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RESEARCH ARTICLE

ANALYSIS OF CERTAIN PHYSICO CHEMICAL PARAMETERS OF RIVER MARA BHARALI IN THE SONITPUR DISTRICT OF ASSAM, INDIA WITH SPECIAL REFERENCE TO ITS MOLLUSCAN DIVERSITY

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ABSTRACT

Rivers play a major role in integrating and organizing the landscape, and moulding the ecological setting of a basin. The present investigation was conducted in the remnants of old channel of Jia Bharali named as Mara Bharali at Tezpur in the Sonitpur district of Assam, India. Sampling stations were selected from Solmara Bridge (N-26º41'13.65" and E-92º48'59.32") near Tezpur University, Tezpur to Maithan (N-26º37'05.69" and E-92º49'34.34") where the river meets the river Brahmaputra. The temperature, pH and turbidity of the river water was found to be within the WHO permissible limit. However, Site-II, III and IV showed higher turbidity above permissible limits. During the post monsoon the TDS ranged between 700 – 1800 mg/L whereas during the winter the value was found to be between 600 – 1500 mg/L which was above the WHO permissible limit. DO values depleted in winter and was found to range between 1.8 – 4.2 mg/L. Free CO_2 value was found to be maximum during monsoon at site II (Mara Bharali Bridge) at 57.2 mg/L. A total of 06 (six) molluscan species were recorded from the sampling sites during the period of study which indicates that productivity of the river is moderately rich. The molluscan community was represented by two classes, viz., *Bivalvia* and *Gastropoda* of which 01 species was *Bivalvia* and 05 species were *Gastropoda*.

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INTRODUCTION

Environmental flow and riverine health have become a global concern. The river ecosystem receives water primarily from their water sheds, marginal run off and domestic sources. The surface water quality of a river basin is thus intimately connected with public health and is very important for sustaining aquatic life in the area. Rapid industrialization, water abstraction and the extensive use of pesticides in agriculture have severe strains on rivers and resulted in deterioration of its quality. Rivers therefore, play a major role in integrating and organizing the landscape, and moulding the ecological setting of a basin. They are the prime factors controlling the global water cycle and in the hydrologic cycle they are the most dynamic agents of transport. People along the river use water for many purposes. However, the surface water quality is deteriorating due to anthropogenic activities, industrialization, farming activities, transportation, urbanization, animal and human excretions and domestic wastes. Aquatic organisms need a healthy environment. Maximum productivity depends on optimum level of physicochemical parameters (Sadia *et al.,* 2013).

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Regular monitoring of the physico-chemical parameters of water bodies have been carried out for decades in different developed countries. Assessments of general water quality and dissolved metals concentrations in aquatic ecosystems have been extensively conducted. However, there are limited studies of water quality and pollution status of rivers in developing countries (Khound *et. al.*, 2012). The river Jia Bharali is one of the largest tributaries of the Brahmaputra in the north bank. It is known as Kameng river in neighbouring Arunachal Pradesh. Originating from the Indo- China border, it traverses about 242 km before meeting the Brahmaputra near Bhomoraguri, Tezpur. The present investigation has been conducted in the old channel of Jia Bharali named as Mara Bharali because no such works has been conducted earlier. Allen (1905) stated that sometimes prior to 1824 the major change in the shift of the river course from the Mara Bharali to the present one has taken place. Macro-invertebrates are great candidates for biological monitoring. They are widely used for the biological monitoring programmes of water quality of rivers (Norris & Norris, 1995). Aquatic insects had been used to assess the biological integrity of stream ecosystem in various studies (Resh and Carter, 2010; Rosenberg & Resh, 1993). The majority of these efforts have been conducted on variety of streams at global level and at national level. Molluscs, a group of most diverse and dominant benthic fauna in water bodies, perform a key role in the

functioning of aquatic ecosystem. Molluscans are of great significance because they form the food of fishes and their productivity play an important link in the food chain. Molluscans communities are good indicators of localized conditions, indicating the water quality. The freshwater ecosystems in India harbour a rich diversity of Molluscs, representing 212 species belonging to 21 families. Of these, 164 species were recorded from rivers and streams (Subba Rao, 1993). The presence of thriving population of molluscan indicates the land is not acidic; hardly molluscs survive beyond a pH of 5 (Boycott, 1934). Biological monitoring of rivers using macro invertebrate is accepted as a useful tool for the assessment of water quality (Hellawell, 1986).

MATERIALS AND METHODS

Study area

Sampling stations were selected in the old channel of Jia Bharali named as Mara (meaning dead) Bharali (at 05 sampling stations) from Solmara Bridge (N-26º41'13.65" and E-92º48'59.32") near Tezpur University, Tezpur to Maithan (N-26º37'05.69" and E-92º49'34.34"), Tezpur, Assam, India where it meets the river Brahmaputra (Fig.1). The Jia Bharali catchment is bounded by longitudes 92°00/- 93°25/E and latitudes 26°39/- 28°00/ N. The five (05) sampling stations selected in the old channel of Jia Bharali named as Mara (meaning dead) Bharali where the present investigation was conducted include, Site V-Solmara Bridge (N-26º41'13.61" and E-92º48'59.32"), Site IV-Uriamguri village (N-26º40'15.14" and E-92º50'21.36"), Site III- Porowa Bridge (N-26º39'10.05" and E-92º47'49.28"), Site II-Mara Bharali Bridge (N-26º38'06.60" and E-92º48'47.08") and Site I - Maithan (N-26º37'05.69" and E-92º49'34.34") where it meets the river Brahmaputra.

Methodology

The water samples were collected from the 05 sampling stations of river Mara Bharali (Fig. 1). The selected parameters were studied for one year from March, 2015 to February, 2016 on a seasonal basis viz., pre-monsoon (Mar-May), monsoon (Jun-Aug), post-monsoon (Sept-Nov) and winter (Dec-Feb). For ecological study of the rivers, following aspects were undertaken:

(A) Physical parameters

(i) Temperature: Water and air temperature was recorded with the help of a good quality mercury thermometer.
(ii) TDS: Total dissolved solids (TDS) was determined with the help of a TDS meter.
(iii) Turbidity: Turbidity of the water samples from sampling stations was measured with the help of a turbidimeter.

(B) Chemical parameters

(i) Hydrogen-ion-concentration (pH): It was determined by an electronic pH meter.
(ii) Dissolved oxygen (DO): Dissolved oxygen of water was estimated by following modified Winkler's method.
(iii) Free CO_2: FCO_2 was determined as per Trivedy *et al*. (1987).

(C) Biological parameter

Molluscs from each sampling station was collected by hand picking method and preserved in 70% ethyl alcohol for further studies. Collected molluscs was washed, photographed with the help of a digital camera and identified as per Tonapi (1980) and Subba Rao (1989).

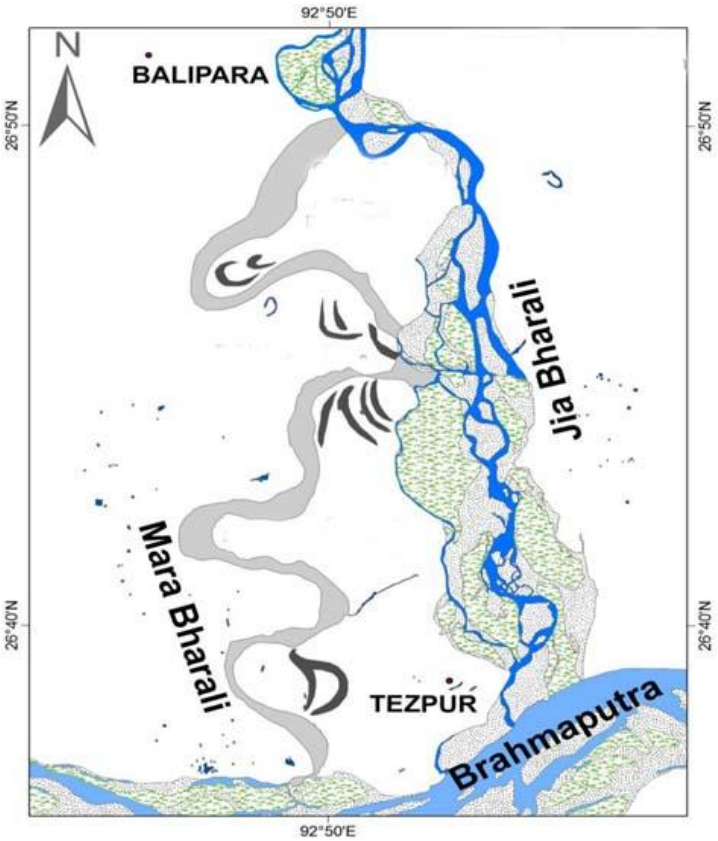

Fig. 1. Map showing the area of study on the bank of river Mara Bharali at Tezpur in the Sonitpur district of Assam, India

RESULTS AND DISCUSSION

In the present investigation the monthly and seasonal variation of certain physico-chemical parameters of river Mara Bharali has been studied together with its molluscan diversity.

Temperature: Temperature is an important ecological feature that influences the behavioral characteristics of organisms, solubility of gases and content of salts in water. The fluctuation of temperature usually depends on the season, geographic location, sampling time and content of effluents entering the river system (Dallas and Day, 2004). In the present investigation, the water temperature was found to vary with atmospheric temperature and was found to be maximum during the post monsoon season at 33^0C and minimum during winter at 19^0C (Table 2 & 3). The water temperature is well within the WHO permissible limit. Temperature exerts a strong influence on many physical and chemical characteristics of water including the solubility of oxygen and other gases, chemical reaction and toxicity, with microbial activity (Duffus, 1980). A higher temperature depletes solubility of dissolved oxygen in water and reduces its concentration. Vulnerability of organisms to the toxins e.g. cyanide, zinc, phenol and xylene is found intensified as temperature increases (Merritts *et al*., 1998).

pH: Change in alkalinity may be result of change in pH. The pH value increases due to the activity of photosynthetic algae which consumes CO_2 dissolved in water (Kang *et al.*, 2001). According to Fakayode (2005), the pH of a water body has importance in determination of water quality as it chemically reacts with remaining factors. Aquatic organisms are sensitive to pH fluctuations and their biological treatment requires pH control or monitoring. Significant difference was not found in pH during the assessment period. During the present investigation it was found that during the monsoon season the pH vary between 6 – 7.6, during post monsoon between 6.7 – 7.5 and in winter between 7 – 7.5 (Table 1, 2 & 3) which was within the range of WHO permissible limit of 6.5 – 8.5.

Turbidity: Turbidity which is the measure of water clarity indicates the degree to which light entering a column is scattered by suspended solids. The Maithan site (Site-1) showed the turbidity in the range of 11 – 35 NTU during the period of study. Comparatively Solmara Bridge (Site-5) showed lower turbidity in the range 4.5 – 15 NTU. The rest of the sites showed much higher turbidity at 38 – 70 NTU (Table 1, 2 & 3). The turbidity of Solmara Bridge site was lower than that of Maithan site, which indicated high amount of suspended particles present at the Maithan site and therefore more polluted than Solmara Bridge site.

Table 1. Physico-chemical parameters of the Mara Bharali river during monsoon

Parameters	Station					Mean ± SD
	I	II	III	IV	V	
Air temperature (^{0}C)	29	32	31	29	32	30.6±1.51
Water temperature (^{0}C)	27	28	27	30	29	28.2±1.30
pH	7.6	6.7	6	6.3	6.2	6.56±0.66
TDS (mg/l)	500	500	600	500	400	500±70.71
Turbidity (NTU)	35	58	56	70	15	46.8±21.78
Free CO_2 (mg/l)	17.6	57.2	22	17.6	17.6	26.4±17.32
Dissolved oxygen (mg/l)	7.4	6.6	6.2	8	7.6	7.16±0.74

Table 2. Physico-chemical parameters of the Mara Bharali river during post-monsoon

Parameters	Station					Mean ± SD
	I	II	III	IV	V	
Air temperature (^{0}C)	33	36	33.5	35	34	34.3±1.20
Water temperature (^{0}C)	31	33	32	32	32	32±0.70
pH	7.5	7.0	7.1	6.7	7.2	7.1±0.29
TDS (mg/l)	900	1100	1800	900	700	1080±426.61
Turbidity (NTU)	33	50	50	60	13	41.2±18.51
Free CO_2 (mg/l)	30.8	35.2	39.6	44	35.2	36.96±5.01
Dissolved oxygen (mg/l)	7.0	11.4	8.6	7	8.2	8.44±1.80

Table 3. Physico-chemical parameters of the Mara Bharali river during winter

Parameters	Station					Mean ± SD
	I	II	III	IV	V	
Air temperature (^{0}C)	22	21	20	19.7	19.8	20.5±0.98
Water temperature (^{0}C)	24	22	22	19	19	21.2±2.16
pH	7.5	7.4	7.0	7.3	7.4	7.32±0.19
TDS (mg/l)	1100	1100	1500	1100	600	1080±319.37
Turbidity (NTU)	11	39	38	46.5	4.5	27.8±18.73
Free CO_2 (mg/l)	17.6	13.2	17.6	13.2	13.2	14.96±2.40
Dissolved oxygen (mg/l)	1.8	4.0	1.8	2.6	4.2	2.88±1.16

Table 4. List of the Molluscan species found in the river Mara Bharali at 5 different sampling sites (I, II, III, IV and V)

S.No.	Taxa	Class	Family	Genus	Species	Site
1	Mollusca	Bivalvia	Unionidae	*Lamellidens*	*marginalis*	II
2	Mollusca	Gastropoda	Viviparidae	*Bellamya*	*bengalensis*	I,II,III,IV,V
3	Mollusca	Gastropoda	Ampullariidae	*Pila*	*globosa*	I
4	Mollusca	Gastropoda	Planorbidae	*Gyraulus*	*convexiusculus*	IV
5	Mollusca	Gastropoda	Pachychilidae	*Brotia*	*costula*	I, II
6	Mollusca	Gastropoda	*Gabbia orcula*	*Gabbia*	*orcula*	I, II, V

Fig. 1. ***Gyraulus convexiusculus***

Fig. 2. ***Gabbia orcula***

Fig. 3. ***Bellamya bengalensis***

Fig. 4. ***Pila globosa***

Fig. 5. ***Brotia costula***

Fig. 6. ***Lamellidens marginalis***

The WHO permissible limit for turbidity of drinking water is between 5 – 25 NTU. As water became more turbid, less sunlight can penetrate and therefore the rate of photosynthetic activity is lowered. In addition, suspended materials absorbed heat from sunlight and raise the water temperature which indicate limited amount of dissolved oxygen in water (Thorvat *et al.*, 2012).Turbidity of river water can be low or high depending on the water current and sedimentation (Smitha and Shivashankar, 2013).

Total dissolved solids: Total dissolved solid depends on various factors such as geological character of watershed, rainfall and amount of surface runoffs and gives an indication of the degree of dissolved substances (Driche, 2008; Siebert, 2010). According to Wilcox (1955) aquatic media is classified based on the concentration of TDS. Water is desirable for drinking up to a TDS permissible limit of 500 mg/L. TDS in water is found due to content of carbonates, bicarbonates, chlorides, phosphates and nitrates of calcium, magnesium, sodium, potassium, manganese, organic matter salt and other particles (Fakayode, 2005). The total dissolved solids found at all the five sites ranged between 400 - 600 mg/L (Table 1) during the monsoon which is within the WHO permissible limit. However, during the post monsoon the TDS ranged between 700 – 1800 mg/L whereas during the winter the value is between 600 – 1500 mg/L (Table 2 &3) which is above the WHO permissible limit. Therefore, the river water is unfit for human use during the post monsoon and winter season.

DO: Dissolved Oxygen (DO) content has a vital role for maintaining aquatic life and is susceptible to slight environment changes. Oxygen depletion often results during times of high community respiration and hence DO has been extensively used as a parameter delineating water quality and to evaluate the degree of productivity of water (Chapman and Kimstach, 1992). Dissolved oxygen affects the growth, survival, distribution, behavior and physiology of aquatic organisms (Joshi and Bisht, 1993). It is also found to be an important limnological parameter indicating level of water quality and organic pollution in the water body (Kataria *et al.,* 1995). In the present investigation, DO values depleted in winter and was found to range between 1.8 – 4.2 mg/L (Table

3). During the monsoon it ranged between 6.2 – 8.0 mg/L and in post monsoon the range was between 7.0 – 11.4 mg/L (Table 1 & 2). Productivity of the riverine system was therefore found to be highest during the post monsoon season in the area of study. Seasonal variation in DO content was related to temperature and biological activities (Parashar *et al.*, 2003). A high pollution load has decreased the DO values at considerable level. Our results were similar to as recorded by Chetana and Somasekhar, (1997), Sawyer *et al.*, (2003), Thilaga *et al.*, (2004) and Bhattarai *et al.*, (2008).

CO_2: Carbon dioxide is the end product of organic carbon degradation in almost all aquatic environments and its variation is often a measure of net ecosystem metabolism (Wetzel, 2006). Free CO_2 value was found to be maximum during monsoon at site II (Mara Bharali Bridge) at 57.2 mg/L (Table 1). It may be due to decrease in productivity leading to decomposition forming more CO_2 in the water. During post monsoon the free CO_2 was found to range between 35.2 – 44.0 mg/L whereas during winter the free CO_2 was estimated between 13.2 – 17.6 mg/L (Table 2 & 3).

Molluscan diversity of Mara Bharali river

A total of 06 (six) species were recorded from the sampling sites during the period of study (Table 4; Fig. 1-6). The molluscan community was represented by two classes, viz., Bivalvia and Gastropoda of which 01 species was Bivalvia and 05 species were Gastropoda (Table 4; Fig. 1-6). A similar study was conducted on molluscan community of the Bharathapuzha river in Kerala and thirteen species of molluscs belonging to five orders, eight families and ten genera were reported (Bijukumar *et al.*, 2001). Suryawanshi *et al.* (2012) studied biodiversity of molluscs from river Godavari, reservoir and pond and reported 24 species of fresh water molluscs. The abundance of the molluscan fauna indicates the rich productivity. The species inhabiting bottom of the river play an important role in converting organic matter into biomass which in turn is consumed by the fishes. Thus the molluscs help in the secondary productivity and form an important component in the food web of the river ecosystem. Macro-invertebrates of the Mara Bharali river was found to be rich in Molluscan diversity. A total 06 species of molluscs were identified from river and it indicates that productivity is moderately rich. The molluscs help in the secondary productivity and form an important component in the food chain and food web of the river ecosystem.

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