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Research Paper

BIODIVERSITY OF PHYTOPLANKTON, ZOOPLANKTON AND ZOOBENTHOS IN EAST COAST, BAY OF BENGAL NEAR NELLORE, ANDHRA PRADESH (INDIA)

Nanasaheb C Kankal[1]* and Sarita Warudkar[1]

*Corresponding Author: **Nanasaheb C Kankal,** ✉ nc_kankal@neeri.res.in

The study of phytoplankton, zooplankton and zoobenthos at 8 sampling locations were identified around coastal area of Bay of Bengal during summer season (April, 2010) to assess the water quality and bio-ecoaesthetic value of the area. Among the major taxonomic groups, bacillariophyceae was the most dominant phytoplankton species. Based on study of zooplankton, it appeared that the area is mostly preferred by Cladocera (*Daphnias sp*., *Allonella sp.and Moina sp*), fallowed by Rotifera (Brachionus sp. and Keratella sp.), Copepoda (*Cyclops sp.*; *Nauplius larva*)) and Ptotozoa *(Acanthocystis sp.)* were identified. Zoobenthos was dominated by Foraminifera (11 sp.) followed by Ophiuroides (7 sp.), Ostracoda (3 sp), Polychaeta (1 sp.). An average counts for phytoplankton, zooplanktons, zoobenthos were computed as 165/ml, 1825/m^3 and 17750/m^2 respectively. Higher diversity indices for all these groups phytoplankton, zooplankton and zoobenthos were ranged as 2.615, 2.072 and 2.18 respectively indicating lowest or no impact of pollution or no adverse impact in the study area of Bay of Bengal near Nellure, (Andhra Pradesh, India).

Keywords: Water quality, Pollution, Diversity index, Bay of Bengal, Sea coast

INTRODUCTION

It is established that the total biological productivity of the more fertile parts of the sea is greater than that of much agricultural land and in the sea itself the shorelines form the more fertile and productive parts despite highly complex and variable environmental conditions. Compared to the deep seas, coastal waters are rich in energy and nutrients mostly derived from land drainage and benthic decay of maritime detritus. The photosynthetic productivity of the seas around the coastal water is usually 35 to 75 times of that of the open ocean and coastal benthic production per unit area exceeds that in the water column by a factor of ten. The high energy and nutrients of the coastal waters, specially in the semi-enclosed land-locked bays, imply that they also have (through inputs from land) a great variety of

[1] National Environmental Engineering Research Institute (NEERI), Nehru Marg, Nagpur-440020, India.

offending substances or pollutants compared to the deep seas which are still, as a whole, relatively free from pollution. Biotic environment comprises of microorganisms, i.e., phytoplankton, zooplankton, benthos and nekton.

Biological productivity of the ocean is influenced by factors, viz. light, nutrients, primary, secondary and tertiary production. Light penetration in the ocean determines the depth of the photosynthetic zone whereas the nutrients particularly nitrogen and phosphorus influence the promotion of productivity. Phytoplankton or the planktonic algae give the production at the primary stage of the food chain while zooplankton and fish are at the secondary and tertiary levels of the food chain. Phytoplankton provides food for herbivores and hence forms a major link in the food chain. Primary productivity in terms of phytoplankton population in sea is governed by rate of photosynthesis and availability of nutrients. The energy necessary for the metabolic process is derived from light and is stored as chemical energy in organic compounds. Overall, phytoplankton population density is higher during winter and summer-monsoon and low during the winter-monsoon seasons.

The phytoplankton, zooplankton and zoobenthos constitute important links in aquatic food chain. They are good indicators of water pollution. They play a major role in pollution monitoring studies. These are the basic aspects for environmental impact assessment evaluation. The phytoplankton and zooplankton are practically suitable choice of indicators of water quality due to ease of sampling, their cosmopolitan distribution and lot of available information on these groups. The monitoring for biological parameters is rapid, inexpensive and reliable requiring only biological examination of the water samples. The impact of pollution is directly reflected by the survival status of flora and fauna. The biological data gives an overall picture of the subsequent effects of pollution. The study on biological parameters will lead to detecting various factors contaminating or polluting the aquatic environment. With a view to conserve environmental quality and safety of natural flora and fauna, studies of biological aspects of the ecosystem is of priority in an environmental impact assessment studies. Natural flora and fauna in water is the best indicator of environ-mental quality. These indicators serve as inexpensive and efficient early warning and control system and hence included in the study.

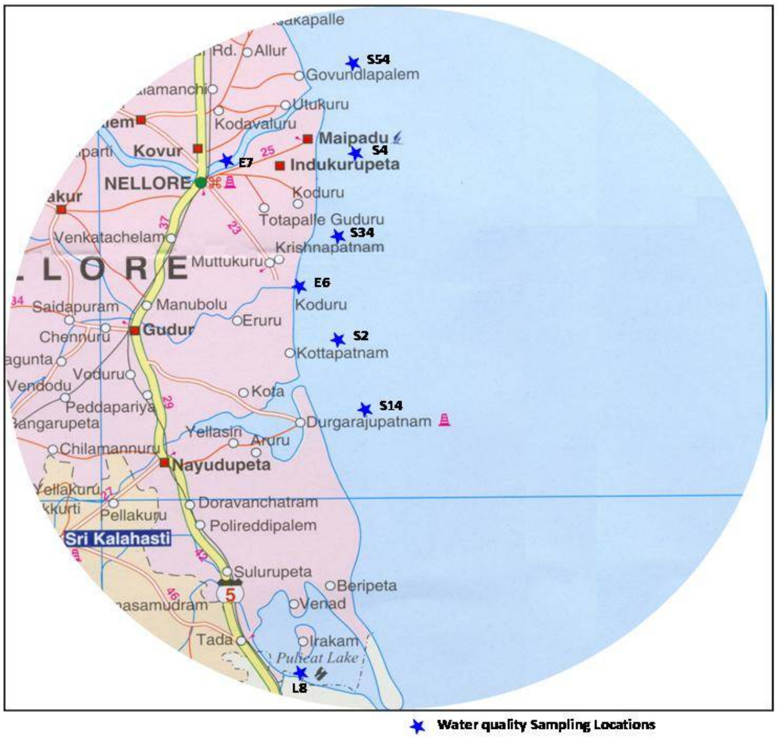
Due to Krishnapatanam sea port and fishing activities in the area there is tremendous pollution pressure on the water quality in the area. The present investigation was carried out to focus attention on biotic floral and faunal features in the area. The objective of the study is to estimate diversity index of phytoplankton, zooplankton and zoobenthos to identify the level of pollution impacts in the study region Bay of Bengal.

MATERIALS AND METHODS

This study area is the part of the Palar and Pennar basins located in Bay of Bengal in the area, immediately offshore of the coast located between 12°12' 37" to 14°49'39 N latitudes and 79°58'44" to 80°05'35" E longitudes to the south-east of Nellore (EIA Report, NEERI, 2010).

The area of the study is 9400 km^2. Studies were carried out on phytoplankton, zooplankton and zoobenthos to examine the water and sediment quality of the coastal region (Figure 1). The sampling was done during summer season (April, 2010) in the study area. The sampling programme covered a 10 kms radial distance around coastal area in Bay of Bengal near Nellore,

Figure 1: Offshore Water Sampling Locations in the Study Area



in Andhra Pradesh and Tamil Nadu states. The sampling locations were selected for water and sediment quality assessment covering pollution impacted region for phytoplankton and zooplankton. Sampling programme was conducted for the period of about 15 days in summer. For zoobenthos, bottom sediment samples were collected by Van Veen grab sampler having the area of 0.03 m^2 with the depth of 15 cm. The sediment samples thus collected was sieved through 500µ mesh sieve for macrobenthos. Core sampler was used to collect the sediment for meiofauna and sieved through 45µ mesh sieve. The organisms retained on both the sieves were preserved immediately with 4% buffered formalin.

Physico-chemical and biological parameters have been determined to establish the water quality status of the existing offshore, estuary, river and lake water. Total 8 water samples were collected for establishment of water quality out of which 5 samples were collected from offshore and 1 each from Muttukuru estuary, Penner River and Pullicat Lake in the study area. The physico-chemical parameters estimated for ascertaining the water quality status of water environment in the summer season are presented in Table 1. All the analysis and estimations were carried out as per the procedure described in the 20th edition of Standard Methods, 1998 (APHA, AWWA and WEF). Heavy metals were determined by ICP using JY-24 Model of Jobin Yvon, France.

Different types of offshore areas play an important role in formation of sediment. The study has large deposits of sediments. These sediments account for variations in particle size,

Table 1: Coastal Water Quality

S. No.	Parameter	Offshore	Estuary	River	Lake
1.	Temperature (°C)	29.0	30.0	31.5	33.5
2.	pH	7.5	7.4	7.2	7.1
3.	D.O. (mg/l)	2.1-5.8	4.2-6.2	3.4	4.2
4.	Alkalinity (mg/l)	134	132	140	125
5.	Chloride (mg/l)	187318	18521	23427	83
6.	Salinity ($\%_0$)	33.90	33.45	-	-
7.	Nitrate as N (mg/l)	0.0302	0.043	0.071	0.019
8.	T. Phosphate (mg/l)	1.62	1.23	0.87	1.38
9.	COD (mg/l)	< 5	< 5	19	10
10.	BOD (mg/l)	< 1	< 1	5	3
11.	O&G (mg/l)	0.075	0.018	0.003	0.007
12.	HC (mg/l)	1.078	1.558	1.808	1.687
13.	Ni (mg/l)	ND	0.001	0.03	0.04
14.	Cd (mg/l)	0.0124	0.043	0.065	0.065
15.	Cr (mg/l)	0.013	0.01	0.022	0.026
16.	Cu (mg/l)	0.005	0.011	0.014	0.015
17.	Fe (mg/l)	0.144	0.099	0.658	0.170
18.	Mn (mg/l)	0.025	0.042	0.056	0.058
19.	Zn (mg/l)	0.916	1.222	1.888	1.890
20.	Co (mg/l)	0.013	0.025	0.065	0.098

sand, soils, clay, sand particles, silt are important ingredients of soil as they determine the characteristics of sediments. The sediments also contain hydrocarbons, heavy metals and benthos. The sediment sampling locations represented as shown in Table 2. Total 9 sediment samples were collected as per the standard procedure to evaluate the existing status of sediment quality. Representative samples from depth (5-20m) were collected from offshore, estuary and river surrounding the areas of various distances from the study area. Standard methods have been followed for the analysis of sediment samples. The chemical characteristics of sediment were determined by preparing sediment extract in distilled water in ratio 1:1. Potassium was determined by Flame photometer. Heavy metals in soil samples were determined by acid digestion and analysis on Atomic Absorption Spectrophotometer (AAS).

The plankton refers to those microscopic organisms free floating or suspended in natural water bodies. The plankton consisting animal species are called as zooplankton and plant

Table 2: Sediment Quality

S. No.	Parameter	Offshore	Estuary	Pennar River
1.	pH	7.27-7.98	6.94-7.79	7.56
2.	EC (mS/m)	7.80-10.80	8.10-10.30	1.41
3.	HC (gm/kg)	0.356-1.444	0.056-0.253	0.333
4.	Oil & Grease (gm/kg)	1.0-1.75	1.45-1.60	1.0
5.	Organic Carbon (%)	0.26-2.88	0.24-0.72	1.56
6.	Total Nitrogen (%)	0.07-0.18	0.06-0.18	0.15
7.	Total Phosphorus (%)	0.09-0.19	0.07-0.08	0.11
8.	Total Potassium (%)	0.015-0.146	0.019-0.020	0.013
9.	Ni (mg/kg)	0.065-0.122	0.012-0.023	0.020
10.	Cd (mg/kg)	0.09-0.024	0.018-0.024	0.162
11.	Cr (mg/kg)	ND	ND	ND
12.	Cu (mg/kg)	0.005-0.030	0.018-0.024	0.162
13.	Pb (mg/kg)	ND-0.074	ND	0.267
14.	Fe(mg/kg)	0.36-6.715	7.212-15.683	3.507
15.	Mn (mg/kg)	2.320-3.219	1.366-6.683	1.773
16.	Zn (mg/kg)	0.033-0.071	0.097-0.148	0.356
17.	Co (mg/kg)	0.021-0.062	0.033-0.071	0.020

species are called as phytoplankton. Phytoplankton, mostly the unicellular organisms are either multicellular or colonial. The density of phytoplankton is much higher than that of zooplankton. Therefore, representative water sample of about 100 ml was collected from the water body in clean, good quality of plastic bottles. These samples were preserved by adding Lugol's Iodine solution @ 1 ml per 100 ml of water sample. Lugol's solution was prepared by dissolving 20 gm potassium iodide (KI) in 50 ml distilled water. This solution is diluted by adding 150 ml distilled water. Then 20 ml glacial acetic acid was added to the solution and stored in coloured bottle and kept in cool place. Some phytoplankton organisms are unicellular whereas others are multicellular or colonial. Therefore, Lackey Drop Counting procedure was adopted lo enumerate these algae. The Lackey Drop (Microtransect) method is a simple method of obtaining counts of considerable accuracy with samples containing a dense plankton population. The phytoplankton density in clean water is very less while it is dense in polluted water. Therefore, the phytoplankton in clean water needs to be concentrated before counting for accurate estimation. The water sample was concentrated 15 times by centrifugation at 250 rpm for 15 min. The supernatant water was decanted and the pellet of algal cell was suspended in 1ml drilled water.

Pipette out 0.04 ml of concentrated water sample to a glass slide and covered with an 18 mm glass cover slip. Microorganisms are counted in strips on slide from a drop of centrifuged, decanted and concentrated water sample and number of individuals of each organism is counted in 45 x magnification. The number is expressed per ml of the sample.

- Pipette was selected such that it gives 25 drops / ml then the volume of one drop is 0.04 ml
- Area of cover slip was observed (18mm x 18mm) = 324 mm^2
- Area of strip observed (18 x 0.51) = 9.18 mm^2
- Number of microscopic fields in 18 mm long cover slip =35
- Diameter of microscopic field = 18/35 = 0.51 mm
- Area of microscopic field = 3.14 x (0.51/2 = 0.22 mm^2
- Average count of organism per strip were noted
- The count of algae per microscopic field was calculated

$$\text{No./ml} = \frac{Y \times 35 \times 25 \times X}{15} \quad \text{OR}$$

$$\text{No./ml} = \frac{\text{Y x Area of cover slip x No. of drops/ml x Vol. of Concentrated (ml)}}{\text{Area of microscopic field x 15}}$$

where,

Y - it is the number of organism divided by total number of strips observed for a sample

35 - It is number of microscopic strips in 18 mm length of cover slip

25 - Number of drops making up for 1 ml in a pipette

X - Volume of concentrated sample after centrifuging and decanting supernatant

15 - Volume in ml of water used for centrifugation

The diversity was calculated for each community by Shannon Wiener Diversity Index (SWDI). It is where proportion is obtained by dividing the number of individuals of species by total number of individual in a sample for which $\log_2$.

$$d = \sum \frac{n}{i = 1n} (ni / n).\log_2 (ni/n)$$

Zooplankton density is always lesser then phytoplankton density. Therefore around 20-50 L of water was passed through plankton net (mesh size 64 micron) to concentrate zooplankton. The zooplankton thus collected and preserved immediately with an appropriate quantity of buffered formalin (5%) to make a final concentration. The entire water was centrifuged, decanted and concentrated to make 1 ml volume for observation under S-R (Sedgwick-Rafter) counting cell. The S-R Cell was in rectangular chamber (50 mm long x 20 mm wide x 1 mm deep) having total area of the bottom as 1000 mm^2 and total volume is 1000 mm^3 (1 ml). The cover slip was placed diagonally across the cell which helped to prevent formation of air bubbles in the cell. Over filling of cell was avoided because this would yield a depth greater than 1 mm and could produce an invalid count. Lengthy examination was avoided that permit large air spaces caused by evaporation to develop in the chamber. To prevent formation of air spaces, occasionally placed a small drop of distilled water on edge of cover glass. Before counting, let the S-R cell stand for at least 15 minutes to settle the zooplankton and counted the organisms settled on the bottom. The zooplankton was observed and counted under the microscope using 10 x magnifications. The number per m^3 is expressed by the following formula:

$$\text{No./m}^3 = \frac{C \times V_2}{V_1 \times V_3}$$

where,

C = total number of counted individuals of species in a sample

V1 = volume of concentrated sample through plankton net

V2 = centrifuged, decanted and concentrated volume of sample in ml

V3 = volume of grab sample in m^3 i.e., 20 L / 1000

OR

No/m^3 =

$$\frac{\text{No. of plankton in 1 mL of S – R cell x volume of net concentrated (mL)}}{\text{Volume of water passed through plankton net (litres)}}$$

Benthos is an organism that inhabits the bottom of an aquatic body. Many of them are sessile while some creep over a burrow in mud. The quality and quantity of the animals found at the bottom are related to the nature of substrate and to the depth. Their number and distribution depends up on physico-chemical and biological characteristics of water. The sediment samples were collected from different locations in the area was passed through 500 micron mesh sieve and again through 45 micron sieve for segregation. The microorganisms retained on both the sieves were preserved immediately with 4% buffered formalin. The diversity was calculated for each community by Shannon Wiener Diversity Index (SWDI) as shown in phytoplankton analysis.The organisms were identified with the help of available reference (Kameawara Rao, et al., 1987; Krishna, 1986; Kasturirangan, 1963 and Wickstead, 1965).

RESULTS AND DISCUSSION

Charecteristics of Water

The physico-chemical characteristics of seawater in the study area were presented in Table 1. The variations in temperature of water body have great bearing upon the biological productivity. The lowest yearly seawater temperature in this region is 20.5^{0}C and maximum is 29.9^{0}C. Seasonal fluctuations in water temperature distribution play an important role in influencing biological processes. Temperature affects the organisms through direct physiological mechanisms. Temperature related responses vary according to different species and the repercussions for ecosystem dynamics depend upon food web interactions (Kinne, 1963). Variation in salinity was ranged from 31.61-36.04%$_0$ (Parts per thousand) with an average of 33.90%$_0$. pH ranges between 7.60 and 8.23 while DO ranged from 2.1-5.8 mg/l. Vertical distribution of DO shows sharp decrease from 50 m to 80 m depth of sea and thereafter the values remain almost constant (EIA Report, NEERI, 2010). These depth of occurrence of oxygen maxima and minima appears to be governed mainly by water movement, circulation and mixing besides biological processes. The average of DO values computed as 4.3 mg/l which indicate higher in range as there is no waste water to be discharged in the water. The average value of DO in the sample of Thane Creek (3.1 mg/l) reported by Kankal *et al.*, 2011) and Ulhas river estuary (3.9 mg/l) Mishra, 2002 indicating slight change in water quality due to discharge of small scale industrial and domestic effluents in the estuary water. Lower values of COD (<19mg/l), BOD (<5 mg/l) and Oil and Grease levels (<1mg/l) and DO (4.3 mg/l) were well below prescribed limits under Bureau of Indian Standardsfor controling of marine coastal areas (IS: 7967, 1976) and WHO. The results of physical parameters Viz. pH, temperature, turbidity and TSS during summer season in the water are found in the range of 7.1-7.5, 29^0-33.5^0C., <1-2.4NTU and 12-108 mg/l. The offshore water quality sources in the study area showed low concentrations of heavy metals except zinc and iron which were recorded higher in river water than standards at some places. Higher BOD, Organic matter and low DO in the water sample indicate impact of domestic pollution in the study area in Thane creek and Ulhas estuary it was an indication of organic pollution in that region. Somani *et al.*, 2002 and Goldin *et al.*, 2002 reported that high BOD and low DO value in creek water indicate higher domestic pollution

Charecteristics of Sediment

Different type of offshore areas plays an important role in formation of sediment. The study area has large deposits of sediment. The sediments also contents hydrocarbons, heavy metals and benthos, etc. Chemical characteristics of sediment samples collected from offshore, estuary and river analyzed for various parameters viz. pH, electrical conductivity (EC), organic carbon, total nitrogen, phosphorous, potassium and heavy metals contents the same was presented in Table 2. It was observed that the sediment is medium in organic and nutrient contents shows poor quality. Heavy metal pollution is serious because it can persist for many decades. It creates problems in nutrient utilization of benthic organisms. However, the levels of heavy metals are found below the level of prescribed standards.

Phytoplankton

During summer season, in offshore, estuary, river and lake waters the Shannon Wiener Diversity Index (SWDI) varies between 1.97-2.742 (avg. 2.615) indicating no impact of pollution. The population dynamics of offshore water were estimated by phytoplankton count in number/ml, which were observed in the range of 112-224 No./ml (Avg. 151 No./ml) indicates the phyto-plankton count was almost same in all the water sampled as shown in Figure 2(a) and presented in Tables 3 and 4). The dominent class of the phytoplankton 5 species of *Chlorophyceae (Ankistrodesmus sp, Cosmarium sp, Scenedesmus sp, Chlorococcum sp, Chlamydomonas sp* while 7 Bacillariophyceae (*Navicula sp, Nitzschia sp, Cymbella sp, Cyclotella sp, Synedra sp, Gyrosigma sp*) and 1 species of *Cyanophyceae* (*Osillatoria*) were recorded. No toxic algae were found in the study region. The percent composition reveals highest count for Chlorophyceae followed by Bacillariophyceae and Cyanophyceae. The dominance of Chlorophyceae and Bacillariophyceae as well as low algal count and higher SWDI values indicate no impact of pollution with medium productivity. Palmer's Pollution Index (PPI) values found to be less than 15 in offshore water indicated good quality of water and more than 15 in river and lake water indicates medium to high organic pollution (EIA Report, NEERI, 2010).

Zooplankton

The observations on zooplankton density for

Table 3: Water Quality: Biological Parameter – Phytoplankton

S. No.	Type of Water	Sampling Location	Depth (m)	Total Phyto-Plankton Count (No./ml)	Composition of Algal Group (%)			SWDI	PPI
					Chloro-phyceae	Bacillario-Phyceae	Cyano-phyceae		
Offshore Water									
1.	Sea watwer	Surface	0.5	112	50	50	-	1.97	6
2.	Sea Water	Surface	0.5	134	33	67	-	2.58	10
3.	Sea Water	Surface	0.5	112	60	40	-	2.245	8
4.	Sea Water	Surface	0.5	224	50	50	-	2.245	10
5.	Sea Water	Surface	0.5	190	59	41	-	2.742	15
Estuary Water									
6.	Muttu Kuru	Surface	0.5	190	35	47	18	2.697	12
River Water									
7.	Pennar River	Surface	0.5	168	40	53	7	2.883	21
Lake Water									
8.	Pulicate Lake	Surface	0.5	190	41	47	12	2.93	18

Table 4: Phytoplankton Species Observed

Chlorophyceae	Bacillariophyceae	Cyanophyceae
Ankistrodesmus sp	*Navicula sp*	*Osillatoria sp*
Cosmarium sp	*Nitzschia sp*	
Scenedesmus sp	*Cymbella sp*	
Chlorococcum sp	*Cyclotella sp*	
Chlamydomonas sp	*Synedra sp*	
	Gyrosigma sp	

offshore and river, lake water quality during summer season shown in (Table 5), and presented in Figure 2(b). The zooplanktons were represented by 2 Copepoda, 2 Rotifera, 3 Cladocera, and 1 Protozoa species Table 6. Above discussions indicate good quality of offshore water with moderate productivity. Generally the low tide samples exhibited higher density than high tide samples (Kotangale, 1994). Cladocera was dominant group followed by Rotifera, Copepoda and Protozoa. In the present study of offshore water quality, the SWDI and zooplankton population density varies between 1.84-2.250 (avg. 2.072) and 1200-2000 No./m³ (Avg. 1825 No./m³) respectively it shows that the count in sea water was less and higher in river and lake watrer Figure 2(b). The percent composition reveals highest count for Rotifera and Copepoda. Tiwari and Nair, 2002 reported highest numerical abundance of Copepods contributing to the bulk of biomass in Dharamtar Creek samples. Usually monsoon and postmonsoon months are the most productive period of zooplankton from secondary production stand point of view (Menon *et al.*, 1977) and often exhibit higher diversity index value (Srinivasan and Santhanam, 1991). However, higher species diversity value was recorded in summer as compared to premonsoon and monsoon seasons at Coleroon estuary (Jagadeesan and Ayakkannu 1992). Tolerance of Rotifers to the

Table 5: Biological Parameters – Zooplankton

S. No.	Type of Water	Sampling Location	Depth (m)	Total Zooplankton/ m^3	Composition of Zooplankton (%)				SWDI
					Rotifera	Cladocera	Copepoda	Protozoa	
Offshore Water									
1.	Sea water	Surface	0.5	1200	50	-	33	17	1.916
2.	Sea Water	Surface	0.5	1600	38	-	50	12	2.250
3.	Sea Water	Surface	0.5	1600	50	-	50	-	2.0
4.	Sea Water	Surface	0.5	1200	33	-	67	-	1.916
5.	Sea Water	Surface	0.5	2000	40	20	40	-	2.245
Estuary Water									
6.	Muttu Kuru	Surface	0.5	1600	50	-	50	-	2
River Water									
7.	Pennar River	Surface	0.5	2800	27	-	43	-	1.84
Lake Water									
8.	Pulicate Lake	Surface	0.5	2600	46	16	38	-	2.405

Figure 2: Faunal Dominance in the Sea Water, Estuary and Coastal River and Lake

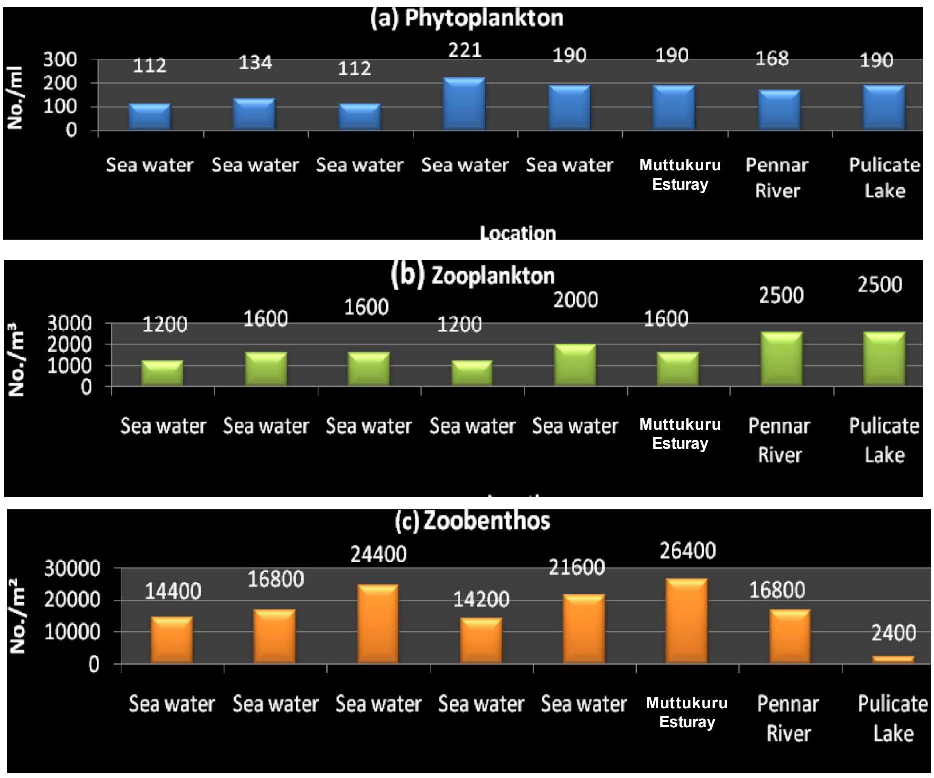


Table 6: List of Zooplankton Species Observed (Summer 2010)

Rotifera	Protozoa	Cladocera	Copepoda
Brachionus sp	*Acanthocystis sp*	*Daphnia sp*	*Cyclops sp*
Keratella sp		*Allonella sp*	*Nauplius larva*
		Moina sp	

Table 7: Zoobenthos in Sediment

S. No.	Table Benthos/m^2	Composition of Benthos Group (%)				SDI
		Foraminifera	Ostracoda	Polychaeta	Heteropoda	
Sea Bottom						
1.	14,400	50	50	-	-	1.91
2.	16,800	57.15	42.85	-	-	2.24
3.	24,400	72.72	27.28	-	-	2.23
4.	19,200	62.5	25	12.5	-	2.75
5.	21,600	55.56	11.11	33.33	-	2.50
6.	26,400	82	9	9	-	2.36
7.	16,800	71.40	28.60	-	-	1.94
8.	24,00	90	-	10	-	1.57

Table 8: List of Zoobenthos

S. No.	Family	Benthos Species
1.	Foraminifera	*Bolivina*
		Globiogerina
		Elphidum
		Calcarina
		Amphistegina
		Triloculina
		Rosalina
		Ammonia
		Globigerinita
		Rotalia
		Triloculina
2.	Ophiuroidea	*Brittle Srar*

Table 8 (Cont.)

S. No.	Family	Benthos Species
		Lymnea
		Sphaerium
		Masculium
		Anedonta
		Hydrobia
		Goniobaoss
3.	Ostracoda	*Macrocyprina*
		Cytherellioidea
		Paranesidea
4.	Polychaeta	*Polychaete larva*
5.	Oreasteridae	*Oreaster reticulatus*

higher salinity was observed by (Somani, 2002). The values of diversity index in the Thane creek ranged between 1.37- 2.17 (average 1.77). Thus the index value of zooplankton shows moderately polluted nature of water in the Thane Creek.

Zoobenthos

The data on benthos community collected from offshore, estuary and river sediment samples is presented in Table 7. The benthos count varies between 2400-26400 No./m^2 (Avg. 17750 No/m^2), it indicates that zoobenthos counts observed very less in lake water as shown in Figure 2(c) and higher count in sea water where sediment formation is more than lake. The Shannon Weiner Diversity Index (SWDI) varies from 1.92 -2.50 (avg. 2.18). It indicates medium impact of pollution or medium adverse impacts. The percent composition reveals highest count for Foraminifera followed by Ostracoda and Polychaeta. The count of benthos was observed to be highest at surface sediment than dipper bottom. The benthic fauna was represented by 11 Foraminifera, 7 Ophiuroidea, 3 Ostracoda and 1 each of Polycheta and Oreasteridae (Table 8). It was dominated by Foraminifera. Benthos were dominated more in the sediment depth of 4-6 mm and decreased progressively in the deeper layers showed patchy dispersion, related to the availability of food and predation (Ansari and Ingole, 1983). Setty, 1976 observed abundance of Foraminifera population in polluted water of Cola Bay, Goa. Higher value of benthos count may be due to the nutrient enrichment of organic contents (Mishra, 2002). Enrichment of coastal waters due to riverine flow and land runoff also seems to be one of the factors contributing to richness of fauna in nearshore regions. According to Patil *et al.*, (1975 and 2002) the availability of food and the associated chemical changes influence the population dynamics. The diversity indices for phytoplankton, zooplanktons and zoobenthos shows moderately polluted nature of water of the Thane Creek because of effluent discharge of domestic and industrial waste Kankal *et al.*, 2011.

CONCLUSION

- The average count of phytoplankton, zooplankton and zoobenthos were recorded very low numbers (151/ml, 1825/m^3 and 17750/m^2) respectively and comparatively which are very low count that indicate good quality of water.
- It is an indication that the area is free from domestic wastewater (sewage) or organic pollution.
- Higher counts of phytoplankton, zooplankton and zoobenthos in the water bodies it is an indication of domestic or industrial effluent discharge.
- SWDI = < 1 indicate maximum impact of pollution or adverse factor
- SWDI = 1-2 indicate medium impact of pollution or adverse factor
- SWDI = > 2 indicate lowest or no impact of pollution or adverse factor
- The present study shows that the average SWDI for Phytoplankton, zooplankton and zoobenthos ranged as 2.615, 2.072 and 2.18 respectively indicating lowest or no impact of pollution or adverse impact of pollution in the coastal area of Bay of Bengal near Nellure, Andhra Pradesh.

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REFERENCES

1. Ansari Z A and Ingole B S (1999)," Meiofauna of some sandy beaches of Andaman Islands", *Indian J. Marine Sciences,* Vol. 12, pp. 245-246.
2. Standarda Methods (1992), for examination of water and wastewater, APHA, AWWA, WPCE, Washington, DC.
3. Environmental Impact Assessment (EIA Report, NEERI, 2010), Palar Bessin, Nellore (AP) – Bay of Bengal.
4. Goldin Q, Athalye R P, Somani V U, Borkar M U and Patil N N (2002) "Present status of water quality of Thane Creek and Ulhas River Estuary". Proc. The National Seminar on Creeks, Estuaries, and Mangroves: Pollution and Conservation, pp. 58-62.
5. Jagadeesan P and Ayakkannu K (1992)," Seasonal variation of benthic fauna in marine zone of Coleroon estuary and inshore waters, south east coast of India", *Indian J. Marine Science,* Vol. 21, pp. 67-69.
6. Jiyalal Ram M, Vijayalakshmi R Nair and Desai B N (1990), "Distribution of phyto-plankton of Mithapur (Gujarat)", *J. of the Indian Fisheries Association* Vol. 19, pp. 49-57.
7. Kameswara Rao K, Sivadas P, Narayanan B, Jayalakshmy K V and Krishna Kutty M (1987), " Distribution of foraminifera in the lagoon of certain islands of the Lakshadweep Archipelago, Arabian Sea India", *Indian J. Marine Sciences,* Vol. 16, pp. 161-178.
8. Kankal N C, Lokhande K S, Indurkar M M and Wate S R (2011), "Biodiversity of zooplankton and zoobenthos at Thane Creek, Mumbai in west coast of India", *Asian J. Exp. Sci.*, Vol. 25, No. 2, pp. 63-71
9. Kasturirangan L R (1963), "A key for the identification of the more common planktonic copepoda of Indian coastal water", CSIR New Delhi.
10. Kinne O (1963), "The effects of temperature and salinity on marine and brackish Water Animals" *Oceanogr. And Mar. Biol., Ann. Rev.*1, pp. 301-340.
11. Kotangale J P, Ghosh T K and Gadkari A (1994), "Diversity of zooplankton and Benthos at Dahanu, Danda and Savta Creek in West Coast of India", *Proc.Acad. Environ.Biol.*, Vol. 3, No. 1, pp. 1-8.
12. Krishna Pillai N (1986), "Introduction to planktonology", Himalaya Publishing House, Bombay.
13. Menon N R, Gupta T R C, Hariharan V, Kotti R J and Shetty H P C (1977), " Marine plankton of Mangalore waters - a pre pollution assessment", in *Proc. Symp. Warm water Zooplankton*, NIO, Goa. pp. 274-283.
14. Mishra V (2002), "Study of macrofauna and mangrove mudflats of Ulhas river estuary", Ph.D. Thesis, University of Mumbai, Mumbai.
15. Patil N N, Goldin Q, Somani V U, Kurve P N and Athalye R P (2002), "Study of zooplankton distribution from Ulhas River Estuary and Thane Creek", in Q Goldin (Ed.), *Proc. The National Seminar on Creeks, Estuaries, and Mangroves: Pollution and Conservation*, pp. 109-115.

16. Patil H S, Dodakundi G B and Rodgi S S (1975), "Succession on zooplankton and phytoplankton in a sewage stabilization pond", *Hydrobiologia*, Vol. 47, pp. 253-265.

17. Setty M G A P (1976), "The relative sensitivity of benthonic foraminifera in the polluted marine environment of Cola Bay, Goa" in Proc. VI Ind. Coll. Micropal. Strat, pp. 225-234.

18. Somani V U, Patil N N, Goldin Q, Athalye R P (2002), "Study of rotifers in Thane Creek and Ulhas River Estuary", in Q Goldin (Ed.), Proc. The National Seminar on Creeks, Estuaries, and Mangroves: Pollution and Conservation, pp. 103-105.

19. Srinivasan A and Santhanam R (1991): "Tidal and Seasonal variations in zooplankton of Pullavazhi brackish water, south east coast of India", *Indian J. Marine Sciences,* Vol. 20, pp.182-186.

20. Tiwari L R and Vijayalakshmi R Nair (2002), "Plankton biodiversity of Dharamtar Creek adjoining Mumbai Harbor", *Proc. The National Seminar on Creeks, Estuaries, and Mangroves: Pollution and Conservation*, pp. 96-102.

21. Wickstead J H (1965)," An introduction to the study of tropical plankton", *Hutchinson Tropical Monographs*.