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Comparative Zooplanktonic Diversity with Respect to Physicochemical Parameters of Saraswati and Shingoda Rivers of Gujarat, India

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Coordinates: 20°55'13.42"N; 70°36'39.64"E

Keywords: Limnology, Phytoplankton

Abstract

Zooplanktons are bio-indicators of water ecosystems. Their diversity depends on the water condition. In the present study, samples were collected from the six different locations of two Rivers namely; Saraswati and Shingoda for the study of zooplankton diversity. These rivers are located in Gir-Somnath district of Gujarat. The entire work was carried out during the winter season and the effort was being made to analyze the diversity of Zooplankton in different selected sites to compare the diversity found in both the rivers. During the survey 14 physicochemical parameters of water like pH, Electric conductivity, DO, BOD, TS, TDS, TSS, Total Hardness, Ca⁺⁺ Hardness, Mg⁺ Hardness, Alkalinity, Acidity, Salinity, and Chlorinity were also analyzed. Total 16 species of zooplankton were recorded among which *Acrocalanus gracilis*, *Calanopia minor*, *Centropages tenuiremis*, *Copepod nauplii*, *Tortanus barbatus*, *Pseudodiaptomus serricaudatus* and *Tortanus forcipatus* were the most dominant zooplankton.

Introduction:

Water quality means the physical, chemical and biological characteristics of water (Parikh & Mankodi, 2012). The term plankton refers to an organism which has drifting habitat and includes all forms of both macro and microscopic life which floats freely in water or if motile, are unable to swim against currents. The plankton community is comprised of phytoplankton and zooplankton (Roy *et al.*, 2015). Phytoplanktons are important because they are the chief primary producers of an aquatic environment which fix solar energy by the process of photosynthesis by assimilating carbon dioxide and water to produce carbohydrates (Ansari & Singh, 2017). Zooplankton is a vital component for the freshwater ecosystems and is one of the first biological communities that indicate the environmental changes or perturbation towards their immediate habitat (Montes-Ortiz & Elías-Gutiérrez, 2018). Phytoplankton requires sunlight for photosynthesis so they are always found near surface water. Zooplanktons feed on phytoplankton. Physicochemical parameters are very important factors that play a significant role in water bodies to maintain plankton diversity and variation. Phytoplanktons are free floating unicellular, filamentous and colonial autotrophic forms of aquatic habitat and its movement depends on water currents (Kumary & Shilly

2017). They are primary producers in aquatic habitat and form the first trophic level in the food web. They are also a food source for other aquatic organisms. Zooplanktons also play an important role in the food chain as they are second in trophic level as primary consumers and consumes phytoplankton, and also contribute to the next trophic level (Sharma *et al.*, 2013). Zooplanktons have been considered to be the ecological indicators of water bodies (Gajbhiye & Desai, 1981; Roy *et al.*, 2015) and their biomass, abundance and species diversity have been used to determine the quality of the aquatic environment (Roy *et al.*, 2015). The planktonic forms are represented by Protozoa, Arthropoda, Rotifera and they are dominating the planktonic diversity (Sharma & Mankodi, 2011). Zooplankton is classified under the following classes: Protozoa, Copepoda, Rotifera, Cladocera and Ostracoda (Rice *et al.*, 2012). Planktonic communities are influenced by the prevailing physicochemical parameters and these determine their abundance, occurrence and seasonal variations (Singh, 2015).

Wetlands or Rivers harbour a rich biological diversity, provide sustenance for millions of people and face ongoing threats as results of human activities throughout the world (Balcer *et al.*, 1984).

Gujarat is the seventh largest state of India by its

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geographical area. It comprises three different geographic regions. South Gujarat, North & Central Gujarat and Saurashtra & Kutch. Larger area of Gujarat is arid, semi-arid & water scarcity prone zone (Goswami & Mankodi, 2012). Gir-Somnath is a district of Gujarat which enjoys an average annual rainfall of 669 mm (Shah, 2017). Saraswati and Shingoda Rivers are very important rivers of Gir-Somnath district and they contain water more than six to seven and eight to ten months in a year respectively which supply water for the potable and agricultural purpose to adjoining villages. Saraswati River and Shingoda River both originate from two different places but meet in the Arabian Sea at Triveni Sangam-Somnath.

In this study, two samples were collected from upstream, two samples from midstream and two samples from downstream from Shingoda and Saraswati River. A total of twelve samples were collected from these rivers, fourteen physicochemical parameters were analyzed and planktonic diversity was investigated.

Materials and methods:

Study area: six-sample collection points were selected from River Saraswati and Shingoda (sampling sites). Samples were collected from suitable depth in the water column from the water surface. GPS locations of sampling sites were noted down (Table-1). Water samples were collected in a plastic bottle (non-metallic, free-flushing sample recommended for the same).

Table 1.sampling sites and GPS Location

No. Stream	Sites: Village name	GPS Location
Saraswati River		
1 Upstream	1:Rasulpara	21° 5' 32.39"N 70° 39' 20.38"E
	2:Jambur	21° 1' 57.72"N 70° 36' 19.13"E
2 Midstream	3:Bhimdevad	20° 58' 16.15"N 70° 36' 47.47"E
	4:Prachi	20° 55' 13.42"N 70° 36' 39.64"E
3 Downstream	5:Umbari	20° 54' 4.88"N 70° 31' 31.27"E
	6:Triveni-Sangam	20° 52' 52.72"N 70° 25' 10.41"E
Shingoda River		
1 Upstream	1:Jamvala	21° 1' 16.09"N 70° 46' 34.05"E
	2:Jamjir	20° 57' 51.43"N 70° 45' 56.27"E
2 Midstream	3:Ghantvad	20° 55' 57.31"N 70° 45' 38.18"E
	4:Chhachhar	20° 51' 48.04"N 70° 45' 24.08"E
3 Downstream	5:Kodinar	20° 47' 41.60"N 70° 41' 56.95"E
	6:Mul Dwarka	20° 45' 44.30"N 70° 40' 21.40"E

The Standard method was used for water collection and analysis. For plankton diversity, plankton net was used. For Sample collection and analysis of water sample, various methods used are given ahead.

Three liters of water samples were collected from each site for physicochemical analysis, approximately from less than 1.5 feet of river water surface. Time of water collection and temperature of water were measured at the field site and transferred the preserved samples to the laboratory as soon as possible for further testing. The average temperature range was recorded between 18°C to 30°C at

each site (winter period).

Sample Collection for Zooplankton Analysis: the zooplankton samples were collected by filtering 6 Litre water through plankton net of 20µm mesh size of filtering cloth and concentrated up to 100 ml. The concentrated zooplankton sample was preserved immediately with the help of 4% formaldehyde for 48 hrs, and further incubation drop count Method was used for identification of plankton diversity (Chavda et al., 2017). The samples were analyzed qualitatively under the Compound microscope and Light microscope for the study of different types of zooplankton (Goswami & Mankodi, 2012).

Physico-Chemical Parameters: a total of 14 physico-chemical parameters of these collected water samples were analyzed. These parameters include; pH, EC, TS, TDS, TSS, DO, BOD, Total Hardness, Ca++ hardness, Mg++ hardness, Acidity, Alkalinity, Salinity, Chlorinity (Chavda et al., 2018). All the analysis were done by following common prescribed methods.

Results and Discussion:

Rivers are great ecosystems and it supports a great biodiversity. In the present research work we have investigated interactions between physicochemical parameters with their impact on planktonic biodiversity during winter time period of 2018. The quality of River water is generally governed by some physico-chemical and biological parameters. Table-2a Shows physico-chemical parameters of Saraswati River and table 2b shows physico-chemical parameters of Shingoda River.

Table -2a: Physico-Chemical Parameters of Saraswati River

No.Parameters	1	2	3	4	5	6
1 Time	7:15 am	8:13 am	9:45 am	10:48 am	3:18 pm	4:14 pm
2 Temperature	19°C	20°C	21°C	23°C	30°C	30°C
3 pH	8.89	8.38	8.46	8.29	8.34	8.95
4 Conductivity (µs/cm)	0.11	0.41	0.21	0.36	0.16	2.02
5 DO (mg/L)	5.1	4.3	5.5	5	6.3	6
6 BOD (mg/L)	1.75	1.65	1.65	1.6	1.3	1.6
7 TS (mg/L)	733.2	703.2	451.6	492.6	295.6	891
8 TDS (mg/L)	680	654	398	445	250	841
9 TSS (mg/L)	53.2	49.6	53.6	47.6	45.6	50
10 Total Hardness (mg/L)	192	236	184	152	212	364
11 Ca++ Hardness (mg/L)	32	208	44	96	168	172
12 Mg+ Hardness (mg/L)	160	28	140	56	44	192
13 Salinity (mg/L)	32.98	25.55	20.60	19.78	17.99	55.98
14 Alkalinity (mg/L)	780	730	760	750	780	830
15 Acidity (mg/L)	250	200	220	240	230	190
16 Chlorinity (mg/L)	875	849	802	799	808	883

1-Rasulpara, 2-Jambur, 3-Bhimdevad, 4-Prachi, 5-Umbari, 6- Triveni-Sangam

Table -2b:Physico-Chemical parameters of Shingoda River

No.Parameters	1	2	3	4	5	6
1 Time	8:10 am	8:41 am	9:12 am	10:32 am	12:08 pm	2:04 pm
2 Temperature	21°C	23°C	24°C	25°C	28°C	29°C
3 pH	8.99	8.01	8.93	8.43	9.03	8.9
4 DO (mg/L)	4.9	5.5	6.5	5.9	3.8	6.1
5 BOD (mg/L)	1.65	1.45	1.5	2.05	2.2	1.65
6 Conductivity (µs/cm)	0.73	0.71	0.75	0.71	1.2	3.5
7 TS (mg/L)	379.8	378.8	465	488.8	599.4	892.2
8 TDS (mg/L)	333	334	419	444	549	845
9 TSS (mg/L)	46.8	44.8	46	44.8	50.4	47.2
10 Water Hardness (mg/L)	160	232	280	152	292	408
11 Ca++ Hardness (mg/L)	52	32	128	56	168	228
12 Mg+ Hardness (mg/L)	108	200	152	96	124	180
13 Salinity (mg/L)	19.78	14	18.95	14.83	91.54	89.89
14 Alkalinity (mg/L)	750	720	763	767	730	810
15 Acidity (mg/L)	190	210	230	230	199	189
16 Chlorinity (mg/L)	799	849	859	843	858	878

1-Jamvala, 2-Jamjir, 3-Ghantvad, 4-Chhachhar, 5-Kodinar, 6-Mul Dwarka

Table 3(a). Diversity of Zooplankton-Saraswati River

S. N.	Zooplankton Name of species	Abundance in no/ml of 6 sites						Rep. by single genus/species	% of Diver sity
		1	2	3	4	5	6	Total	AVG
1	<i>Temora discaudata</i>	2	0	2	1	1	2	8	1.33
2	<i>Canthocalanus pauper</i>	1	1	1	1	4	0	8	1.33
3	<i>Copepod nauplii</i>	0	1	3	3	0	3	10	1.67
4	<i>Calanopia minor</i>	1	0	0	0	3	2	6	1.00
5	<i>Acrocalanus gracilis</i>	0	1	2	0	0	0	3	0.50
6	<i>Pseudodiaptomus serricaudatus</i>	0	2	3	2	2	3	12	2.00
7	<i>Centropages furcatus</i>	1	0	2	1	1	2	7	1.17
8	<i>Calanopia elliptica</i>	2	1	0	0	1	1	5	0.83
9	<i>Tortanus barbatus</i>	0	0	1	1	3	0	5	0.83
10	<i>Tortanus forcipatus</i>	1	0	0	0	1	1	3	0.50
11	<i>Keratella tropica</i>	0	1	2	0	1	2	6	1.00
12	<i>Microcyclops spp.</i>	0	0	3	1	0	3	7	1.17
13	<i>Centropages tenuiremis</i>	1	1	0	1	1	1	5	0.83
Total		9	8	19	11	18	20	85	14.17

Figure-1: Graphs representing the Comparative Physico-Chemical Parameters of both the rivers, collected from 6 various sites

Table 3(b). Diversity of Zooplankton-Shingoda River

S. N.	Zooplankton Name of species	Abundance in no/ml of 6 sites						Rep. by single genus/species	% of Diver sity
		1	2	3	4	5	6	Total	AVG
1	<i>Temora discaudata</i>	1	0	2	1	2	2	8	1.34
2	<i>Canthocalanus pauper</i>	2	1	0	3	0	3	9	1.5
3	<i>P. serricaudatus</i>	0	0	1	1	1	1	4	0.67
4	<i>Calanopia minor</i>	1	2	2	2	0	0	7	1.17
5	<i>Acrocalanus gracilis</i>	2	0	0	1	1	3	7	1.17
6	<i>Copepod nauplii</i>	1	2	3	3	0	1	10	1.67
7	<i>Centropages furcatus</i>	0	0	2	2	1	2	7	1.17
8	<i>Hyperia galba</i>	3	0	1	3	0	0	7	1.17
9	<i>Tortanus barbatus</i>	2	1	3	1	1	2	10	1.67
10	<i>Tortanus forcipatus</i>	1	0	0	3	0	2	6	1
11	<i>Keratella tropica</i>	1	0	1	1	1	3	7	1.17
12	<i>Diacyclops spp.</i>	0	2	2	2	1	2	9	1.5
13	<i>Microcyclops spp.</i>	2	1	1	4	0	0	8	1.34
14	<i>Diaptomus castor</i>	4	2	1	0	0	2	9	1.5
15	<i>C. tenuiremis</i>	2	1	2	2	2	1	10	1.67
Total		22	12	21	29	10	24	118	19.67

Plate-1: Some Dominant species of zooplanktons; a-Acrocalanus gracilis, b-Calanopia minor, c- Centropages tenuiremis, d-Copepod nauplii, e-Tortanus barbatus, f-Pseudodiaptomus serricaudatus, g-Tortanus forcipatus

The The average pH of Saraswati River and Shingoda River was recorded 8.55 and 8.71 respectively. The highest pH was recorded 9.03 at Kodinar (sampling site # 5 Shingoda River) and lowest was recorded 8.01 at Jamjir Waterfall (sampling site # 2, Shingoda River).

The average DO of Saraswati River and Shingoda River was recorded 5.36 mg/L and 5.45 mg/L respectively. The highest DO was recorded 6.5 mg/L at Ghantvad (sampling site #3, Shingoda River) and lowest was recorded 3.8 mg/L at Kodinar.

The average BOD of Saraswati River and Shingoda River was recorded 1.59 mg/L and 1.75 mg/L respectively. The highest BOD was recorded 2.2 mg/L at Kodinar and lowest was recorded 1.3 mg/L at Umbari (sampling site #5, Saraswati River).

The average conductivity of Saraswati River and Shingoda River was recorded 0.54 μ S/cm and 1.26 μ S/cm respectively. The highest Conductivity was recorded 3.5 μ S/cm at Mul dwarka (sampling site # 6, Shingoda River) and lowest was recorded 0.11 μ S/cm at Rasulpara (sampling site #1 Saraswati River).

The average TS of Saraswati River and Shingoda River was recorded 594.53 mg/L and 534 mg/L respectively. The highest TS was recorded 892.2 mg/L at Mul dwarka and lowest was recorded at Umbari 295.6.

The average TDS of Saraswati River and Shingoda River was recorded 544.66 mg/L and 487.33 mg/L respectively. The highest TDS was recorded 845 mg/L at Mul Dwarka and lowest was recorded 250 mg/L at Umbari (sampling site #5, Saraswati River).

The average TSS of Saraswati River and Shingoda River was recorded 49.93 mg/L and 46.66mg/L respectively. The highest TSS was recorded 53.6 mg/L at bhimdeval and the lowest was recorded 44.8 mg/L at Jamjir waterfall & Chhachhar (sampling site # 4, Shingoda River).

The average Total Hardness of Saraswati River and Shingoda River was recorded 223.33 mg/L and 254 mg/L respectively. The highest Total Hardness was recorded 408 mg/L at Mul dwarka and the lowest was recorded 152 mg/L at Prachi (sampling site #4, Saraswati River) and Chhachhar.

The average Ca++ Hardness of Saraswati River and Shingoda River was recorded 120 mg/L and 110.66 mg/L respectively. The highest Ca++ Hardness was recorded 228 mg/L at Mul dwarka and the lowest was recorded 32 mg/L at Rasulpara & Jamjir waterfall.

The average Mg+ Hardness of Saraswati River and Shingoda River was recorded 103.33 mg/L and 143.33 mg/L respectively. The highest Mg+ Hardness was recorded 200 mg/L at Jamjir waterfall and the lowest was recorded 28 mg/L at Jambur (sampling site #.2, Saraswati River)

The average alkalinity of Saraswati River and Shingoda River was recorded 771.66 mg/L and 756.66 mg/L respectively. The highest Alkalinity was recorded 830 mg/L at Triveni sangam is and the lowest was recorded 720 mg/L at Jamjir waterfall.

The average acidity of Saraswati River and Shingoda River was recorded 221.66 mg/L and 208mg/L respectively. The highest acidity was recorded 250 mg/L at Rasulpara and the lowest was recorded 189 mg/L at Mul dwarka.

The average Chlorinity of Saraswati River and Shingoda River was recorded 836 mg/L and 847.66 mg/L respectively. The highest Chlorinity was recorded 883mg/L at Triveni sangam and the lowest was recorded 799 mg/L at Prachi & Jamvala.

The average Salinity of Saraswati River and Shingoda River was recorded 28.81 mg/L and 41.49 mg/L respectively. The highest Salinity was recorded 91.54 mg/L at Kodinar and the lowest was recorded 14 mg/L at Jamjir waterfall.

Table 4: Zooplankton diversity in Saraswati and Shingoda Rivers

Zooplankton Specieses	Saraswati	Shingoda
<i>Temora discaudata</i>	++++	++++
<i>Canthocalanus pauper</i>	++++	++++
<i>Copepod nauplii</i>	+++++	+++++
<i>Calanopia minor</i>	+++	+++
<i>Acrocalanus gracilis</i>	+	+++
<i>Pseudodiaptomus serricaudatus</i>	+++++	++
<i>Centropages furcatus</i>	+++	+++
<i>Tortanus barbatus</i>	++	+++++
<i>Tortanus forcipatus</i>	+	+++
<i>Keratella tropica</i>	+++	+++
<i>Microcyclops spp.</i>	+++	++++
<i>Centropages tenuiremis</i>	++	+++++
<i>Calanopia elliptica</i>	++	----
<i>Hyperia galba</i>	----	+++
<i>Diacyclops spp.</i>	----	++++
<i>Diaptomus castor</i>	----	++++

The study recorded a total of 13 species of zooplankton with a total of 85 individuals (Table-3a).

There were highest 20 individuals of zooplankton recorded at sampling site #6 (Triveni Sangam) which is the last site of sampling due to high DO. Due to low DO at

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sampling site #2 i.e., Jambur, lowest 8 individuals of zooplanktons were recorded. (Table-3a).

Here, a total of 12 individuals of *P.serricaudatus* were recorded which was highest with an average of 2 and the percentage of diversity was 14.11%. There are 3 individuals of *A.gracilis* and 3 individuals of *T.forcipatus* recorded, which was the lowest of zooplankton species and its average was 0.5. Thus, the percentage of diversity recorded was 3.52%. (Table-3a).

There is a total of 15 species of zooplankton recorded in Shingoda River and a total of 118 individuals was recorded. Highest 29 individuals were recorded at sampling site #4 i.e., Ghantvad. Lowest of 10 individuals were recorded at sampling site #5 i.e., Kodinar. (Table-3b)

Highest 10 individuals of *C.nauplii*, 10 individuals of *T.barbatus* and 10 individuals of *C.tenuiremis* were recorded with an average of 1.67 and the percentage of diversity was 8.47%. Lowest 4 individuals of *P.serricaudatus* were observed with an average of 0.66 and the percentage of diversity was 3.38%. (Table-3b, 4).

Conclusion:

In the present study, it was noted that physicochemical parameters were directly related to planktonic diversity. Growth of zooplankton was correlated with the phytoplankton as because they are the main food source of zooplankton. Their growth depends on the physicochemical parameters. Planktons were important to maintain the ecosystem of the water body and they were bio-indicators of water eco-system. The zooplankton study was carried out to understand its relation with physicochemical parameters. Based on the analysis of physicochemical parameters, the average DO of Shingoda River was recorded slightly higher than the Saraswati River. At Kodinar (sampling site #5, Shingoda River) BOD and pH was recorded highest compared to other sampling sites. The study recorded a total of sixteen different species of zooplankton among which 13 species (85 individuals) were found in Saraswati River and 15 Species (118 individuals) were found in Shingoda River. The results show that the increasing DO is directly associated with the plankton diversity because zooplankton species diversity is higher in Shingoda River than the Saraswati River. At Kodinar (sampling site #5, Shingoda River) water was not potable and not useful for agricultural purpose and plankton diversity was found low as compare to other sites. Water quality of Shingoda River was better than the Saraswati River except at Kodinar (sampling site #5).

Acknowledgment:

We pay our gratitude to Nilesh Gojiya for helping in sample collection and Rx. Krupa Vyas for her support. Cordial thanks to AV Dhara Gareja, Shreya Joshi, Malay Vyas, Jatin Gohil, Shital Bhada, Priyanshi Gondaliya, Deepa Kher, Piyush Amheda for their technical help and companionship. Lastly, AV wants to thank Usha Zala, Savan Tank and Pooja Agravat for their support.

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