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ZOOPLANKTON DIVERSITY AND PHYSICOCHEMICAL PARAMETERS OF HIRAN RIVER AND A VERAVAL COASTAL REGION, GUJARAT, INDIA

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ABSTRACT
Qualitative analysis of zooplankton besides physicochemical parameters of water was carried out during the study. In the present study, we had compared the relationship between zooplankton diversity and water quality parameters of Hiran River and Veraval Coastal area. The present study was carried out from September 2019 to February 2020. In the current investigation, impact of different physicochemical parameters on zooplankton population was investigated. Data analysis highlighted significant difference in zooplankton abundance among the various types of water body. During the study parameters like pH, TS, TSS, TDS, DO, BOD, Total hardness, Ca^{++} hardness, Mg^{++} hardness, Electric conductivity, Na and K were recorded. Zooplanktons are bio-indicators of water ecosystems. Their diversity depends on the water conditions. They play an integral role in transfer of energy to the consumers hence they form the second tropic level in the energy flow. The findings of the present study provide useful knowledge on the spatial organization of zooplankton diversity in different types of water bodies.

INTRODUCTION

The oceans covers over seventy one percent of the planet surface regulating the weather conditions of the earth, supplying living and non-living resources and providing social and economic product and services for the human population. Among the marine ecosystems, coastal areas of the ocean are more fertile and productive regions of the sea. Ecosystem is defined as 'the complex of a community of organisms and its environmental functioning as an ecological unit'. An aquatic ecosystem that is based on water, whether it is a pond, lake, river or ocean, Which constitute as the biotic factors and their relationship with their surrounding environment, which collectively can be referred to as the abiotic factor. Main three groups of marine organisms are found in ocean and these are plankton, nekton and benthos. Zooplankton has been derived from the two Greek words "zoon" which means 'animal' and "plankton" suggest that 'wandering'. The term plankton refers to any small organisms (from microns to centimetres) living within the water and drifting by water currents. Plankton denotes a bunch of organisms either animals or plants. Both Phyto and Zoo plankton are vital components of the marine, estuarial and fresh water ecosystems (Baxi *et al*., 2018). Shingoda River is lifeline of Gir Somnath district because it supplies water for irrigation and other uses to adjoining populations. Normally water flows in Shingoda River from June to January and Saraswati River supply water from June to November (Raval *et al*., 2019). Hiran river has source near the Sasa hills in Gir forest. Their drainage basins merge with Arabian Sea near Somnath temple, Gujarat India. Its major tributaries are Saraswati river and ambakhoi stream, and lots of different branches make the river almost complete near a place called Talala. A variety of wildlife, ecological system is supported by Hiran River. Some of the major projects on the river are Kamleshwar dam and Umrethi dam. The productivity of any aquatic system can be judged by phytoplankton biomass. As the river flows from the western part of Gir forest, it is one of the major sources of water for the forest ecology and biodiversity (Tank and Vyas 2019). Physicochemical parameters are very important factors that play a significant role in water bodies, plankton diversity and fluctuation. Phytoplanktons are free floating unicellular, filamentous and colonial autotrophic forms of aquatic habitat movement of which is dependent on water currents (Millman *et al*., 2005). Reports on his monitoring of vital water quality parameters, phyto and zooplankton, diversity of benthos and ecological status of the intertidal macrofauna were very less (Vaghela *et al*., 2010). A varieties of planktonic organisms also resides in this wetland. Changes in its quality and quantity of water affect the abundance of Cyanobacterium *Arthrospira fusiformis* (Raval and Vyas 2019). Zooplanktons are small heterotrophic animals inhabiting the oceans at all depths and occupying almost every short of aquatic environment. They are considered as chief converter of food from plant source to animal source (Rajesh *et al*., 2013). Water is the life of animals and plants and is referred to as Lifeline. It is important to study the natural conditions which are helpful in propagation of aquatic flora and fauna (Shukla and Shukla 2013). The paper deals with the zooplankton diversity and physicochemical parameters of Hiran River and a Veraval Coastal Region of Gujarat, India.

MATERIALS AND METHODS

Two sample collection points were selected from River Hiran and a Coastal site of Veraval. Samples were collected from suitable depth and surface. Specific GPS locations were noted down. GPS location of Hiran River is 20°54′35"N70°21′07"E and GPS location of Veraval Chowpati is 20°53′57"N70°25′39"E. Water samples were collected in sampling bottle.

Five-litre water samples were collected for physicochemical test, from less than 1.5 feet of river water and Coastal water. All samples were transferred to laboratory for further testing.

Map of sampling sites: (fig: 1 to 3)

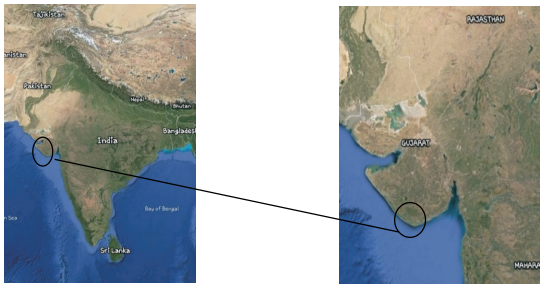


Figure. 1: selected site locations)

Source

google earth retrived on 25 march, 2020 (map is not to scale)

Sample Collection for Zooplankton Analysis

The samples were collected by filtering seven litre water through plankton net of 20μm mesh size filtering cloth and concentrated up to 100 ml. two sampling sites were selected. The zooplankton samples were collected from surface water by filtering 30 liter of seawater through Nylon plankton Net (conical shape), mesh size of 60 micron. Sample was carefully labeled and preserved immediately by using 5% formaldehyde. Zooplankton was identified with the help of various zooplankton identification manuals (Mitra *et al.*, 2004 and Goswami 2012). The samples were analyzed qualitatively under the Compound microscope and Light microscope for the study of diverse types of zooplanktons (Goswami and Mankodi, 2012).

Physicochemical Parameters

During the study period, Total twelve Parameters of these collected water Samples were analyzed. These parameters are pH, TS, TDS, TSS, DO, BOD, Total Hardness, Ca^{++} hardness, Mg^{++} hardness, EC, Sodium, Potassium. Zooplanktons were considered as biological indicators. Zooplanktons were collected by using plankton net having 300mm mesh size. Analytical procedures for all water quality parameters were as per (APHA 1995).

RESULTS AND DISCUSSION

Hiran river is passing through many villages of Gir-Somnath District. Hiran River lastly meets in to Arabian sea. The quality of river water is governed by some physicochemical and biological parameters. Table 1 shows physico chemical parameters of Hiran river. Our second sampling site was part of Arabian sea. Second sampling site was marine water of veraval coast (chowpati). In the present research work we have investigated interactions between physicochenical parameters and zooplankton diversity. Table 2 shows physicochemical parameter of veraval coast.

According to (Baxi *et al.*, 2018) pH showed normal and alkaline range 7.5 to 8.3, maximum in winter (8) and minimum in summer and monsoon (7.8). In our study the average pH of coastal water was 8.2. The highest pH was recorded as 9 in January and lowest pH was recorded 7.4 in February. The range of TSS (Total suspended solid) showed wide variation 1984 mg/L to 7860 mg/L, maximum in monsoon (4644 mg/L) and minimum in summer (3551 mg/L). In our study the average TSS of coastal water was recorded 1180.8 mg/L. The highest TSS was recorded 1283 mg/L in February and lowest TSS was recorded 1075 mg/L in January. TDS (Total dissolved solid) was recorded 2.02ppt to 16.8ppt; maximum was in monsoon (9.53ppt) and minimum in summer (6.90ppt). In our study the average TDS of coastal water was recorded 763 mg/L. The highest TDS was recorded 835 mg/L in January and lowest TDS was recorded 708 mg/L in September.

The highest pH value 8.57 and EC 2.15 highest recorded in Triveni Sangam (Tank and Vyas 2019). The minimum value of pH 7.83 sasan and EC 0.43 were recorded in Bhalchhel. In our study the average pH of Hiran River was recorded 7.8. The highest pH was recorded 8.3 in January and lowest PH was recorded 7 in September. The average EC of Hiran river was recorded 6171.5 μs/cm. The highest EC was recorded 6453 μs/cm in September and lowest EC was recorded 5800 μs/cm in February. The highest Potassium 3.71 mg/L highest recorded in Umrethi known as a Hiran II. The minimum value of Potassium 2.57 mg/L recorded in Kamleshwer dam. The average of Potassium was 3.10 mg/L (Tank and Vyas). In our study the average potassium of Hiran River was recorded 4.216 ppm. The highest potassium was recorded 4.8 ppm in January and lowest potassium was recorded 3.2 ppm in December.

According to study of (Pal *et al.*, 2015), Turbidity in consideration of total suspended solids (TSS) was high at manmade wetland (24.5 NTU) than natural wetland (5.64 NTU). Surface water temperature at natural wetland was 18.60C and at manmade wetland was 20.30C. In our study the average TSS of Hiran River was recorded 507.66 mg/L. The highest TSS was recorded 1150 mg/L in January and lowest TSS was recorded 546 mg/L in September (Sampling site Hiran River). (Pal *et al.*, 2015) During study fifteen types of Zooplanktons were primarily identified from the water sample of natural wetland. Out of those, two are crustacean larvae (Nauplius sp. and Zoea sp.), five are Cladocera's (Miona sp., Chydorus sp., Diphanosoma sp., Alona sp. and Daphnia sp.), four are Copepods (Heliodiaptomus sp., Cyclops sp., Mesocyclops sp., and Tropocyclops sp.) one was Ostracod (Cypris sp.) and the remaining three are Rotifers (Brachionus sp., Keratella sp. and Lacane sp.). In the water sample of manmade wetland, four types of zooplanktons were primarily identified. All of identified species from MWL (manmade wetland) are in adult form and all of the species belong to the order-Copepoda (Cyclops sp., Heliodiaptomus sp., Tropocyclops sp.

and Mesocyclops sp.). So, the samples collected from manmade wetland shows copepod dominance. Fifteen types of zooplanktons were primarily identified from the water sample of natural wetland. Whereas, in the water sample of

Figure. 2: Veraval coastal sampling site)

Figure 3: Hiran river sampling site)

Table 1: Physicochemical Parameters of Hiran River

No.	Parameters	Sep	Oct	Nov	Dec	Jan	Feb
1	pH	7	7.8	8	7.5	8.3	8.2
2	TS (mg/L)	1200	1485	1285	1307	1500	1435
3	TSS (mg/L)	546	950	840	697	1150	983
4	TDS (mg/L)	654	535	445	610	350	452
5	DO (mg/L)	6	5	4.8	6.2	6.7	5.3
6	BOD (mg/L)	4.8	4.5	3.9	5.4	5	3.6
7	TOTAL Hardness(mg/L)	117	138	166	200	177	182
8	Ca++ Hardness(mg/L)	45	58	72	43	105	116
9	Mg++ Hardness(mg/L)	72	80	94	157	72	66
10	EC (μs/cm)	6453	5800	6048	6410	5920	6398
11	SODIUM (ppm)	23	29.8	28	30. 4	32	29
12	POTASSIUM (ppm)	3.7	5	4	3.2	4.8	4.6

Table 2 :Physicochemical Parameters of Coastal water

No.	Parameters	Sep	Oct	Nov	Dec	Jan	Feb
1	pH	8	8.5	7.9	8.4	9	7.4
2	TS (mg/L)	1800	1985	1808	2052	1910	2108
3	TSS (mg/L)	1092	1303	1083	1249	1075	1283
4	TDS (mg/L)	708	682	725	803	835	825
5	DO (mg/L)	4	4.9	3.4	5	3.8	4.2
6	BOD (mg/L)	1.3	1.6	2	1	2.2	1.9
7	TOTAL Hardness(mg/L)	562	650	704	648	758	789
8	Ca++ Hardness(mg/L)	170	182	203	162	216	193
9	Mg++ Hardness(mg/L)	392	468	501	486	542	596
10	EC (μs/cm)	42050	29080	32500	38700	40200	33030
11	SODIUM (ppm)	1734	1935	1845	2003	1676	1750
12	POTASSIUM (ppm)	380	290	320	298	308	353

Table 3 :Diversity of Zooplankton-Hiran River

Zooplankton diversity of Hiran River										
	Species	Abundance						Representation by group and individual species		
No.	Zooplankton	Sep	Oct	Nov	Dec	Jan	Feb	Total	Avg	% of diversity
1	Acrocalanus gibber	2	1	0	2	0	4	9	1.5	14.28
2	Acrocalanus gracilis	3	0	2	2	1	0	8	1.33	12.69
3	Branchionus falcatus	0	0	2	0	1	1	4	0.66	6.349
4	Branchionus forficula	1	0	2	0	0	1	4	0.66	6.349
5	Calanopia minor	0	1	0	2	4	0	7	1.166	11.11
6	Copepod nauplii	0	1	0	3	2	3	9	1.5	14.28
7	Kerattla tropica	2	0	0	0	3	0	5	0.83	7.936
8	Microcyclop rubellus	3	1	0	2	0	0	6	1	9.523
9	Pseudodiaptomus aurivilli	2	1	0	1	0	0	3	0.5	4.761
10	Temora discaudata	1	0	2	3	1	1	8	1.33	12.69
11	Tortanus barbatus	0	0	2	1	0	1	4	0.66	6.349
	Total							67	11.136	

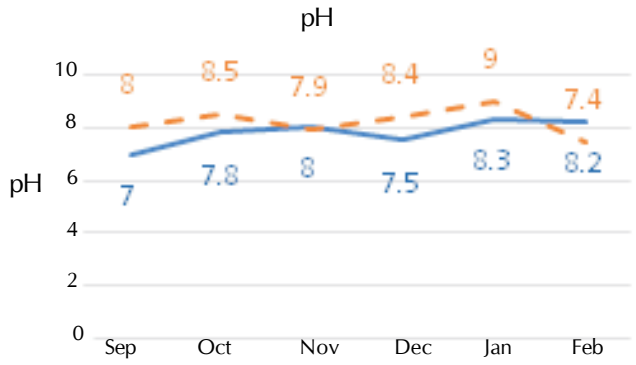
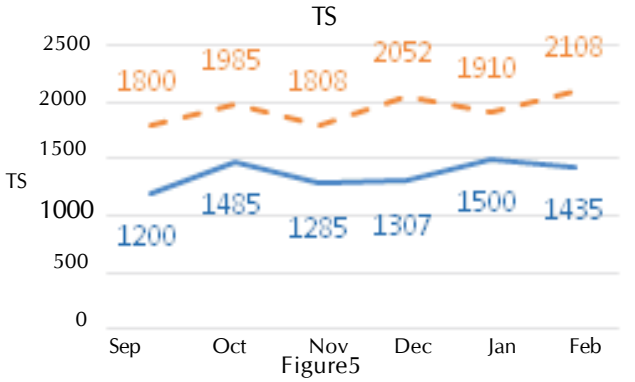


Figure 4



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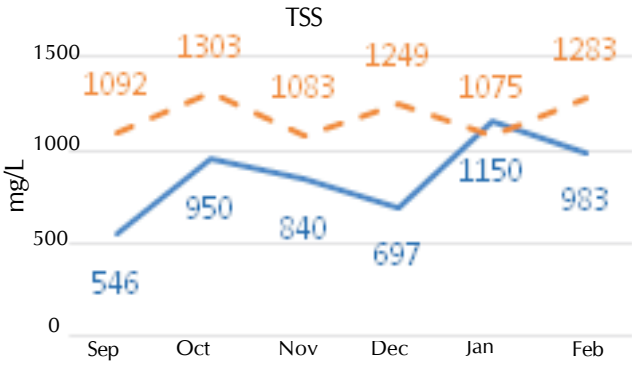

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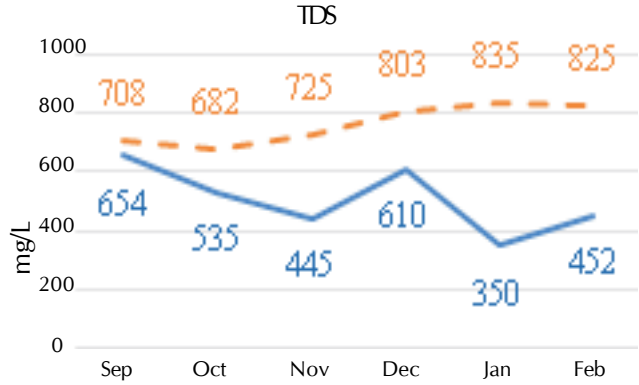

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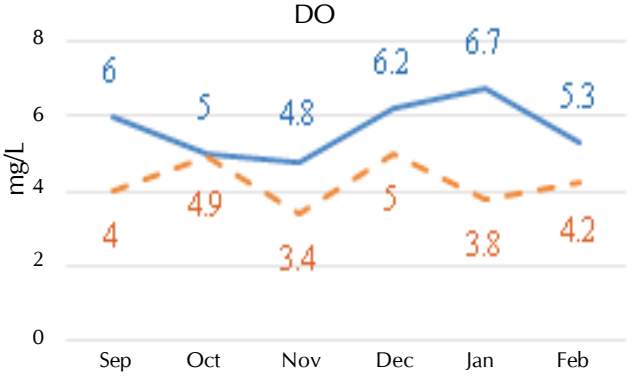

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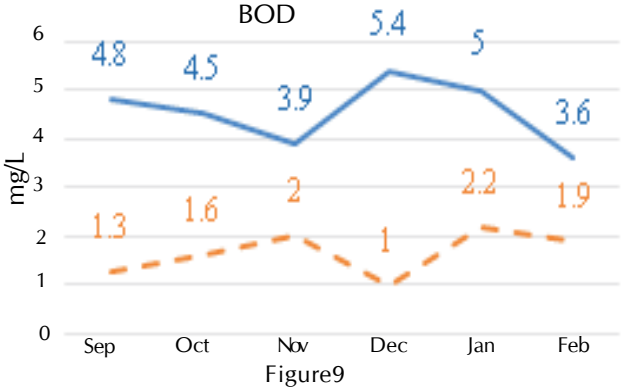

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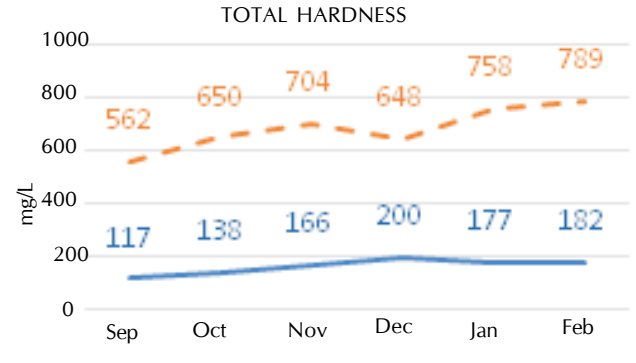

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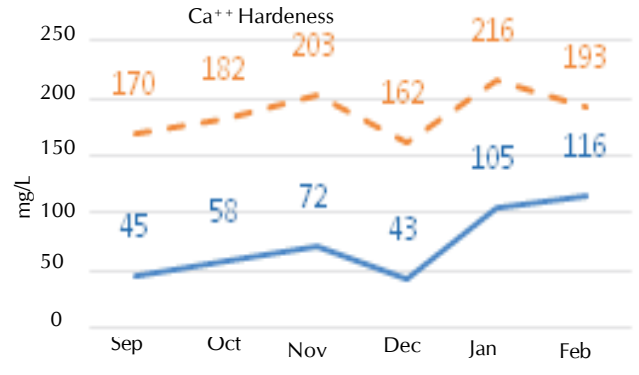
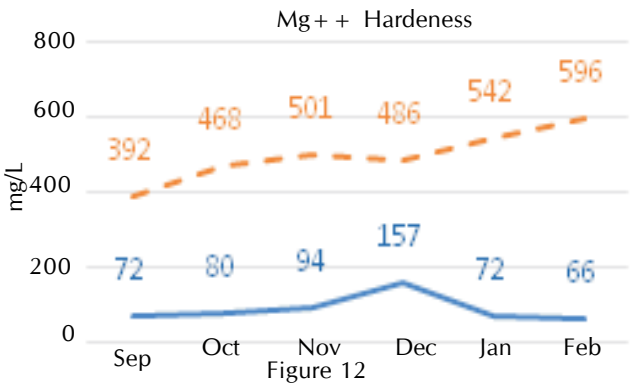


Figure11

manmade wetland, only four types of zooplanktons were primarily identified. Natural wetland sample contains two crustacean larvae, five Cladocera species, four Copepod species, one Ostracod species and three Rotifer species. Whereas manmade wetland sample contains only four Copepod species. So, natural wetland shows higher species



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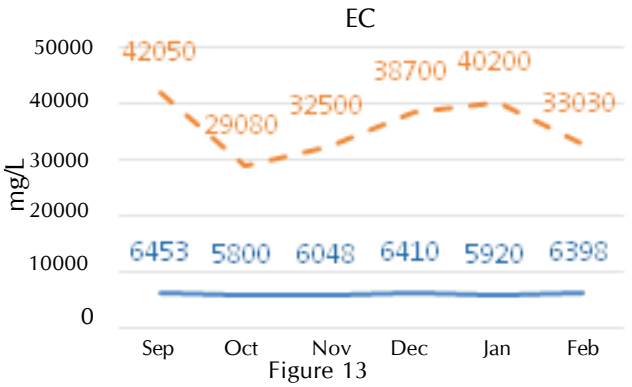

Figure 13

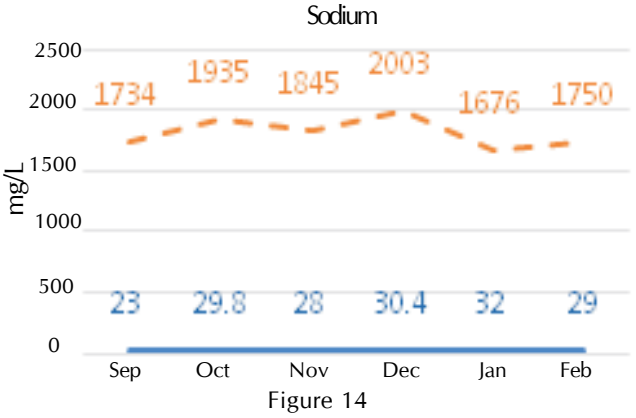

Figure 14

Data from Veraval Coast

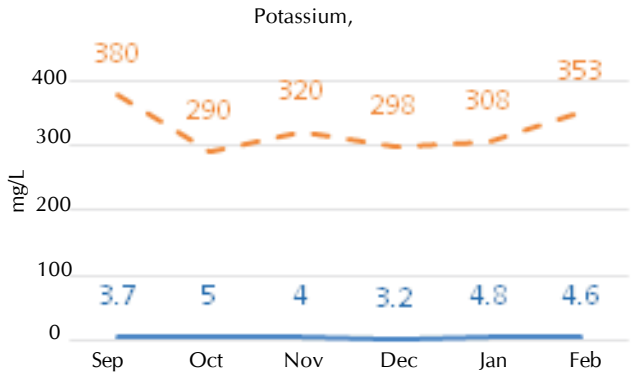

Figure 15

Data from Hiran River

Table 4 : Diversity of Zooplankton-Veraval coast

Zooplankton diversity of Veraval Coast										
	Species	Abundance						Representation by group and individual species		
No.	Zooplankton	Sep	Oct	Nov	Dec	Jan	Feb	Total	Avg	% of diversity
1	Acartica clausi	2	0	1	1	0	2	6	1	11.53
2	Acrocalanus gibber	1	0	3	1	0	1	6	1	11.53
3	Calanopia minor	1	0	2	1	0	1	5	0.83	9.61
4	Calanus finmarchicus	0	1	0	2	2	0	5	0.83	9.61
5	Copepod nauplii	0	2	1	0	3	2	8	1.33	15.38
6	Crustacean larva	0	2	1	0	1	0	4	0.66	7.69
7	Diphanosoma brachyurum	2	1	0	1	0	1	5	0.83	9.61
8	Lecane luna	0	1	1	0	0	1	3	0.5	5.76
9	Microcyclop rubellus	2	1	0	0	3	1	7	1.166	13.46
10	Microstella rosea	0	1	0	2	1	0	3	0.5	5.76
	Total							52	8.646	

diversity than manmade wetland. In our study Total 11 species of zooplankton were observed and total 67 individual were observed. There were highest 16 individual in December. Lowest 10 individual of the zooplankton were observed in November. Out of those eight are belongs to crustacea and three are belongs to rotifera.

During the study we recorded a total of 16 species of zooplankton. In our study we recorded crustacean larvae as well. As shown at table no. 3 a total 11 species of zooplankton were observed and total 67 individual belonging to eleven species were observed. There were highest 16 individual in December. Lowest 5 individual of the zooplankton were observed in October. Total 10 species of zooplankton were observed and total 52 individual were recorded (table no. 4). There were highest 10 individual in January. Lowest 8 individual of the zooplankton were observed in December and September.

(Baxi *et al*., 2018) According to his study total 18 group of zooplankton including from 9 class and 8 animal phyla were found in study area during study period. Among them 10 Arthropoda, 2 Protozoa, and other phylum like Coelenterates, Annelida, Mollusca, Echinodermata, Rotifers, and Chordata comprising single group of zooplankton. Among 18 groups, zooplankton diversity maximum recorded during winter (15) next to monsoon (14) and summer (12). Foraminifera, Tintinnids, Copepod (Calanoida, Cyclopoda, Harpacticoida), Mysis larvae, nauplius larvae, veliger larvae were found almost every season of year. maximum Zooplankton density was found in winter (39.56%) next to summer (38.46%) and

Table 5: Comparative Zooplankton Diversity of – Hiran River and Veraval coast

No.	Zooplankton species	Author (Year)	Hiran river	Veraval Coast
1	*Acrocalanus gibber*	Giesberecht (1988)	+ + + + +	+ + +
2	*Acrocalanus gracilis*	Giesberecht (1988)	+ + + +	-
3	*Acartica clausi*	Giesberecht (1889)	-	+ + +
4	*Branchionus falcatus*	Zacharis (1898)	+ +	-
5	*branchionus forficula*	Wierzejski (1891)	+ +	-
6	*Calanus finmarchicus*	Gunnerus (1770)	-	+ + +
7	*Calanopia minor*	Scott A. (1902)	+ + + +	+ + +
8	*Copepod nauplii*	Milne Edwards (1840)	+ + + + +	+ + + +
9	*Diphanosoma brachyurum*	Gliwicz (1969)	-	+ + +
10	*Kerattla tropica*	Apstein (1907)	+ + +	-
11	*Lecane luna*	Muller (1776)	-	+ +
12	*Microstella rosea*	Dana (1847)	-	+ +
13	*Microcyclop rubellus*	Lilljeborg (1901)	+ + +	+ + + +
14	*Pseudodiaptomus aurivilli*	Cleve (1901)	+ +	-
15	*Temora discaudata*	Giesberecht (1889)	+ + + +	-
16	*Tortanus barbatus*	Schmeli and Giesbrecht (1898)	+ +	-

monsoon (21.97%). Zooplankton density (no/L) recorded maximum in winter and minimum in monsoon. In our study total 10 species of zooplankton were observed and total 52 individual were observed. There were highest 12 individual in January. Lowest 8 individual of the zooplankton were observed in December. One crustacean larva was also found during the study. Out of those eight are belongs to crustacea subphylum and one is belonging to rotifera subphylum.

As compared to Baxi *et al*., we recorded four common species, *copepod nauplii*, *calanopia minor*, *microcyclops rubellus*, *acrocalanus gibber* of zooplanktons in to fresh and marine water. *Copepod nauplii*, *calanopia minor* acrocalanus gibber had been also reported in fresh water by (Raval *et al*., 2019). *Copepod nauplii* had been also observed in marine water by (Vaghela *et al*., 2010). *Calanopia minor* had been reported by (Kharate *et al*., 2017). *Microcyclops* rubellus had been also observed by (Dede and Deshmukh 2015). *Acrocalanus gibber* had been also reported in marine water by (Srichandan *et al*., 2015).

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