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Diversity status of zooplankton & water quality assessment of coast of Alang shipbreaking yard, Bhavnagar district, Gujarat, India

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Abstract
The study was carried out to check the seasonal variation in zooplankton diversity & water quality of Alang shipbreaking yard, Gujarat coast, India. A total number of 18 group of zooplankton were recorded. Among these groups, Foraminifera, Tintinnids, Copepoda (Calanoida, Cyclopoida, Harpacticoida), Mysis larvae, Nauplius larvae were found common during the year. Maximum diversity was found during winter and minimum in summer. Maximum zooplankton density found in winter (39.56%) and minimum density found in Monsoon (21.97%). Salinity, Temperature, Turbidity & TSS (total suspended solid) showed more seasonal variation value compare to other water quality parameters.

Keywords: Zooplankton, diversity and distribution, Arthropoda, Gulf of Khambhat, India

Introduction
Large variety of organisms are found in sea water, so it is called dwelling place in earth [1]. Main three groups of marine organisms are found in ocean and these are plankton, nekton and benthos. The term plankton refers to any small organisms (from microns to centimeters) living in the water and drifting by water currents. Plankton denotes a group of organisms either animals or plants. The animal plankton is known as zooplankton & plant plankton is a Phytoplankton. Both phyto-zoo plankton are vital components of the marine, estuarine and freshwater ecosystems [2]. Majority of them are microscopic, unicellular or multicellular forms with size ranging from a few microns to a millimeter or more. They are small animals found near the surface in aquatic environments. They are usually weak swimmers and mostly drifting by the water currents [3]. In marine eco-system, zooplankton plays an important role as a link in marine food web, connecting the energy transfer between primary producers and higher level organisms, such as shrimp to fishes [4]. Phytoplankton and marine bacteria are main food source of zooplankton. Zooplankton is also play very important role as a biological indicator organism in the marine life. Any changes in zooplankton community could affect the community of primary producer to higher trophic level organisms [5]. Zooplankton comprises the second level in the food chain and includes tintinnids, foramonifers, amphipoda, copepoda, calanoida, different larvae of benthic invertebrates and fish larvae etc. Copepoda, crustacean larvae and protozoan are widely distributed zooplankton in the aquatic and fresh water environments. The Zooplankton of the Arabian sea largely comprised of group copepoda [6]. In marine zooplankton, mostly abundant crustaceans larvae is nauplius larvae [7]. Physical & Chemical properties of water are important to the diversity & distribution of zooplankton or any other flora and fauna in marine, estuary & freshwater ecosystem [8, 9].
Alang is the largest ship shipbreaking yard in the world. However, very few researchers worked on diversity and ecological status of zooplankton particular Alang & Bhavnagar coastal area. Vacharajani & Mankodi *et al*. (2007) [10]. Surveyed and identified the 7 group of zooplankton from Gopnath (near alang) coast of Gulf of Khambhat, Gujarat. Tewari *et al*. 2001 [11]. Reported 8 group of zooplankton from alang and piram(10 km away from alang). Total 64 genera of phytoplankton and 19 groups of zooplankton were recorded in different coastal area of Gujarat [12]. Many reports on pollution and EIA study also reported about the plankton diversity at alang coast.
Due to ship scrapping activity, higher contents of heavy metals (specially iron) and other scrapping materials have been recorded in sea water of Alang which are hazardous for the

fauna, flora and human life [13-16]. Tewari *et al*. 2001 [11] reported that species diversity and biomass of biota at Alang were mostly effected by heavy metals & petroleum hydrocarbon pollution. Study of zooplankton is necessary for understand the ecological status of biota of any water reservoir (marine, estuary and fresh water).

Materials and Methods

Study area

India has a long coastline of 8,118 kms. Gujarat, the state of India, located on the country's western coast, on the Arabian Sea. Total coastline of Gujarat is 1,600 km and it has two gulf, Gulf of Kachchh and Gulf of Khambhat. The gulf of Khambhat is an inlet of the Arabian Sea on the western side of India. It is a situated between Saurashtra peninsula and mainland of Gujarat. Saurashtra region is located south-west part of Gujarat. The surrounding area along the gulf of Khambhat consists of 7 districts and one of them is Bhavnagar. The coastline of Bhavnagar District is muddy due to heavy discharge of suspended particles (silt, clay and sand) and other materials brought by the Sabarmati, Narmada, Mahi and Tapi, Bhadar Rivers (mainly south Gujarat rivers). Because of heavy runoff freshwater, the water of Gulf of Khambhat is turbid [17]. Approximately 10 kms long sea front on the western coast of the Gulf of Khambhat. Alang, shipbreaking yard (21°23'26.92"N, 72°10'32.67"E) situated on north-west edge of Gulf of Khambhat. By road it is about 50 kms distance from Bhavnagar district. The location map of alang coast is presented in Figure 1.

Methods

The zooplankton samples were taken from surface water of intertidal area by filtering 30 liter of seawater through Nylon plankton Net (conical shape), mesh size of 60 micron. Sample was carefully labeled and preserved immediately on using 5% formaldehyde, stained with Rose bengal solution. The plankton counting chamber (Sedgwick rafter cell) was used for identification and counting of zooplankton samples. Samples observed under Trinocular microscope (ZEISS Trinocular microscope). Zooplankton was identified with the help of different zooplankton identification field manuals [1, 18, 19] and other standard literatures, monographs, research papers etc. Lackey's drop count method was used for study of zooplankton [20]. Water analysis was done by different instruments and different standard methods. Water samples were collected monthly from November-2015 to October-2016. Samples were brought to the laboratory for further analysis. Samples were stored in cleaned, air dried plastic bottles. The air and water temperature were measured using a standard mercury centigrade thermometer. The water pH, TDS (Total dissolved solid) and Conductivity were measured by Multi-Parameter PCSTestr-35 (OAKTON, EUTECH). The Multi-Parameter PCSTestr-35 was calibrated with standard buffer chemicals prior to use. The water salinity was measured by using Handy Refractometer. The Turbidity was measured by Nephelometer CL 52D (ELICO). DO (Dissolved oxygen) and BOD (Biological oxygen demand) of water were measured by standard Winkler's method. TSS (Total suspended solid) was done by water filtration method. Spectrophotometric method was used for chlorophyll-a estimation. Generally there are three main season in Saurashtra region (Gujarat, India),Winter (November to February), summer (March to June) and monsoon (July to August). The study period covers 12 month of data (November 2015 to October 2016) that represented these three main season.

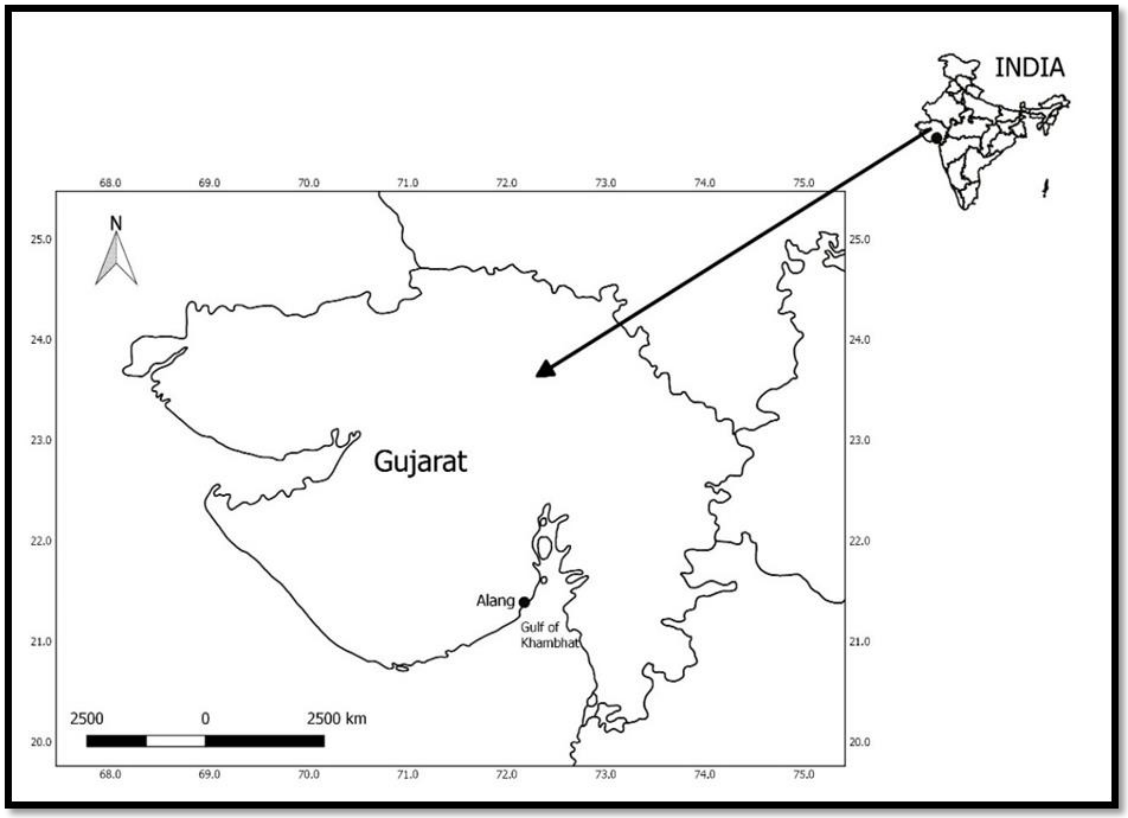

Fig 1: Location map of Alang coast, Gujarat, India

Result and Discussion

Total 18 group of zooplankton including from 9 class and 8 animal phyla were found in study area during study period. Among them 10 Artropoda, 2 Protozoa, and other phylum like Coelenterates, Annelida, Mollusca, Echinodermata, Rotifers, and Chordata comprising single group of zooplankton (Table-1). Among 18 groups, zooplankton diversity maximum recorded during winter (15) next to monsoon (14) and summer (12). Foraminifera, Tintinnids, Copepoda (Calanoida, Cyclopoda, Harpacticoida), mysis larvae, nauplius larvae,veliger larvae were found almost every season of year. Group wise seasonal mean density of zooplanktonat Alang described in (Table-2). Zooplankton density maximum found in winter (39.56%) next to summer (38.46%) and monsoon (21.97%). Zooplankton density (no/l) recorded maximum in winter and minimum in monsoon (Figure-2). Maximum number of density was found of phylum Arthropoda (63.37%) followed by Protozoa (15.47%), Mollusca (15.32%), Colentreata (2.35%), Chordata (1.51%), Annelida (0.83%), Rotifera (0.72%), Echinodermata (0.62%) (Figure-3). In total recorded zooplankton density, maximum density comprise by Copepoda (28.56%) followed by Nauplius larvae (20.20%), Veliger larvae (15.32%), Foraminifera (11.12%) and then other zooplankton. During sample analysis some phytoplankton were also observed like *Synedra sp*, *Nitzschia sp*, *Amphipora sp*, *Biddulphia sp*, *Coscinodiscus sp*, *Pleurosigma sp*, *Gyrosigma sp*, *Melosira sp*, *Bacteriostrum sp*, *Navicula sp*, *Thalassiothrix sp*, *Surirella sp* etc.

Abiotic factors like Temperature, Salinity, Turbidity, TDS (Total dissolved solids), TSS (Total suspended solids), DO (Dissolved oxygen), BOD (Biological oxygen demand) were influenced mostly by the weather condition, tide condition and monsoon season. Minor and major variations were showed in various water quality parameters during study period (Table-3). Range of Air temperature was 25 °C to 34.5 °C during study period (November to October, maximum was in summer (32.3 °C) & minimum in winter (28 °C). Sea water temperature was recorded 21 °C to 36 °C, maximum was in summer (31 °C) & minimum was in winter (24.5 °C). pH showed normal and alkaline range 7.5 to 8.3, maximum in winter (8) & minimum in summer and monsoon (7.8). Higher value of turbidity (NTU) was recorded 402NTU to 904NTU, maximum in summer (620NTU) & minimum in monsoon (541NTU). The salinity range was varied from 26‰ to 39‰, highest in summer (36.2‰) and lowest in monsoon (31.7‰). The range of TSS (Total suspended solid) showed wide variation 1984 mg/l to 7860 mg/l, maximum in monsoon (4644 mg/l) & minimum in summer (3551 mg/l). TDS (Total dissolved solid) was recorded 2.02ppt to 16.8ppt, maximum was in monsoon (9.53ppt) & minimum in summer (6.90ppt). Conductivity range was 3.10mS to 18.15mS during study time, maximum conductivity was recorded in winter (11.93 mS) & minimum in summer (10.55 mS). DO (Dissolved oxygen) showed normal variation and very near to low value 2.72 mg/l to 4.54 mg/l, maximum in winter (4 mg/l) & minimum in monsoon (3 mg/l). BOD (Biological oxygen demand) was recorded from 0.5 mg/l to 2.4 mg/l, maximum in summer (1.67 mg/l) & minimum in monsoon (1 mg/l).

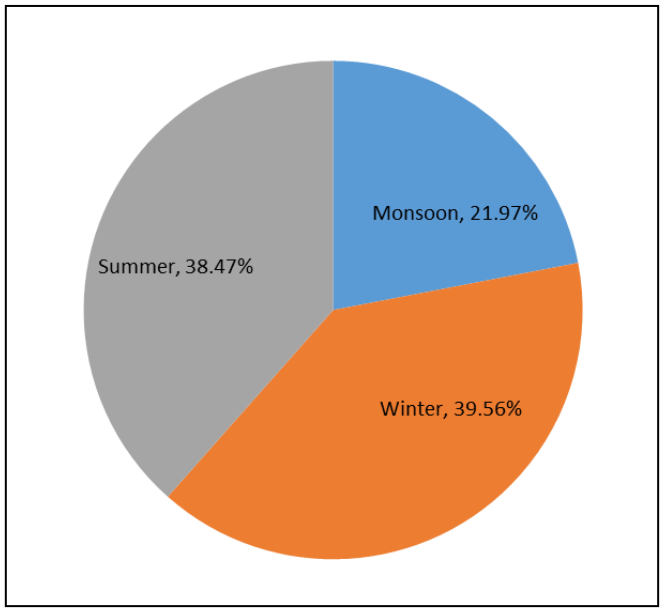

Fig 2: Seasonal variation of zooplankton density.

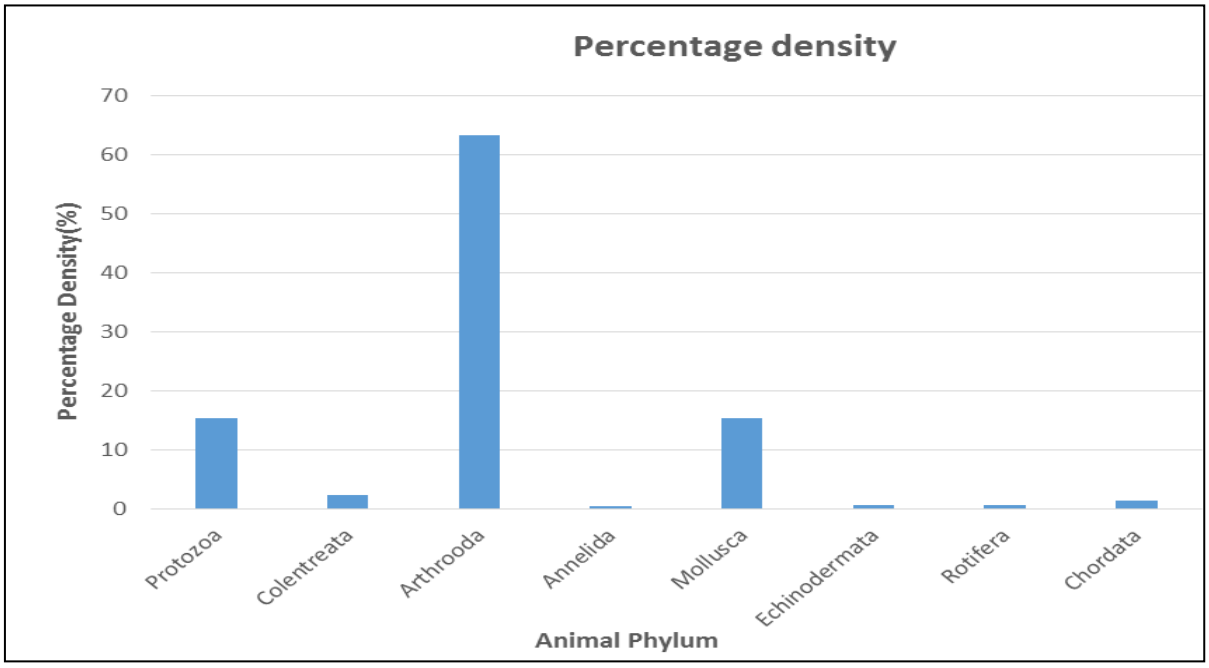

Fig 3: Percentage of Phylum wise zooplankton density

Table 1: Zooplankton diversity at Alang shipbreaking yard

Sr no.	Name of Group	Phylum	Class	Winter	Summer	Monsoon
1	Foraminifera	Protozoa	Flagellata	+	+	+
2	Tintinnida		Cillita	+	+	+
3	Planula larvae	coelenterate	Scyphozoa	+	+	-
4	Calanoida	Arthropoda	Crustacea	+	+	+
5	Cyclopoida			+	+	+
6	Harpacticoida			+	+	+
7	Mysis larvae			+	+	+
8	Nauplius larvae			+	+	+
9	Zoea larvae			+	-	-
10	Megalopa larvae			+	-	-
11	Ostracoda			+	-	+
12	Amphipoda			-	+	+
13	Cladocera			+	+	+
14	Polychaeta larvae	Annelida	Polychaeta	-	+	+
15	Veliger larvae	Mollusca	Bivalvia	+	+	+
16	Bipinnaria larvae	Echinodermata	Asteroidea	+	-	-
17	Rotifera	Rotifera	Monogononta	-	-	+
18	Fish larvae	Chordata	Chondrichthyes	+	-	+
Total	18	8	9	15	12	14
Winter(November to February), Summer(March to June), Monsoon(July to August)						

Table 2: Group wise seasonal mean density of zooplankton at Alang shipbreaking yard

Sr no	Name of Group	Winter (no/l)	Summer (no/l)	Monsson (no/l)	Total (no/l)
1	Foraminifera	9.18	2.83	5.70	17.71
2	Tintinnids	1.82	2.5	2.62	6.94
3	Planula larvae	1.75	2.0	-	3.75
4	Calanoida	5.8	11.24	6.83	23.87
5	Cyclopoida	3.66	7.58	2.08	13.32
6	Harpacticoida	0.7	6.49	1.25	8.31
7	Mysis larvae	2.91	2.79	0.79	6.49
8	Nauplius larvae	21.34	9.51	1.33	32.18
9	Zoea larvae	0.88	-	-	0.88
10	Megalopa larvae	0.45	-	-	0.45
11	Ostracoda	0.87	-	4.99	5.86
12	Amphipoda	-	3.33	0.41	3.74
13	Cladocera	2.75	1.58	1.5	5.83
14	Polychaeta larvae	-	0.33	0.5	0.83
15	Veliger larvae	9.32	11.08	4	24.4
16	Bipinnaria larvae	1	-	-	1
17	Rotifera	-	-	1.16	1.16
18	Fish larvae	0.58	-	1.83	2.41
	Total (no/l) and percentage	63.01 (39.56%)	61.26 (38.47%)	34.99 (21.97%)	159.26

Table 3: Seasonal variation in water quality parameters

Sr no	Water quality parameter	Winter	Summer	Monsoon
1	Air Temperature (°C)	28	32.3	31.3
2	Water Temperature (°C)	24.5	31	30
3	pH	8	7.8	7.9
4	Salanity (‰)	35.8	36.2	31.7
5	Turbidity (NTU)	546	620	541
6	TSS (mg/l)	3600	3551	4644
7	TDS (ppt)	8.87	6.90	9.53
8	DO (mg/l)	4.0	3.4	3
9	BOD (mg/l)	1.01	1.67	1
10	Conductivity (m S)	11.93	10.55	10.67
11	Chlorophyll a (µg/l)	18.82	16.43	13.86
TDS (Total dissolved solids), TSS (Total suspended solids), DO (Dissolved oxygen), BOD (Biological oxygen demand).				

Conclusion

This Study indicated that coast of alang has the favorable environment (specially winter and summer) for arthropoda, mollusca and foraminifera zooplankton. Very low value of density and diversity of annelid, coelenterata and echinodermata were recorded and that indicate animal of these phylum are lower density in Gulf of Khambhat. DO (Dissolved oxygen) was recorded near low level range but BOD (Biological oxygen demand) was not recorded at standard pollution level but in normal range. The value of DO & BOD was high in summer and winter compare to monsoon. Salinity and Dissolved oxygen level was slightly low whereas

total suspended solid and turbidity recorded high range during monsoon, this may be the reason of lower density in monsoon. Previous study regarding pollution level showed that Heavy metals & Petroleum hydrocarbon pollution more in this yard and their effect on marine biota may be different level so detail study regarding pollution level and its effect on marine biota. The present study provides knowledge about primary resources for the food chain (lower organisms to higher organisms) of particular coastal area and about the population dynamics of zooplankton in marine ecosystems.

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