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Physico-chemical and biological properties of water from the river Meghna, Bangladesh

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Abstract
Meghna is one of the most famous rivers in Bangladesh and endures country’s important multi-species commercial fishery. The present study was conducted to assess the physico-chemical and biological parameters of Meghna Rivers water in three spots during the period of January, 2014 to December, 2014. Nineteen (ten were physical and nine were chemical) physico-chemical parameters of water *viz* Water depth, Water temperature, Air temperature, Water colour, Odour of water, Bottom type, Transparency, Conductivity, Turbidity, Total Dissolve Solids (TDS), Dissolve Oxygen (DO), Free carbon dioxide, pH, NH_3, Total alkalinity, Total hardness, Biological Oxygen Demand (BOD) (B), Biological Oxygen Demand BOD (N) and Chemical Oxygen Demand (COD), plankton community of both phytoplankton and Zooplankton were studied in aforesaid sampling spots of Meghna river. Maximum water depth was recorded from Meghna ghat area. Among these sampling spots highest transparency was recorded from Bhairab region. Dissolve oxygen concentration was found highest 7.5 mg/L in Chandpur. Free carbon dioxide was found maximum in Meghna ghat area 3.7 mg/L. Chlorophyceae, Bacillariophyceae, Dinophyceae, Myxophyceae were the major groups of phytoplankton. Cladocera, Copepod, Rotifer and Sididae were the major groups of Zooplankton. Pleuroceridae, Lepidopteridae, Chironomidae, Lepidopteridae, Unionidae, Viviparidae and Sphaeridae etc were the major groups of benthos. Micro invertebrates such as Chironomus larvae (Red blood), Chironomus larvae (others), Nematoda, Oligochaeta, Polychaeta, Bristle worm, Coleopteran larvae, Dragon fly nymph, Stone fly nymph were also identified. At present from the findings of physicochemical and biological parameters of water indicate water quality of Meghna river are safe for aquatic lives, but the continuous sewage disposal may create problems in the future.

Keywords: Physico-chemical, Biological, Water, Meghna River and Bangladesh.

1. Introduction
Industrial pollution is one of the main causes for decreasing open water capture fisheries. Aquatic ecosystem needs careful protection to maintain the water quality and its standard. Water quality plays an important role for the production of fisheries. Rivers and streams are highly heterogeneous at spatial as well as temporal scales, and several investigators have documented this heterogeneity focusing on the physico-chemical dynamics of rivers. Variation in the quality and quantity of river water is widely studied in the case of several world rivers. The spatiotemporal variation in trace elements in Patuxent river, Maryland [24]. The variations in nutrient level in the Nemunas river of Russia [25]. During periods of high flux, the structure of the plankton can be strongly influenced by differential loss of organisms as a consequence of their vertical position in the water column, swimming capacity and reproductive rates. However, the interference can also be indirect, through modifications in the physical and chemical conditions of the environment. In addition, typical longitudinal gradients generally observed in reservoirs, lateral components, such as arms and bays, can contribute significantly to the maintenance of heterogeneous patterns in the zooplankton distribution [31]. Despite of the importance of physical–biological interactions, the structure of the zooplankton in reservoirs can also be influenced by biological interactions and adaptative characteristics [13]. There is no consensus on whether the heterogeneity of the spatial distribution of the plankton of reservoirs is stable or ephemeral [7]. Plankton stresses the relative importance of the spatial and temporal components on heterogeneity, the influence of longitudinal gradients along the main axis and the influence of the main tributaries.

Micro invertebrate assemblages have been used as bio indicators of stream biological integrity [14, 19] within this framework, the use of a multimetric approach that utilizes the index of biotic integrity (IBI) has gained interest in biological assessment of rivers and streams in urban and suburban catchments [9, 16, 21]

2. Materials and Methods
2.1 Study area
The study was carried out from Bangladesh Fisheries Research Institute, Riverine Station, Chandpur (N-23014.616^0 and E-90037.818^0) during the period of January, 2014 to December, 2014 covering the area of Chandpur sadar (Chandpur), Meghna ghat (Narayangonj) and Bhairab (Kishorgonj). The samples of water were collected from selected sites. The characteristics of sampling sites are described in Table 1.

Table 1: Sampling location with GPS point

Station No.	Sampling site	GPS point (Longitude and Latitude)	
S1	Chandpur Sadar	N-23014.616^0	E-90037.818^0
S2	Meghna ghat	N-23026.108^0	E-90036.859^0
S3	Bhairab	N-21003.104^0	E-90059.918^0

2.2 Assessment of physico-chemical parameters
Common physical tests of water include colour, odour, temperature, transparency, solids concentrations e.g., Total Dissolved Solid (TDS) and turbidity. Colour and odour were examined through external sensory organ whereas other physical properties were evaluated through latest models of digital temperature and turbidity meter. Transparency was measured through secchi disk reading. Chemical parameters such as Conductivity (µs/cm), Transparency, TDS (mg/L), Dissolve Oxygen (mg/L), pH, Total alkalinity, Total hardness, ammonia (NH_3), BOD (mg/L) and COD (mg/L) were analyzed on the same day of sampling. Free CO_2 content was determined by Phenolphthalein indicator method [33]. In this method, at first we take 100 ml water sample then add 6 drops Phenolphthalein indicator and finally titrated with NaoH until pink color. Total alkalinity was estimated by using phenolphthalein and methyl orange indicator method [33]. In this method, at first we take 100 ml water sample then add 6 drops Phenolphthalein indicator and 6 drops methyl orange. Finally this solution titrated with 0.2 N H_2SO_4 until orange color. Total hardness was determined by EDTA titrimetric method. HACH test kit (Model-FF-2, USA) was used to measure pH, dissolved oxygen (DO), ammonia. Total Dissolved Solid (TDS), conductivity was measured by EC meter (HANNA instruments: H19143).

The Biochemical Oxygen Demand (BOD) of polluted water is the amount of oxygen required for the biological decomposition of dissolved organic matter. Usually, the time is taken as 5 days and the temperature 20 °C as per the global standard. The BOD test is among the most important method in sanitary analysis to determine the polluting power, or strength polluted water. It serves as a measure of the amount of clean diluting water required for the successful disposal of sewage by dilution. The test has its widest application in measuring waste loading to treatment plants and in evaluating the efficiency of such treatment systems. The test consists in taking the given sample in suitable concentrations in dilute water in BOD bottles. Two bottles are taken for each concentration and three concentrations are used for each sample. One set of bottles is incubated in a BOD incubator for 5 days at 20 °C; the dissolved oxygen (initial) content (D1) in the other set of bottles will be determined immediately. At the end of 5 days, the dissolved oxygen content (D2) in the incubated set of bottles is determined. In this method, at first we take 100 ml original water sample then add 2 ml $MnSo_4$ and 2 ml alkyl iodide. After that add 2 ml concentrated H_2So_4 and mixed well. Then add 6 drops starch solution and finally titrated with $Na_2S_2O_3$ until colorless.

COD results are reported in terms of mg of oxygen. At first 50 ml sample was taken and allow with 1g H_2SO_4 and glass beads. Then 5 ml H_2SO_4 and Ag_2SO_4 was added very slowly. Cool in room temperature. After cooling 25 ml 0.0417 M $K_2Cr_2O_7$ was added. Then solution containing flask was added in condenser. Then 70ml of H_2SO_4 and Ag_2SO_4 was added through open end of condenser and continuous shaking was done for well mixing. Cool the solution containing flask in room temperature. Then double volume of distilled water was added. An excess of oxidizing agent is added, the excess is determined by another reducing agent such as Ferrous Ammonium Sulphate (FAS). An indicator ferroin (0.0417 N) is used in titrating the excess dichromate against ferrous ammonium sulphate.

2.3 Assessment of biological parameters
Sampling of plankton assemblage from sub-surface water (four times in a day at 6, 12, 18 and 24 hrs to know the diurnal variation) were done by filtering 50 liters of river water through a 25 µ and 50 µ plankton net for qualitative (preferably up to species level) and quantitative analyses. For plankton counting, the S-R (Sedgwick Rafter) cell was used which is 50 mm long, 20 wide and 1 mm deep. Before filling the S-R cell with sample, the cover glass was diagonally placed across the cell and then samples were transferred with a large bore so that no air bubbles in the cell covers were formed. The S-R cell was let standard for at least 15 minute to settle planktons. Then planktons on the bottom of the S-R cell were counted by microscope. By moving the mechanical stage, the entire bottom of the slide area was examined carefully. Organisms lying between two parallel cross hairs were counted as they passed a vertical line. Identification of plankton (phytoplankton and zooplankton) up to generic level was made according to Presscot (1964) [18], Needham and Needham (1963) [17] and Belcher and Swale (1978) [6].

Number of plankton in the S-R cell was derived from the following formula [5]:

$$\text{Number of species/Liter} = \frac{C \times 1000 \text{ mm}^3}{L \times D \times W \times S}$$

Where,

C = Number of organisms counted
L = Length of each stripe (S-R cell length) in mm
D = Depth of each stripe in mm
W = Width of each stripe in mm
S = Number of stripe

Sampling of macro-invertebrates was done using an Ekman's dredge and no. 40/60mm sieve for qualitative and quantitative analysis.

2.4 Data Processing and Analysis
The relevant data were processed and analyzed through manually and for computer based analysis MS Excel of Office 2007 version was used.

3. Results

3.1 Physico-chemical features of water

Physico-chemical parameters (Ten physical and nine chemical) of three sampling stations were studied and wide range of fluctuation was observed among the sampling stations. Almost all parameters were found suitable but some are deviated from the desired range. The range of the values showed seasonal fluctuation and the deviations among the spots also.

Table 2: Physico chemical parameters of water from the river Meghna

Parameters	Chandpur (Mean±SD)	Meghna ghat (Mean±SD)	Bhairab (Mean±SD)
Water depth (ft)	15.5±4.0	18.2±5.9	14.9±6.1
Air temp (^{0}C)	26.8±8.2	27.4±6.6	28.8±8.2
Water temp (^{0}C)	25.1±5.5	26.2±4.9	26.6±7.8
Water colour	Light green	Muddy	Light green
Odour of water	Fresh	Fresh	Fresh
Bottom Type	Sandy clay	Sandy hard	Sandy clay
Transparency (cm)	45.2±20.5	44.3±32.6	49±21.7
Conductivity (µs/cm)	310.5±110.2	466±557.7	284.5±315.8
Turbidity	50.7±23.5	54.4±31.2	46.5±26.5
TDS (mg/l)	160.4±80.2	229.9±273.7	153.6±149.6
Dissolve O_2 (mg/l)	7.5±1.8	7.3±0.2	7.4±2.5
Free CO_2 (mg/l)	3.0±1.1	3.7±1.2	2.8±1.2
pH	8.0±2.3	7.8±0.4	8.4±2.3
NH_3 (mg/l)	0±0	0±0	0±0
Total alkalinity	115.5±65.2	110.7±59.9	119.6±41.9
Total hardness	138.3±45.2	107.2±37.2	143.7±47.7
BOD (B) (mg/l)	6.2±2.0	5.4±2.1	6.1±1.9
BOD (N) (mg/l)	6.5±2.3	6.7±0.7	7.7±2.4
COD (mg/l)	10.2±6.8	17.4±13.2	8.7±8.1

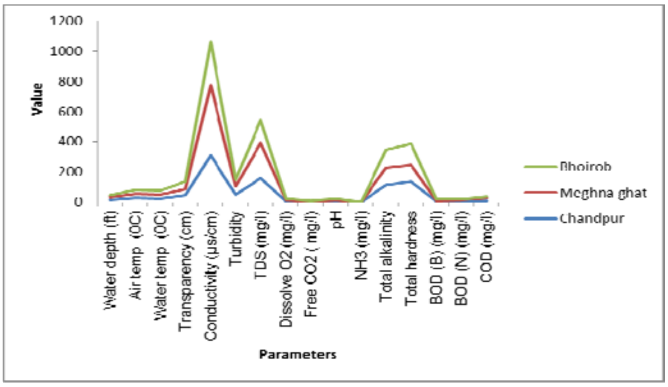

Fig 1: Annual average variation in the physico-chemical parameters.

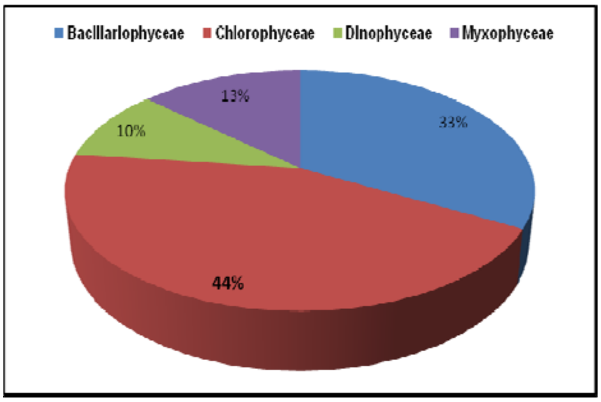

Fig 2: Phytoplankton composition of the selected spots of Meghna River.

3.2 Biological features of water

Abundance of plankton in three sampling spots also showed a wide range of variation. More than 40 genera of plankton were identified under 4 families [17, 18, 6]. Total plankton density was found 1500±695.4 (Nos./l) in Chandpur, 1450±670.2 (Nos./l) in Meghna ghat and 1400±710.5 (Nos./l) in Bhairab respectively. Chlorophyceae, Bacillariophyceae, Dinophyceae, Myxophyceae were the major groups of phytoplankton. Cladocera, Copepod, Rotifer and Sididae were the major groups of Zooplankton. Phytoplankton was largely dominated over zooplankton throughout the study period. The mean contribution of phytoplankton was more than 91.33% in all three rivers and zooplankton contributed the rest.

The benthos and macro invertebrate samples of the selected stations were collected and identified in the laboratory. About 13 genera of benthos were observed under seven families. Dominated by the Bulimidae family and was followed by the others *viz.* Pleuroceridae, Lepidopteridae, Chironomidae, Lepidopteridae, Unionidae, Viviparidae and Sphaeridae etc. Chironomus larvae (Red blood), Chironomus larvae (others), Nematoda, Oligochaeta, Polychaeta, Bristle worm, Coleopteran larvae, Dragon fly nymph, Stone fly nymph were also identified.

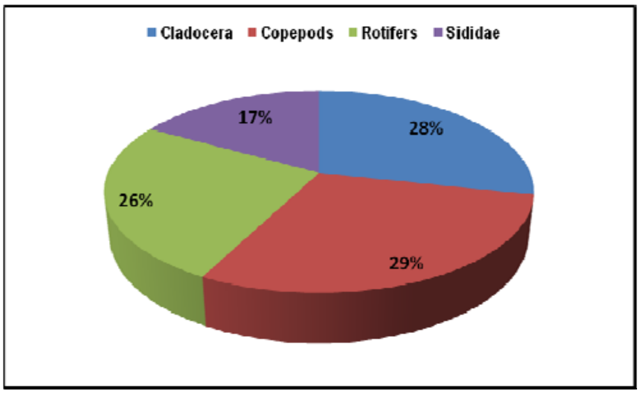

Fig 3: Zooplankton composition of the selected spots of Meghna River

4. Discussion

The results of means and SD of the studied physical and chemical properties for water samples in the selected three sites are given in (Table No. 2). Because of its great impact on aquatic life, water temperature is an important component of a water quality assessment [11]. Temperature is a critical water quality parameter, since it directly influences the amount of dissolved oxygen that is available to aquatic organisms [4]. Temperature affects the distribution, health, and survival of aquatic organisms. While temperature changes can cause mortality, it can also cause sub-lethal effects by altering the physiology of aquatic organisms [11]. Temperatures outside of an acceptable limit affect the ability of aquatic organisms to grow, reproduce, escape predators, and compete for their habitat. The fluctuation in river water temperature usually depends on the season, geographic location, sampling time and temperature of effluents entering the stream [2]. The transparency of productive water bodies should be 40cm or less [23]. The pH of a water body is very important in determination of water quality since it affects other chemical reactions such as solubility and metal toxicity [12]. The pH was found to be 7.8 to 8.4 in present study. Adequate DO is necessary for good water quality, survival of aquatic organism and decomposition of waste by microorganism [10, 15, 22]. Maximum DO value was found to be 7.3 to 7.5 mg/L. The rise in temperature in the river water can be correlated with increase in carbon dioxide levels [30]. Alkalinity of water is a measure of weak acid present in it and of the cations balanced against them [29]. Total alkalinity of water is due to presence of mineral salt present in it. It is primarily caused by the carbonate and bicarbonate ions. Total Dissolve Solids (TDS) are a measure of the amount of particulate solids that are in solution. This is an indicator of nonpoint source pollution problems associated with various land use practices. They are the direct measurement of particle concentration that quantifies the diffraction of light caused by particles in the water [11]. TDS concentration was found to be 160.4 mg/L to 229.9 mg/L in the present study. TDS concentrations have been recommended by the USEPA (up to 500 mg/L) [32] as useful indicators of water quality and are important measurements for a number of reasons. Increased TDS are frequently indicators of erosion. BOD directly affects the amount of dissolved oxygen in rivers and streams. ADB, 1994 [1] proposed BOD of 10 mg/L in irrigation water quality standards for Bangladesh. The greater the BOD, the more rapidly oxygen is depleted in the stream. This means less oxygen is available to higher forms of aquatic life. In the present study BOD, B was found 1.9 mg/L to 6.2 mg/L. In the conjunction with the BOD test, the COD test is helpful in indicating toxic conditions and the presence of biologically resistant organic substances [28]. In present study COD values varied between 8.7 mg/L – 17.4 mg/L. The mean contribution of phytoplankton was about 91.3% in all sampling spots and zooplankton contributed the rest. Higher percentage composition of phytoplankton (76.0 - 93.6%) from the Meghna river [26]. The major contribution of phytoplankton (>97.0%) and lower concentration of zooplankton (0.13 - 2.4%) at three stations in the Guala river of Uttar Pradesh, India [27]. Chlorophyceae was found most dominating group in phytoplankton among phytoplankton abundance from Mouri river of Khulna [20]. Bacillariophyceae was formed 2nd place in the total phytoplankton abundance, similar result also reported from Mouri river of Khulna [20]. About 23 genera of zooplankton, of which 12 belonged to Rotifers, 4 to Copepods, 6 to Cladocerans and 1 to Ostracods from the river Buriganga [8]. In the present study zooplankton constituted 8.6% of the total plankton abundance. Zooplankton contributed more than 3% to the total planktonic organisms [3]. Copepods were found the dominating group in zooplankton. Copepods (51.2%) were the most dominating group among total zooplankton abundance [3].

5. Conclusions

Meghna River plays a vital role as the important freshwater resources of Bangladesh. Water of this river system is used for different purposes irrigation, Navigation, Fisheries, dumping of domestic and industrial waste and recreational purposes. The conservation of river is in the interest of man as it's ecological, cultural and tourist value is immense. Thus, intensive investigation and experimental ecology of both physico-chemical and biological factors will allow us to understand more about plankton diversity and distribution in the freshwater ecosystems and it further provides support as to why plankton species and assemblages are good indicators of environmental change. At the present phase, it is essential to use the vast knowledge accumulated on the ecology of zooplankton communities in the Meghna river for the ecosystem management aimed at improving the water quality and conservation of natural biological diversity in the ecosystems.

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