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IMPACT OF WATER QUALITY ON SPECIES COMPOSITION AND SEASONAL FLACTUATION OF ZOOPLANKTON IN THE MOUTH OF HALDI RIVER, WEST BENGAL

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ABSTRACT
The abundance, composition and distribution of zooplankton in relation to water quality parameters such as temperature, pH, dissolved oxygen, alkalinity, total dissolved solids, total hardness and biochemical oxygen demand were studied at monthly intervals from June 2014 to May 2015 in the mouth of Haldi River. A total 22 species of zooplankton were identified, which included 8 species of Rotifers, 4 species of Cladocerans, 7 species of Copepods, and 3 species of Annelids. The effect of several physicochemical parameters like pH ranges from 7.1 - 8.1, water temperature ranges between 19.1 - 30.2^{o}C, Dissolve Oxygen (DO) varies from 3.25 - 6.01mg/L, Total Dissolved Solids (TDS) ranges 290.5 - 670.1mg/L, salinity ranges between 0.0 - 4.1ppt, nitrate ($NO_{3)}$ ranges from 43.66 - 90.09 µM, and nitrite ($NO_{2)}$ ranges from 3.09 - 10.12 µM on the abundance and distribution of coefficient of correlation of zooplankton is discussed in the present study. The investigation reveals that zooplankton better thrive in alkaline water as compare to freshwater and the water of quality Haldi River is suitable for fish production.

KEY-WORDS: Water quality, zooplankton diversity, Haldi River, Monthly variation.

INTRODUCTION
Planktons are small plants or animals that float, drift, or weakly swim in the water column. Major constituent of aquatic organisms is the plankton- the zooplankton and phytoplankton. Zooplanktonare minute aquatic animals that are non-motile or are very weak swimmers. They serve as good indicator of changes in water quality, because it is strongly affected by the environmental conditions and it is quickly responded to changes in environmental quality Gannon and Stemberger (1978). The abundance of zooplankton in river depends on a great variety of abiotic and biotic factors, which collectively affect individual species of the zooplankton community. A variety of ecological processes regulate phytoplankton assemblages and abundances in natural systems Quilan and Phlips (2007). It is observed that great swarms of zooplankton may consume the phytoplankton to such an extent that they create discontinuous distribution of plankton. Haldi River (industrial area) has been shown significant variation of plankton abundance. The change in abundance, species diversity and community composition of zooplankton indicates environmental changes like pH, temperature, nitrates, phosphates total dissolved salt, nutrient levels, alkalinity etc. they are sensitive indicator of pollution in comparison with phytoplankton. Among the zooplankton, rotifers respond more quickly to environmental changes and used as changes in water quality Gannon and Stemberger (1978). They are high in stable environmental conditions and disappear as pollution level increases Das *et al.* (1996).

It is observed that great swarms of zooplankton may consume the phytoplankton to such an extent that they create dis-continuous distribution of plankton. In the present study physicochemical characteristics of water quality in different places of Haldi River mouth has influence significant variation of plankton diversity. It is found that pollution sensitive planktons were available in the river mouth.

MATERIALS & METHODS
Area and duration of the study
The present study were carried out in Haldi River which situated at 22º01´26′′N to 22º04´18′′N latitude and 88º01´56′′ E to 88º08´40 ′′E longitude under the district of Purba Medinipur, West Bengal. The experimental work has been done at every 30 days interval from June, 2014-May, 2015.

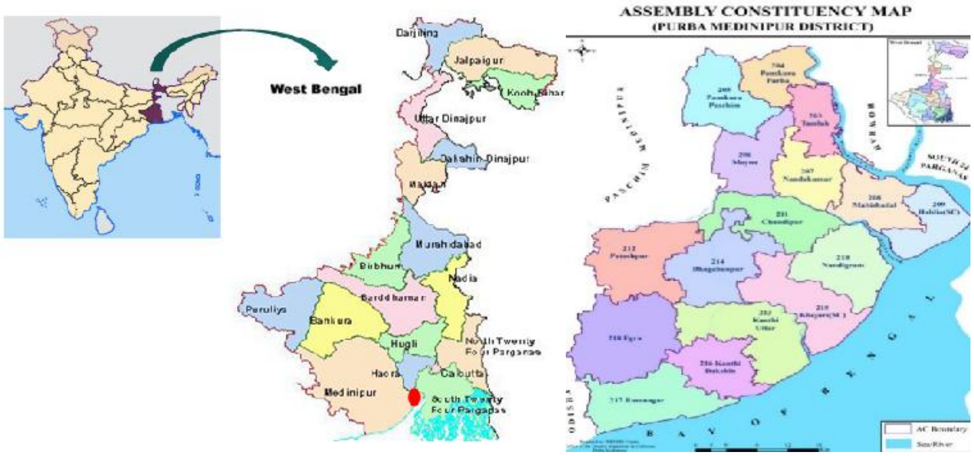

FIGURE-1: Sampling places of Haldi River.

Sampling and data collection

The sampling point was selected based on the entrance of waste materials and nutrients and geomorphological influences. The different physicochemical parameters of water like pH, nitrite, nitrate, salinity, TDS and dissolve oxygen are measured according to the method developed by APHA, 2005. All physicochemical parameters of water samples were measured and results were tabulated in Table 1. zooplankton were narcotized by adding Chloroform to the water sample collected. This avoids sudden contraction of the body of organism in formalin solution. The zooplanktons was preserved in 4% formalin (formalin was diluted with water from sampling area to avoid osmatic change) and brought to the laboratory for identification. The identification of plankton was done under microscope using plankton counting chamber (Sedgewick and Rafter cell counter) Individuals were identified with help of literature provided by (Needham and Needham, 1976).

RESULTS & DISCUSSION

Monthly variation of water quality parameters were tabulated in table No.1.the average monthly changes of water temperature varied from 21.15°c to33.60°c and lowest value observed in the month of January (21.15°c) and highest value in the month of June (33.60°c). Jayaraman *et al.* (2003) stated that difference in water temperature may be due to timing of collection and influence of season. Similar explanation is given by Chetana and Somashekar (1997) to explain monsoon maxima. Monthly changes of pH varied between 7.12 to 8.31and the minimum value was found in the month of August (7.1) and maximum value in the month of May (8.1). The summer minimums are due to increased decomposition rate, leading to acidification and lowered pH Chetana and Somashekar (1997). In keeping with the present observations, Das *et al*. (1992) and Bhargava and Sewani (1996) obtained summer minimum. Patel and Patel (1993) observed summer minimum but recorded monsoon high. Salinity was varied between 0.17 to 3.86 ppt, relatively low in the month July (0.17 ppt) and high in the month of March (3.86 ppt).

Biochemical Oxygen Demand (BOD) ranged varied from 6.63 to 13.27mg/L. Minimum BOD value observed in the month of January (6.63 mg/L) and the maximum BOD value in the month of March (13.27 mg/L). Low BOD in winter was mainly due to higher algal productivity, along with increased solubility of oxygen at low temperatures, while summer maxima resulted from the rapid utilization of oxygen at higher temperatures Chetana and Somashekhar (1997).

Dissolved Oxygen (DO) level varies between 3.63 to 7.02mg/L. Minimum value observed in the month of January (3.63 mg/L) and maximum value in August (7.02 mg/L). A decrease in DO is observed as the water temperature decreased Jana and Sarkar (1971b). During observation period total alkalinity ranges between 198 mg/L to 222 mg/L. Minimum value found in the month of May (198 mg/L) and Maximum value in the month of October (222 mg/L). High alkalinity coincides with high planktonic yield Singh *et al.* (2002), Sachidanantha Murthy and Yayuivedi (2006), Kiran *et al.* (2007).

Total hardness varied between 215 mg/L to 310 mg/L. Total hardness value is lowest in the month of May (215 mg/L) and highest in month of January (310mg/L). This is favorable for fish production as reported by Swingle (1967) and Arvindkumar, Chandan Bohra and A.K. Singh (1998).

In the present study the identified zooplankton populations were categorized under four groups including Annelids, Rotifers, Cladocerans, and Copepods. A total of 22 zooplankton species were observed which include 3 species of Annelids, 8 species of Rotifers, 4 species of Cladocerans and 7 species copepods. The composition of identified zooplankton is tabulated in Table 2. This study reveals a tri-model oscillation of the abundance of zooplankton. Moreover, as the study area was tropical, light was never limiting although light intensity may have varied, especially during the monsoon months due to heavy cloud cover which may in turn have played an indirect role in the variability of species composition. The number of each zooplankton species varied from season to season over the one year study period. The zooplankton population increases from winter season and reached maximum in summer. The sudden drop of zooplankton population from June to September is due to monsoon season (Fig. 2). Mandal *et al*. (2006, 2008, 2009 and 2010) has been observed that the plankton density and diversity was highly influential for growth of Indian major carps in china clay mines of West Bengal.

In the present study, zooplanktons of different groups are negatively correlated with pH. The zooplankton abundance also indicates inverse relationship with pH. Similar results were reported by Alam *et al*. (1987) and Patra & Azadi (1987). Most of the planktonic species were died at approximately pH 4 or below and pH 11 or above, except Rotifers group. All of the zooplankton groups are also negatively or inversely correlated with water temperature. Similar findings were obtained by Chowdhury *et al*. (1987), Islam *et al*. (2000) and Patra and Azadi (1987). There was a positively correlation between all groups of zooplankton and three parameters under studied including dissolve oxygen and salinity. Dissolved oxygen is the most important chemical parameter for zooplankton abundance. Like terrestrial animals, zooplankton need oxygen for their respiration. Zooplankton showed positive relationship with DO. Similar results were reported by Miah *et al.* (1981) and Alam *et al.* (1987). Zooplankton abundance showed a negative relationship with water salinity of the present investigation area. These results have parity with the findings of Islam *et al.* (2008); therefore, majority of zooplankton groups revealed a negative correlation with TDS (Table 3).

A species diversity index is a quantitative measure that reflects how many different types of species there are in a dataset, and simultaneously takes into account how evenly the basic entities (such as individuals) are distributed among those types. The data on Shannon-Weiner diversity index in the present study showed higher values for Rotifers while lowest for Annelids (Table 4).

TABLE 1: Seasonal fluctuation of physicochemical parameters of water during June-2014 to May-2015 in the Mouth of Haldi River

Monthly	Water Temp. (^oC)	pH	Salinity (ppt)	DO (mg/L)	NO_3 (µM)	NO_2 (µM)	TDS
January	19.1±4.32	7.7±2.03	4.1±3.33	6.00±1.11	49.49±5.55	4.95±1.21	419.8±21.36
February	20.2±4.61	7.8±2.16	4.0±3.98	3.38±1.25	51.23±4.45	3.09±1.11	436.8±19.21
March	25.5±4.58	8.0±2.28	3.8±3.12	5.81±2.25	63.36±4.89	6.21±2.58	511.4±19.01
April	28.7±5.01	7.5±2.01	3.6±3.35	5.25±2.39	74.31±5.01	3.21±1.28	595.5±20.45
May	30.2±5.26	8.1±2.39	3.9±3.87	6.20±3.01	76.37±5.47	2.86±1.01	670.1±17.14
June	29.5±4.79	7.4±2.20	0.0±3.00	5.98±2.21	85.23±6.25	10.12±4.42	355.6±16.24
July	26.4±4.35	7.3±2.18	0.3±2.87	5.52±2.33	77.24±5.87	9.91±3.33	301.9±15.55
August	27.5±4.58	7.1±1.87	0.0±2.87	4.69±1.89	90.09±6.05	7.17±2.79	290.5±19.01
September	27.9±4.48	7.3±1.75	1.5±3.24	4.81±2.04	52.18±4.41	5.13±2.15	402.1±16.61
October	24.8±4.32	7.5±2.29	1.6±2.00	3.85±2.19	48.06±5.01	4.85±2.11	511.6±17.45
November	23.6±4.01	7.6±2.31	2.5±2.01	3.42±1.75	43.66±4.48	4.50±1.58	375.3±18.18
December	20.3±4.12	7.5±2.22	4.3±4.01	3.25±1.45	48.51±4.56	4.21±1.88	389.6±16.79

Each data is the mean of 5 separate determinations and their Standard Deviation (SD)

TABLE 2: Zooplankton species observed in river mouth from June 2014 to May 2015

SL.NO	Annelida	Rotifera	Cladocera	Copepeda
1.	*Harmothoe imbricate*	*Filinialongiseta*	*Semibalanusbalanoides*	*Cyclops sp*
2.	*Autolytusedwardsi*	*Brachionussp*	*Mysids shirmp*	*Acartiaclausi*
3.	*Polydorasp*	*Keratella* sp.	*Daphniasp*	*Labidocerawollastoni*
4.		*Lepadella*	*Bosminasp*	*Eurytemorahirundoides*
5.		*Trichocerea*		Nauplius stage
6.		*Notholca* sp.		*Mesocyclopssp*
7.		*B.angulsaris*		*Phyllodiaptomussp*
8.		*Trichocerea*		

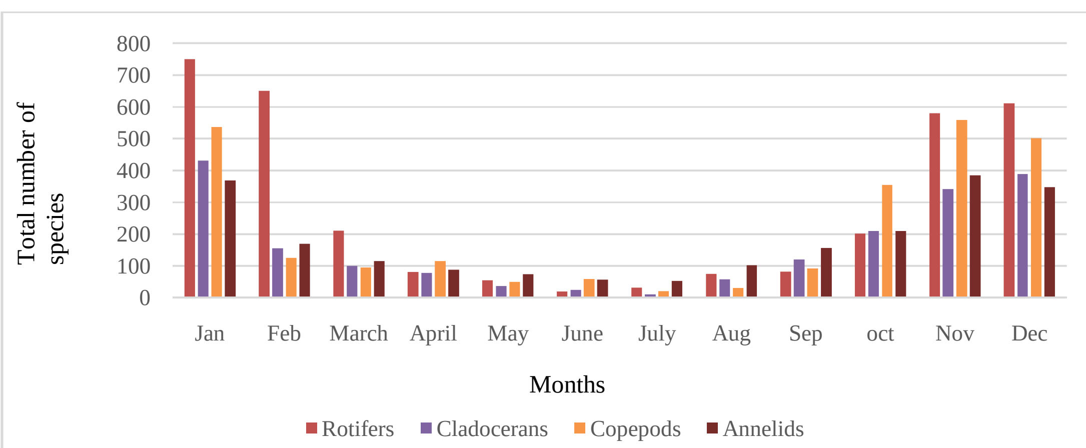

FIGURE 2: Monthly variation of Zooplankton density from June 2014 to May 2015 in the mouth of Haldi River.

TABLE 3: The coefficient of correlation of different zooplankton with different water quality parameters of Haldi River, during June 2014 to May 2015

Serial No.	Particulars	Coefficient of correlation	Comments
1.	Rotifers vs. pH	-0.382	Negatively related
2.	Cladocera vs. pH	-0.501	Negatively related
3.	Copepods vs. pH	-0.413	Negatively related
4.	Annelids vs. pH	-0.448	Negatively related
5.	Rotifera vs. water Temp.	0.002	Positively related
6.	Cladocerans vs. water Temp.	-0.015	Negatively related
7.	Copepods vs. water Temp.	0.148	Positively related
8.	Annelids vs. water Temp.	0.101	Positively related
9.	Rotifers vs. Dissolve oxygen	0.064	Positively related
10.	Cladocerans vs. Dissolve oxygen	0.297	Positively related
11.	Copepods vs. Dissolve oxygen	0.413	Positively related
12.	Annelids vs. Dissolve oxygen	0.261	Positively related
13.	Rotifers vs. Salinity	0.617	Positively related
14.	Cladocerans vs. Salinity	0.512	Positively related
15.	Copepods vs. Salinity	0.417	Positively related
16.	Annelids vs. Salinity	0.443	Positively related
17	Rotifers vs. TDS	-0.128	Negatively related
18.	Cladocerans vs. TDS	-0.115	Negatively related
19.	Copepods vs. TDS	-0.088	Negatively related
20.	Annelids vs. TDS	-0.256	Negatively related

TABLE 4: Different values of Shannon – Weiner index

Species	Pi = ni/N	ln pi	H(pi x ln pi)
Rotifers	0.36	-1.02	-0.37
Cladocerans	0.18	-1.71	-0.31
Copepods	0.32	-1.14	-0.36
Annelids	0.14	-1.97	-0.28
			∑= 1.32

$H = \sum pi \ln (pi)$

Species diversity index = 1.32

CONCLUSION

It can be concluded that the coastal water was suitable for development of plankton population. Seasonal variation in the species assemblage pattern was clearly observed which were primarily regulated by environmental variables like nutrient availability and temperature variations. The growth of algae and diversity of zooplankton indicates the river is not polluted and it is suitable for fish production. The result of Shannon-Weiner diversity index in the present study showed higher values for Rotifers while lowest for Annelids. The water quality of Haldi River mouth is slightly alkaline which is favorable for the growth of plankton.

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