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Article

Physicochemical properties and plankton composition of the river Meghna, Bangladesh

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Abstract: The present study was conducted to assess the physicochemical properties and plankton composition of water from the river Meghna (Shatnol to Chor Alexander) in thirteen (13) sampling spots during the period of July 2014 to June 2015. Ten (three were physical and seven were chemical) physicochemical parameters of water *viz* temperature (air and water), transparency, dissolved oxygen (DO), free carbon dioxide (CO_2), Conductivity, pH, total hardness, total alkalinity and ammonia (NH_3), plankton community of both phytoplankton and zooplanktons were studied in aforesaid 13 sampling spots of the river Meghna. Maximum air temperature was recorded 37°C at Ananda Bazar. Maximum water temperature was recorded 30°C at Kaligonj, Chor Ludhua and Chor Alexander area of the river Meghna. Transparency was found minimum 12 cm at Chor Ludhua and maximum 75 cm at Horina Ghat. The concentration of dissolved oxygen was found maximum at Chor Voirabi and Horina Ghat 7.3 mg/l and was found minimum at Kaligonj 3.5 mg/l. Free CO_2 was found highest at Kaligonj 17 mg/l and lowest at Horina Ghat 5 mg/l. pH was found ranged from almost neutral to alkaline (Minimum 7.2 to Maximum 9). Total hardness was found highest at Chor Alexander 802 mg/l and lowest at Eklaspur 35 mg/l. Total alkalinity was found highest at Chor Alexander 145 mg/l and found minimum at Madrasa Ghat and Hizla 29 mg/l. Conductivity was found highest at Chor Alexander and Chor Ludhua 1000 µs/cm. Ammonia concentration was found ranged from 0.00 to 0.03mg/l. The mean contribution of phytoplankton was about 90.5% of the total planktonic organisms and zooplankton contributed the rest. The major groups of phytoplankton were found Bacillariophyceae, Chlorophyceae, Cyanophyceae, Dinophyceae, Euglenophyceae, Myxophyceae and Xanthophyceae. Total 9 genera of zooplankton were identified from four families namely Rotifera with 2 genera, Cladocera with 3 genera, Copepoda with 3 genera and Ostracoda with 1 genus from the selected sampling spots.

Keywords: physicochemical; plankton; composition; water and the Meghna river

1. Introduction

Bangladesh lies in the delta of the world's three great river systems (the Ganges-Padma, the Brahmmaputra-Jamuna and the Meghna river system and a complex network of 230 rivers. These three mighty river basins drain a catchment area of 1,720,000 km^2 of which only 7% lies in Bangladesh (UN, 1995). The confluences of Padma and Meghna and Tetulia river is a very significant water body. It plays an important role as the major nursery and breeding grounds of national fish, hilsa (*Tenualosa ilisha*) and many other commercially important riverine fishes (Haroon, 1998). Water maintains an ecological balance between various group of living organism and their environment (Khanna *et al.* 2012). The physical and chemical characteristics of water bodies affect the species composition, abundance, productivity and physiological conditions of aquatic organisms. These stressed systems support an extraordinarily high proportion of the world's biodiversity. Biological potentiality of an aquatic ecosystem depends on the biomass of the plankton. The knowledge on the abundance, composition and

seasonal succession of the same is a prerequisite for the successful management of an aquatic ecosystem (Ahmed *et al.* 2003). Phytoplankton is one of the most essential characteristics of the aquatic ecosystem for maintaining its stability and a means of coping with any environmental change (Hambright and Zohary, 2000). Therefore, phytoplankton population observation may be used as a reliable tool for biomonitoring studies to assess the pollution status of aquatic bodies. Phytoplankton is the primary producers for the entire aquatic body and comprises the major portion in the ecological pyramids (Odum, 1971). In the consumer food chain of aquatic ecosystems zooplankton play an important role in the transfer of energy from the primary producer to fish. They play an important role in the natural food chain which constitute important food item of omnivorous and carnivorous fishes. Over the last few decades, there has been much interest in the processes influencing the development of phytoplankton communities, primarily in relation to physicochemical factors (Akbay *et al.* 1999 and Peerapornpisal *et al.* 1999). The algae co-occur even though each species has a specific niche based on its physiological requirements and the constraints of the environment. The present baseline information of the physicochemical properties of river water and plankton composition would be a useful tool for further ecological assessment and monitoring of the river quality.

2. Materials and Methods

2.1. Study area

The present study was carried out monthly during the year July 2014 to June 2015. Total thirteen (13) sampling stations with respective GPS point namely Madrasa Ghat (MG), Ananda Bazar (AB), Eklaspur (Ep), Shatnol (Sn), Horina Ghat (HG), Haim Chor (HC), Chor Voirabi (CV), Ishanbala (Ib) at Chandpur, Alexander (Axr), Chor Ludhua (CL) at Luximpur, Kaligonj (Kg), Hizla (Hz) at Barisal and Chor Jalalpur (CJ) at Shariatpur district were selected on the river Meghna for the collection and analysis of water and plankton samples (Table 1).

Table 1. Name of the sampling stations with GPS point.

Serial No.	Name	GPS Location (Latitute, Longitute)
1.	Madrasa Ghat (MG), Chandpur	23°14.116′N, 90°38.423′E
2.	Ananda Bazar (AB), Chandpur	23°14.825′N, 90°38.756′E
3.	Eklaspur (Ep), Chandpur	23°22.487′N, 90°36.313′E
4.	Shatnol (Sn), Chandpur	23°27.726′N, 90°35.402′E
5.	Horina Ghat (HG), Chandpur	23°09.717′N, 90°38.560′E
6.	Haim Chor (HC), Chandpur	23°05.307′N, 90°38.882′E
7.	Chor Voirabi (CV), Chandpur	23°02.072′N, 90°39.219′E
8.	Ishanbala (Ib), Chandpur	23°08.110′N, 90°38.015′E
9.	Chor Jalalpur (CJ), Sariatpur	23°04.257′N, 90°39.403′E
10.	Hizla (Hz), Barisal	22°53.941′N, 90°31.984′E
11.	Kaliganj (Kg), Barisal	22°52.514′N, 90°35.753′E
12.	Chor Ludhua (CL), Laxmipur	22°45.523′N, 90°49.511′E
13.	Chor Alexandar (Axr), Laxmipur	22°41.275′N, 90°50.348′E

2.2. Sample collection

Water samples were collected from the selected sampling spots (Table1). Surface water samples were collected from 15-30 cm below the river water surface and at distances of 40-80 cm from the bank of the river in labeled sample bottles that were washed with conc. HNO_3 and rinsed repeatedly with distilled water. Before sample collection, sample bottles were rinsed three times also with the river water. Plankton samples were collected from each sampling sites normally at early morning by standard drop count method (APHA, 1995) during the study period. Replicate plankton samples were collected by means of a bucket (50litre) and filtered through bolting silk plankton net of 50µ. The filtrate were transferred to 100ml plastic bottle and preserved immediately in 1:100 Lugol's solution. Counting and identification were done as per Ward and Whipple (1959) and Presecot (1962).

2.3. Assessment of physicochemical properties

Physicochemical water quality parameters such as water temperature (^{0}C), air temperature (^{0}C), Conductivity (µs/cm), transparency (cm), dissolve oxygen (mg/l), free carbon dioxide (mg/l), pH, total alkalinity (mg/l), total hardness (mg/l) and ammonia (mg/l) were analyzed on the same day of sampling. The transparency of the water was measured using 20 cm diameter Secchi disc, which was dipped into the water till the disk disappeared and

the depth was recorded. A centigrade thermometer measured temperature of air and water. Free CO_2 content was determined by phenolphthalein indicator method (Welch, 1948). Total alkalinity was estimated by using phenolphthalein and methyl orange indicator method (Welch, 1948). Total hardness was determined by EDTA titrimetric method (APHA, 1995). HACH water test kit (Model-FF-2, USA) was used to measure pH, dissolved oxygen (DO) and ammonia (NH_3). Conductivity was measured by EC meter (HANNA instruments: H19143).

2.4. Statistical analysis

MS Excel 2010 version was used to the analysis of data obtained, which include descriptive analyses. Likewise correlation was also utilized in the case of testing for any significant correlation between the variables.

3. Results and Discussion

The physicochemical parameters (Avg. ± SD) values obtained from the thirteen (13) sites of the river Meghna were given in Table 2. Presence of phytoplankton and zooplankton were given in Tables 3, 4 and 5. Dominating groups of plankton and total counted plankton were shown in Table 3.

Table 2. Physicochemical properties of water in the selected sampling spots of the river Meghna.

Places	Parameters									
	Air Temp. (^{0}c)	Water Temp. (^{0}c)	Tranperency (cm)	DO (mg/l)	Free CO_2 (mg/l)	pH	T. Hardness (mg/l)	T. Alkalinity (mg/l)	Conductivity (µs/cm)	NH_3 (mg/l)
MG	15.6-37	17.8-30	25-59	5.5-6.5	8.4-10	7.8-8.25	60-68	29-50	148-280	00-0.03
AB	21-37	21.1-30	26-50	6.2-6.4	10.4-16.5	7.8-8.5	46-88	48-62	163-281	0.0
Ep	22-26	20-29	16-66	5.0-6.0	8.0-13.4	7.3-7.5	35-67	27-48	141-263	0.0
Sn	18.9-25	21.1-29	38.3-62	4.0 -6.4	5.6-13.8	7.3-7.5	36-69	30-50	137-268	0.0
HG	22.2-26	19-24	45-75	7.2-7.3	5.0-5.2	7.5-8.3	88-90	41-45	272-290	0.02-0.03
HC	21-32	18.9-29	35-50	5.3-5.7	9.5-12	7.8-8.0	120-185	130-132	223-277	0.0
CV	16.7-32	16.1-29.5	33-56	5.7-7.3	12-17	8.0-8.3	102-124	58-132	211-275	0.0
Ib	20.3-30	18.9-28.5	20-41	5.2-7.2	8.8-15	7.8-8.3	96-121	36-79	218-282	0.0
CJ	21.1-32	19.4-30.5	21-40	5.6-7.1	8.6-15.1	7.5-8.3	94-120	42-80	214-288	0.0
Hz	22.2-30	21.1-28	21-39	5.2-7.1	9.2-14	8.0-9.0	48-97	29-71	176-199	0.0
Kg	22.2-30	20.0-30	19-30	3.5-7.2	15-17	7.8-8.3	85-103	38-71	174-279	0.0
CL	21.1-32	18.9-30	12-27	4.5-6.8	11.4-13	8.0-8.5	115-403	54-137	400-1000	0.0
Axr	18.9-30	19-30	15-41	3.7-6.5	13.0-14	8.0-8.2	417-802	100-145	370-1000	0.0
Mean± SD	**1.4±24.8**	**1.4±23.7**	**9.4±36.3**	**0.6±5.9**	**2.6±11.3**	**0.3±7.9**	**151±141.5**	**32.2±67.9**	**175.6±301.1**	**0.008± 0.003**

3.1. Physical properties

3.1.1. Air and water temperature

Water temperature is an important factor in any aquatic environment affecting biological processes. Temperature is a common indicator to assess the physical condition of water quality. Temperature impacts both the chemical and biological characteristics of surface. From the recorded results the minimum and maximum temperature were shown a great variation from upstream to downstream. High and low seasonal variations were observed at all the sites. Water temperature was high due to low water level, high air temperature and clean atmosphere. Maximum air temperature was recorded 37°C at Ananda Bazar and minimum at 15.6°C at Madrasa Ghat area. Maximum water temperature was recorded 30°C at Kaligonj, Chor Ludhua and Chor Alexander area of the river Meghna and minimum value was recorded from Chor voirabi area (Table 2). The surface water temperature of the river was found always lower than air temperature. The marked variation and significant differences in physicochemical properties of the water indicate the different environmental conditions.

3.1.2. Transparency

In the present study, transparency was found minimum 12 cm at Chor Ludhua and maximum 75 cm at Horina Ghat with a mean of 36.27±9.40 at different sampling stations (Table 2). The transparency of water was found higher at the low tidal stretch of the river. Almost slide mixing muddy water was found in around the estuarine region. Khan and Chowdhury (1994) reported that higher transparency occur during winter and summer due to absence of rain, runoff and flood water as well as gradual settling of suspended particles.

3.2. Chemical properties

3.2.1. Dissolved oxygen (DO)

Dissolve oxygen is the sole source of oxygen for all the aerobic aquatic life and hence it is considered as an important measure of purity for all waters. It reflects the water quality status and physical and biological processes in waters and shows the metabolic balance of a river system. Dissolve oxygen is an important water quality parameter in assessing water pollution (Laluraj *et al.,* 2002). In the present study, the concentration of dissolved oxygen was found maximum at Chor Voirabi and Horina Ghat 7.3 mg/l and was found minimum at Kaligonj 3.5 mg/l with a mean of 5.92±0.61 mg/l (Table 2). Dissolved oxygen content was found gradually decreasing from the upper to lower stretches of the river system (Table 2). Rani *et al.* (2004) also reported lower values of dissolved oxygen in summer season due to higher rate of decomposition of organic matter and limited flow of water in low holding environment due to high temperature. The cause of maximum dissolve oxygen in winter months may be due to the reduced rate of decomposition by decreased microbial activity at low temperature (Prasad and Singh, 2003).

3.2.2. Free carbon dioxide (Free CO_2)

Free CO_2 was found highest at Kaligonj 17 mg/l and lowest at Horina Ghat 5 mg/l (Table 2). Free CO_2 content was found gradually decreasing from the upper to lower stretches of the river system. The rise in temperature in the river water could be correlated with increase in carbon dioxide levels (Talling, 1957) when the water level decreased sharply during summer.

3.2.3. pH

pH can affect the aquatic life indirectly by altering other aspects of water chemistry e.g. low pH levels can increase the solubility of certain heavy metals. In the present study, pH was found ranged from neutral to alkaline (Minimum 7.2 to Maximum 9) at different stations with a mean 7.94±0.3 (Table 2). During the entire period of study pH of surface water was found mostly alkaline in nature. The high values may be due to attributed pollution by water flow and circulation. Fluctuations in pH values during different season of the year were attributed to factors like removal of CO_2 by photosynthesis through bicarbonate degradation, dilution of waste with fresh water, reduction in salinity and temperature, and decomposition of organic matter (Rajasegar, 2003). According to (Chisty, 2002) pH value is very important for plankton growth. Marathi *et al.* (2007) reported pH is ranged 5 to 8.5 is best for plankton growth.

3.2.4. Total hardness

Hardness is important to aquaculture. Hardness of water influenced by the most common sources like as calcium and magnesium and calcium and magnesium are essential in the biological processes of aquatic animals, especially for bone and scale formation in fish (Wurts and Durborow, 1992). In the present study, total hardness was found highest at Chor Alexander 802 mg/l and lowest at Eklaspur 35 mg/l in different sampling locations (Table 2). High values may be due to the addition of calcium and magnesium salts in river water. The increase in hardness can be attributed to the decrease in water volume and increase in the rate of evaporation at high temperature. Hujare (2008) reported total hardness was higher in summer than rainy season and winter season.

3.2.5. Total alkalinity

Alkalinity of water is its capacity to neutralize a strong acid and is characterized by presence of all hydroxyl ions capable of combining with hydrogen ions (Koshy and Nayar, 2000). Total alkalinity was found highest at Chor Alexander 145 mg/l and found minimum at Madrasa Ghat and Hizla 29 mg/l (Table 2). Bhuiyan (1970) recorded the total alkalinity of medium productive water body ranging from 25 to 100 mg/l. Buffering capacity of rivers depends on alkalinity whereas alkalinity is measured to determine the ability of river to resist changes in pH.

3.2.6. Conductivity

Conductivity has a relationship with transparency. When conductivity showed an increasing trend then transparency showed a decreasing trend. Conductivity was found highest at Alexander and Chor Ludhua 1000 µs/cm and was found minimum at Eklaspur 141 µs/cm (Table 2). Increasing levels of conductivity and cations are the products of decomposition and mineralization of organic materials (Abida, 2008).

3.2.7. Ammonia

During the study period, ammonia concentration was found ranged from 0.00 to 0.03 mg/l. Maximum value was recorded from Horina Ghat (Table 2). These values indicate till date ammonia concentrations in the selected sampling spots remain in the suitable range. These values are much lower than the Chisty (2002) and Rani *et al.* (2004).

3.3. Plankton composition

Abundance and quantity of plankton of both phytoplankton and zooplankton in 13 sampling stations of the river Meghna has been presented in Tables 3, 4 and 5.

Table 3. Mean quantitative values of plankton with dominating genera in selected sampling points of the river Meghna.

Places	Total Phyto. (No./l)	Dominating Phyto. (No./l)	Other Phyto. (No./l)	Total Zoo. (No./l)	Dominating Zoo. (No./l)	Other Zoo. (No./l)
MG	146×10^2	*Ulothrix* (91×10^2)	55×10^2	33×10^2	*Brachionus* (25×10^2)	8×10^2
AB	59×10^2	*Ulothrix* (19×10^2)	40×10^2	12×10^2	*Brachionus* (10×10^2)	2×10^2
EP	256×10^2	*Melosera* (105×10^2)	151×10^2	4×10^2	*Nauplius* (3×10^2)	1×10^2
Sn	29×10^2	*Ulothrix* (17×10^2)	12×10^2	8×10^2	*Brachionus* (5×10^2)	3×10^2
HG	410×10^2	*Ulothrix* (183×10^2)	227×10^2	26×10^2	*Brachionus* (19×10^2)	7×10^2
HC	267×10^2	*Ulothrix* (193×10^2)	74×10^2	18×10^2	*Brachionus* (14×10^2)	4×10^2
CV	305×10^2	*Ulothrix* (235×10^2)	70×10^2	13×10^2	*Brachionus* (9×10^2)	4×10^2
Ib	293×10^2	*Ulothrix* (185×10^2)	108×10^2	30×10^2	*Brachionus* (22×10^2)	8×10^2
CJ	239×10^2	*Ulothrix* (98×10^2)	141×10^2	35×10^2	*Brachionus* (20×10^2)	15×10^2
HZ	443×10^2	*Ulothrix* (305×10^2)	138×10^2	27×10^2	*Brachionus* (20×10^2)	7×10^2
KG	389×10^2	*Ulothrix* (278×10^2)	111×10^2	26×10^2	*Brachionus* (17×10^2)	9×10^2
CL	230×10^2	*Ulothrix* (169×10^2)	61×10^2	11×10^2	*Brachionus* (8×10^2)	3×10^2
Axr	196×10^2	*Ulothrix* (112×10^2)	84×10^2	6×10^2	*Nauplius* (3×10^2)	3×10^2
Total	**3252×10^2**	**1990×10^2**	**1272×10^2**	**249×10^2**	**175×10^2**	**74×10^2**

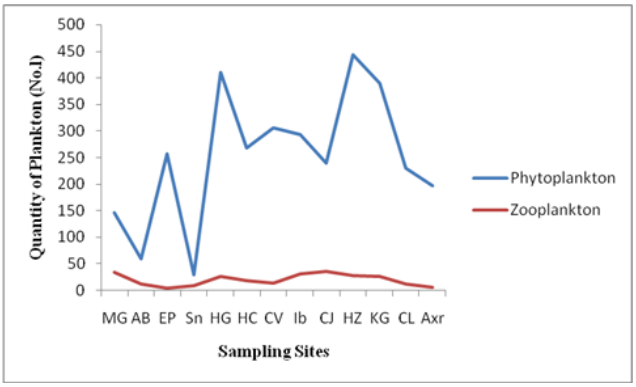


Figure 1. Plankton composition of the river Meghna (Shatnol to Chor Alexandar).

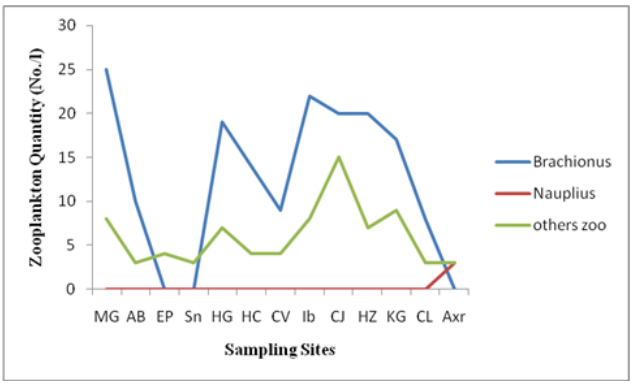


Figure 2. Zooplankton composition of the river Meghna (Shatnol to Chor Alexandar).

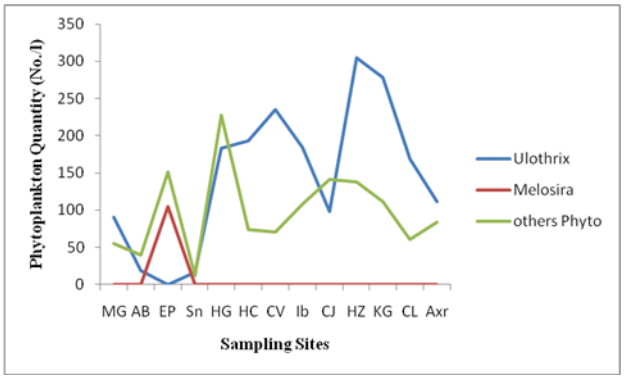
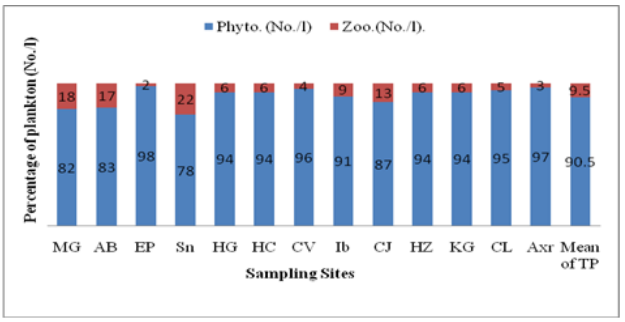


Figure 3. Phytoplankton composition of the river Meghna (Shatnol to Chor Alexandar).



TP=Total Plankton

Figure 4. Percent (%) composition of phytoplankton and zooplankton in the river Meghna (Shatnol to Chor Alexandar).

Table 4. Phytoplankton families with genus composition were observed during the study period.

SL No.	Family	Genus
1.	Cholorophyceae	*Ankistrodesmus*, *Eudorina*, *Crucigenia*, *Chlamydomonas*, *Ceratium*, *Closterium*, *Gonatozygon*, *Microspora*, *Genecularia*, *Pleodarina*, *Spirogyra*, *Scenedesmus*, *Mougeotia*, *Volvox*, *Zygenema*, *Pediastrum*
2.	Dinophyceae	*Ulothrix*, *Protoccocus*
3.	Bacillariophyceae	*Amphora*, *Tabellaria*, *Coscinodesmus*, *Cyclotella*, *Ditoma*, *Fragilaria*, *Melosira*, *Navicula*, *Nitzchia*, *Polycistis*,, *Stphanodesmus*, *Synedra*, *Asterionella*
4.	Cyanophyceae	*Spirulina* , *Scenedesmus*
5.	Myxophyceae	*Tetrapedia*, *Coelosphaerium*, *Merismopedia*, *Oedogonium*, *Aphanocapsa*
6.	Euglenophyceae	*Tribonema*
7.	Xanthophyceae	*Trachelomonus*, *Euglena*

Table 5. Zooplankton families with genus composition were observed during the study period.

SL No.	Family	Genus
1.	Rotifers	*Trichocera*, *Brachionu*
2.	Copepods	*Nauplius*, *Diaptomus*, *Cyclops*
3.	Cladocera	*Daphnia*, *Diaphanosoma*, *Chydorus*
4.	Ostracods	*Cypris*

3.3.1. Phytoplankton

During the study period, 41 genera belongs to Bacillariophyceae with 13 genera, Chlorophyceae with 15 genera, Cyanophyceae with 3 genera, Dinophyceae with 2 genera, Euglenophyceae with 1 genus, Myxophyceae with 5 genera and Xanthophyceae with 2 genera were recorded (Table 4). In the river Meghna, phytoplanktons were dominated largely over zooplanktons (Figure 1). The mean contribution of phytoplankton was about 90.5% of the total planktonic organisms and zooplankton contributed the rest (Figure 4). Shafi *et al.* (1978) reported that higher percentage of phytoplankton 76.0 to 93.6% from the same ecosystem. Sundar *et al*. (1995) also reported

that the major contribution of phytoplankton (> 97.0%) and lower concentration of zooplankton 0.13 to 2.4% at three stations in the Guala river of Uttar Pradesh, India. Higher phytoplankton concentrations in water normally indicate higher productivity. In the present study, total phytoplankton population (3252×10²) was dominated by Dinophyceae (*Ulothrix* 1885 ×10²), secondly Bacillariophyceae (*Melosira* 105 ×10²) and rest of (1262 ×10²) followed by Chlorophyceae, Cyanophyceae, Euglenophyceae, Myxophyceae, Xanthophyceae respectively (Figure 3).

3.3.2. Zooplankton

During the present investigation, total 9 genera of zooplanktons were found with four families namely Rotifera with 2 genera, Cladocera with 3 genera, Copepoda with 3 genera and Ostracoda with 1 genus were identified from the selected sampling spots (Table 5). Zooplankton was found more than 9% in the total planktonic organisms. Shafi *et al.* (1978) and Sundar *et al*. (1995) reported the almost same observation in their investigations. Ahmed *et al*., (2003) also found that zooplankton contributed more than 3% in the total planktonic organisms. Creating factors such as light intensity, food availability, dissolved oxygen and predation affect the population dynamics of zooplankton. In this study, the zooplankton diversity was recorded in the following order, Rotifera>Copepoda>Cladocera>Ostracoda (Table 5). During the present investigation, presence of copepod with 3 genera and Cladocera with 3 genera were the most dominant groups in the study area of the Meghna River (Table 5).

Total zooplankton population (175×10²) was dominated by Rotifera (*Brachionus* 169 ×10²), Copepods (6×10²) and rest of (74 ×10²) followed by others (Table 3). A single genus of zooplankton namely *Brachionus* of specific group was found as a regular component for almost all sampling stations (Figure 2). However in the river Meghna, presence of zooplankton was found highest at Kaligonj and Eklaspur with 6 genera and lowest at Shatnol and Chor Ludhua with 2 genera (Table 5).

4. Conclusions

The present study concluded that physicochemical and planktonic characteristics of all the thirteen sites of the river Meghna showed wide range of variation. Higher presence of phytoplankton in the river Meghna indicates good physicochemical conditions and good water quality to a much extent showed less effect of pollution load. The physicochemical conditions of the river Meghna is good and provide a healthier environment for the growth and survival of fishes as well as biological communities. But it does not mean that the river is free from pollution and it is important to monitor regularly. Mainly management efforts should be made for the conservation approach and sustainable run of the river Meghna otherwise it will pollute rapidly and perhaps might be turn into the deadly condition after a certain period.

Conflict of interest

None to declare.

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