandalei-		+	Miracia sp.	-	+
P.aurivilli	+	+	Clitemnestra sp.	+	+
P.serricaudatus	+	+	Euterpinna acutifrons	+	+
P.sewelli	-	+	Oithona sp.	+	+
P.tollingerae	-	+	Corycaeus sp.	+	-
Pseudodiaptomus sp.	+	+	Mesocyclops sp.	-	+
Temora discaudata	+	-			
Temora turbinata	+	+			

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