

Limnological study of Karnaphuli river in Bangladesh

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Abstract. The study was aimed to estimate the water quality parameters and determine the plankton population of the Karnaphuli River. Water samples were collected from six points (Kalurghat, Sadarghat, Fisheryghat, Kaptai, Jettyghat, Boraichuri) of the river from April to September, 2017. Most of the physico-chemical parameters of the river water were not found in optimal levels. Temperature, transparency, dissolved oxygen (DO), pH, CO₂, total alkalinity, electrical conductivity in water samples were found to range from 26⁰ C to 32⁰ C, 4 to 9cm, 3.2 to 4.6 mg/L, 5.9 to 7.5, 14.8 to 26.7 mg/L, 71 to 105.5 mg/L and 7645 to 11645 μ S/cm, respectively during the experimental period. Thirteen genera of phytoplankton of 8 divisions and 4 genera of zooplankton of 3 divisions were found in the river. Highest number of phytoplankton (34×10^3 cells/L) was found at Kalurghat in July and lowest (14×10^3 cells/L) was at Sadarghat in April. *Cyclotella* was the most abundant *Nitzschia* and *Gymnodium* were the least abundant species in Karnaphuli river. The present study will help to make policy for sustainable management of Karnaphuli river.

Keywords: Karnaphuli river, Physico-chemical parameters, Phytoplankton, Zooplankton

Introduction

Chattogram is known as the economic capital as well as the port city of Bangladesh. Karnaphuli river originating from the Lushai hills in Mizoram State of India ultimately finds its way into the Bay of Bengal through the south-eastern coast of Bangladesh (O' Mallery 1908). The river has importance in Chattogram due to multipurpose use of water like drinking, bathing, fishing, navigation, hydraulic power generation, irrigation etc. (Siddique and Akter 2012). The river connected with lot of canals, tributaries and small rivers playing a dominant role on the hydrobiology of the Karnaphuli River which contributes large amount of contaminated water, solid wastes, sewage (Hossain *et al.* 2006). Due to industrialization huge industries were established producing greater loads of industrial effluent, and the industries are throwing out their effluents directly or indirectly into Karnaphuli river (Islam *et al.* 2016). Industrial effluent along with domestic sewage, commercial waste, agricultural waste adversely affects aquatic biota, fish, shell fishes, phytoplankton and zooplankton (Bhuyan and Islam 2017).

Both anthropogenic and natural activities are responsible for river pollution degrading the water quality, making unsuitable condition for fish, which finally reduce the fish production. Healthy environment with optimum physico chemical parameters of the water body is prerequisite for aquatic organisms. Optimum physico chemical parameters help to obtain the maximum productivity in an aquatic environment. Thus the study involved determination of physico chemical and biological parameters of Karnaphuli river at 6 selected points. The objectives of the study were to assess the present water quality, through analysis of some selected water quality parameters like temperature, transparency, pH, DO, free CO₂, total alkalinity, EC and to determine the qualitative and quantitative abundance of plankton

community in Karnaphuli river. Limnological study is important for fisheries science and will help to develop any sustainable management of aquatic environment. Limnology will help to developing any sustainable management of aquatic environment. Lack of adequate limnological knowledge will carry out any drawback for sustainable management of aquatic environment. This study was conducted to observe the physical, chemical and biological parameters of Karnaphuli river which will be beneficial for raising public awareness and provide scientific information for management of Karnaphuli river.

Materials and Methods

The experiment was carried out for 6 months from April to September, 2017 in six points (Kalurghat, Sadarghat, Fisheryghat, Kaptai, Jettyghat, Boraichuri) of Karnaphuli river to study the physico-chemical parameters and qualitative and quantitative study of plankton population of these points.

Sample collection: Sampling was performed on monthly basis from above mentioned points. Physico-chemical parameters such as temperature (by using Celsius thermometer), transparency (by using Secchi disk), pH (by using PC Stester 35) and electric conductivity (by using PC Stester 35) were measured on spot. Water samples were kept in DO bottle (BOD Bottle, 300ml - Interchangeable Glass Pennyhead Stopper - Borosilicate Glass) and plastic bottle and carried out to the Aquatic Ecology Laboratory of Faculty of Fisheries in Chattogram Veterinary and Animal Sciences University to analyze DO by Winkler's method, alkalinity and free Carbon dioxide (CO₂) by titration method.

Qualitative and quantitative determination of plankton: Sample was collected from 6 selected locations of Karnaphuli river for qualitative and quantitative study of plankton. Ten liters water were collected from each sampling by using Kemmerer water sampler and passed through the plankton net. The mesh size of plankton net was 25 µm. The collected sample (10 liters) was concentrated into 50 ml. The concentrated sample was preserved by using 5% formalin solution for further study.

For quantitative determination, Sedewick-Rsfter (S-R) cell was used. Sample was taken in the S-R cell and placed under microscope at 10X. Ten squares of S-R cell were counted. The number of plankton cells was calculated in the counting plate. Then the total number of plankton cells (cells/L) was calculated according to Rahman (1992).

$$\text{Number of plankton, } N = \frac{A \times C}{F \times V \times L} \times 1000$$

Here,

V = Volume of the S-R cell field

F = Number of field count

C = Volume of final concentration of sample

A = Total of plankton counted

L = Volume of original water

N = Number of plankton cells per liter

Statistical analysis: Statistical analyses were performed by using MS excel (Microsoft office excel-2007, USA) and IBM SPSS Statistics 23 Version. Values are expressed as

means $\pm$ standard deviation (SD). Data were analyzed by a one-way analysis of variance (ANOVA) followed by Tukey's post hoc test to assess statistically significant differences of physico-chemical parameters among the different locations of the Karnaphuli River. The p value statistical significance was set at $p < 0.05$.

Results

Physico-chemical parameters of Karnaphuli river: The mean values with standard deviation of physico-chemical parameters of water of six different location of Karnaphuli river are shown in Table I. Water quality parameters such as pH, DO, CO₂, transparency, total alkalinity and electrical conductivity were found significant differences with selected locations ($p < 0.05$). But the water temperature was not found significant differences with selected site ($p > 0.05$). The highest water temperature (32°C) was recorded in Kalurghat in September and lowest (26°C) was recorded in Fisheryghat in April. The value of transparency was 5 to 7cm, 4 to 6cm, 6 to 8cm, 5 to 8cm, 7 to 9cm, 6 to 8cm in Kalurghat, Sadarghat, Fisheryghat, Kaptai, Jettyghat, Boraichuri of Karnaphuli river, respectively. The mean $\pm$ SD of DO were 3.68 ± 0.09 , $4.05 \pm .45$, $3.50 \pm .32$, $3.54 \pm .25$, $3.77 \pm .10$ and $3.83 \pm .10$ in Kalurghat, Sadarghat, Fisheryghat, Kaptai, Jettyghat, Boraichuri of Karnaphuli river, respectively. The highest dissolved oxygen (4.6 mg/L) was found in Sadarghat in August and lowest (3.2 mg/L) was in Fisheryghat in September. The highest pH (7.5) was found in Jettyghat during September and lowest (5.9) was found in Sadarghat in April.

Table I. Physico chemical parameters (Mean $\pm$ SD) in different locations in Karnaphuli river

Parameters	Kalurghat	Sadarghat	Fishery ghat	Jetty ghat	Kaptai	Boraichuri	Level of significance
Water temp. (°C)	29.17 $\pm$ 1.97	28.75 $\pm$ 1.54	28.92 $\pm$ 1.74	28.92 $\pm$ 1.50	29 $\pm$ 1.41	29.08 $\pm$ 1.96	0.1
Transparency (cm)	5.50 ^{ab} $\pm$ 0.89	5.03 ^b $\pm$.73	6.67 ^a $\pm$.78	6.33 ^{ab} $\pm$ 1.07	7 ^a $\pm$ 1.20	7.02 ^a $\pm$.71	0.00
Dissolved oxygen (mg/l)	3.68 ^{ab} $\pm$ 0.09	4.05 ^a $\pm$.45	3.50 ^b $\pm$.3	3.54 ^b $\pm$.25	3.77 ^{ab} $\pm$.10	3.83 ^{ab} $\pm$.10	0.01
pH	6.97 ^a $\pm$ 0.31	6.38 ^b $\pm$.41	6.73 ^{ab} $\pm$.3	6.60 ^{ab} $\pm$.21	7.02 ^a $\pm$.30	6.50 ^{ab} $\pm$.34	0.01
Carbon di oxide (mg/l)	19.90 ^{ab} $\pm$ 1.55	22.20 ^a $\pm$ 3.44	19.18 ^{ab} $\pm$ 2.00	19.40 ^{ab} $\pm$ 3.41	17.73 ^b $\pm$ 2.10	22.83 ^a $\pm$ 2.02	0.01
Total alkalinity (mg/l)	83.05 ^b $\pm$ 6.90	71.86 ^c $\pm$ 3.78	89.65 ^{ab} $\pm$ 6.62	98.19 ^a $\pm$ 5.16	96.60 ^a $\pm$ 6.08	86.02 ^b $\pm$ 5.87	0.00
Electrical conductivity (μ S/cm)	9076.12 ^{cd} $\pm$ 125.97	8411.83 ^d $\pm$ 565.15	9797.17 ^b $\pm$ 423.40	9050.33 ^{cd} $\pm$ 226.78	11010.67 ^a $\pm$ 576.50	9115.83 ^{bc} $\pm$ 175.23	0.00

*Values are means $\pm$ S.D. Within a row, means with the same letters are not significantly different ($p < 0.05$).

The maximum value of Carbon di oxide (26.7 mg/L) was found in Sadarghat during June and minimum value (14.8 mg/L) was found in Kaptai during May. Total alkalinity ranged from 71 to 105.5 mg/L during the experimental period. The value of electrical conductivity ranged from 8964 to 9225, 7645 to 8973, 9347 to 10245, 8756 to 9347, 10345 to 11754, 8963 to 9382 μ S/cm in Kalurghat, Sadarghat, Fishery ghat, Kaptai, Jettyghat, Boraichuri of karnaphuli river, respectively. The highest electrical conductivity (11645 μ S/cm) was found Kaptai during June

LIMNOLOGICAL STUDY OF KARNAPHULI RIVER IN BANGLADESH

and lowest (7645 $\mu\text{s}/\text{cm}$) found in Sadarghat during April. The monthly variations of different physico-chemical parameters such as transparency, DO, pH, CO_2 , total alkalinity and electrical conductivity are shown in Fig. 1 to Fig. 6.

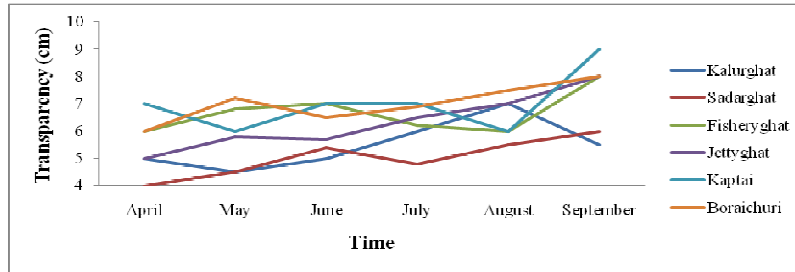


Fig. 1. Monthly variation of transparency in six locations of Karnaphuli river.

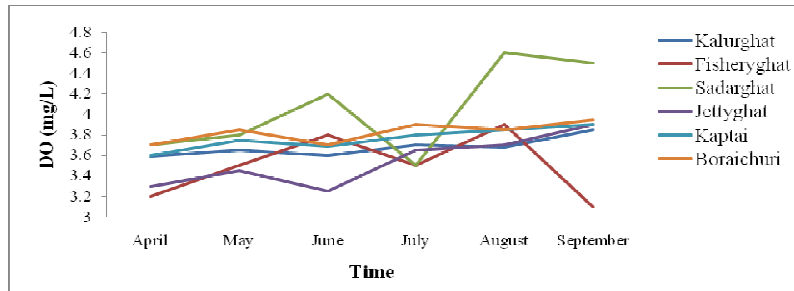


Fig. 2. Monthly variation of DO in six locations of Karnaphuli river.

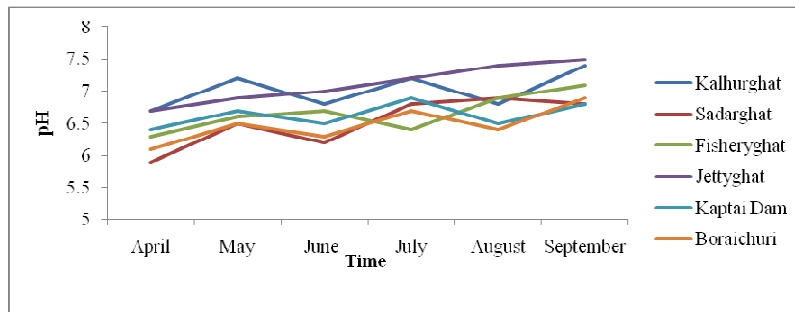


Fig. 3. Monthly variation of pH in six locations of Karnaphuli river.

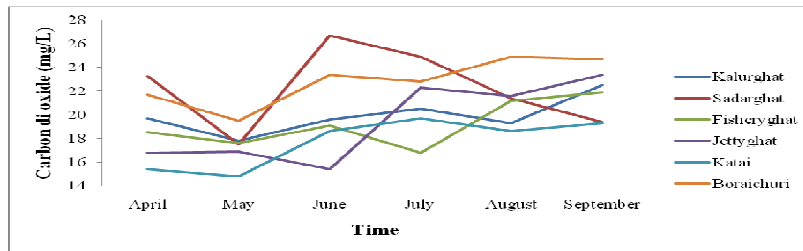


Fig. 4. Monthly variation of CO_2 in six locations of Karnaphuli river

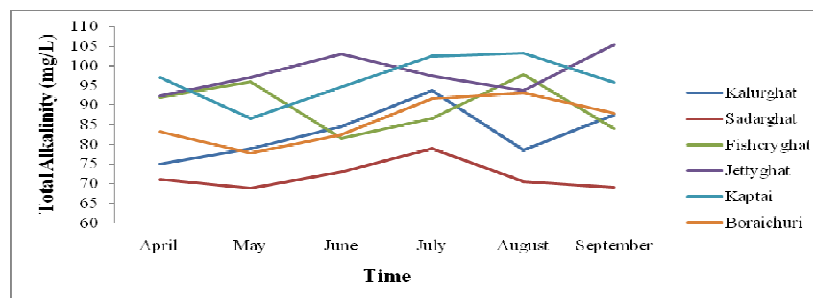


Fig. 5. Monthly variation of total alkalinity in six locations of Karnaphuli river.

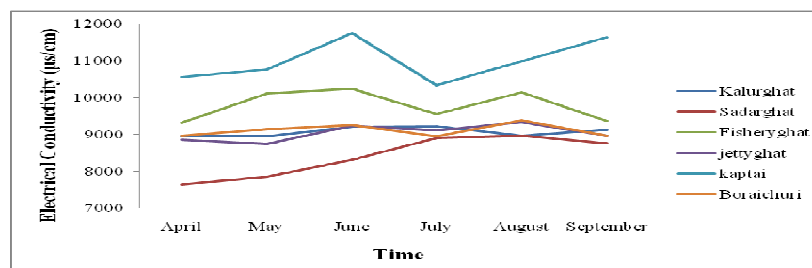


Fig. 6. Monthly variation of electrical conductivity in six locations of Karnaphuli river.

Qualitative and quantitative determination of plankton: The total number of phytoplankton in one liter was varied from 19×10^3 to 34×10^3 , 14×10^3 to 25×10^3 , 17×10^3 to 28×10^3 , 21×10^3 to 33×10^3 , 19×10^3 to 24×10^3 , 16×10^3 to 32×10^3 cells/Lin Kalurghat, Sadarghat, Fisheryghat, Kaptai, Jettyghat, Boraichuri of Karnaphuli river respectively. Monthly variations of phytoplankton community in cells/L of different locations are shown in Fig. 7. The phytoplankton communities in Karnaphuli river in sixth month of sampling were composed of 13 genera of 8 divisions. Division Bacillariophyceae had the highest number (06) of species, followed by the division chlorophyceae, mediophyceae, coscinodiscophyceae, desmidiaceae, gymnodiniaceae, zygnematophyceae, euglenaceae. A pie chart was prepared to measure the percentages of different species in Karnaphuliriver. From pie chart, it is clear that about 27% of total identified species was *Cyclotella*. 2% was *Naviculla* (Fig. 8).

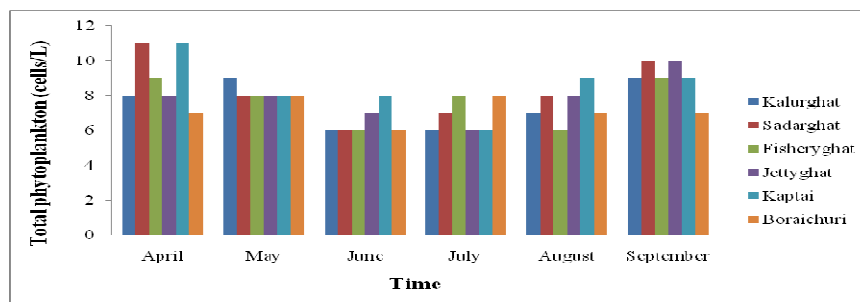


Fig. 7. Monthly variation of total phytoplankton in six locations of Karnaphuli river.

LIMNOLOGICAL STUDY OF KARNAPHULI RIVER IN BANGLADESH

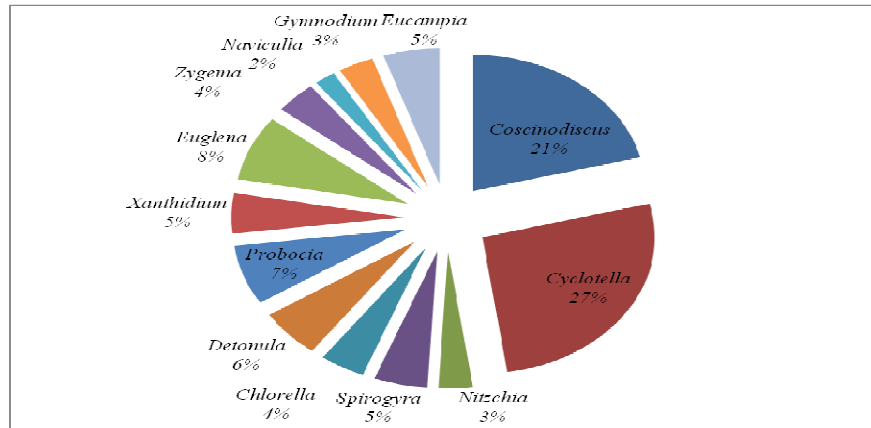


Fig. 8. Percentage of different phytoplankton species.

The zooplankton communities in Karnaphuli river during experimental period were composed of 4 genera 3 divisions. Division rotifera had the highest number (02) of species, followed by the division cladocera (01) and copepoda (01). The maximum species found in Kalurghat in April. Four species were identified from six locations of Karnaphuli river. Among them *Cyclops* was more abundant (34%) and *Keratella* was less abundant (18%) (Fig. 9).

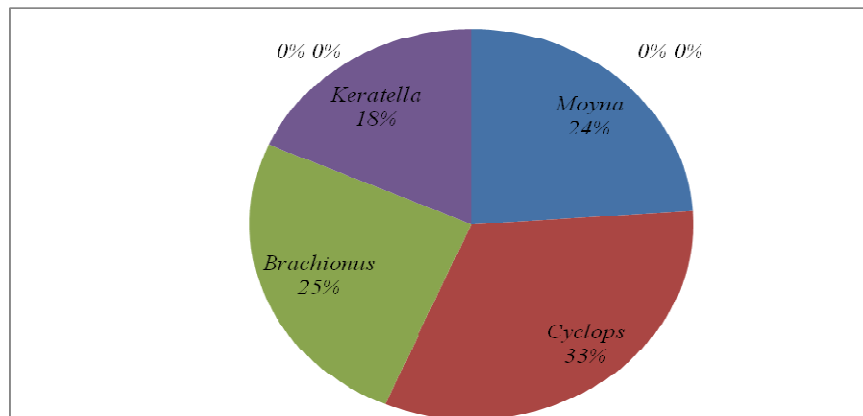


Fig. 9. Percentage of different zooplankton species.

Discussion

The suitable water quality parameters are prerequisite for a healthy aquatic environment. The productivity of waterbody depends on the physical, chemical and other factors of environment. In the present study, the temperature was 26°C-32°C in experimental site during study period. Boyd (1990) stated that tropical and sub tropical species do not grow well when temperature is below 26°C -28°C. So the temperatures of Karnaphuli river is suitable ranges. The transparency value ranged from 4cm to 9cm. Boyd (1982) suggested that a transparency between 15 cm to 40

cm is good for fish health and fish culture. Karnaphuli river is so turbid and is not suitable for fish growth and other organisms in aspects of transparency. The value of DO in mg/L ranged from 3-4 during experimental work. Ellis *et al.* (1946) stated that DO level of 3 mg/L or lower should be regarded as hazardous to lethal for aquatic organism. Iqbal *et al.* (2010) stated that in the case of DO standard for sustaining aquatic life is 4 mg/L. The DO level in the Karnaphuli river was not found in optimum ranges. The value of pH ranged from 5-7.5 in different experimental points. According to Boyd (1982), pH for fish culture should range from 7-9. Umavathi *et al.* (2007) stated that pH ranged between 5.0-8.5 is best for plankton growth. Slightly acidic water was found in Karnaphuli river. Total alkalinity ranged from 71 to 105.5 mg/L during the experimental period. According to Bhuyan and Bakar (2017), total alkalinity ranged from 35 to 67 mg/L. Flura *et al.* (2016) stated that the highest alkalinity range from 114.4 to 189 indicating the level of alkaline is a suitable condition. The value of total alkalinity of Karnaphuli river was found in suitable ranges. The value of carbon di oxide ranged from 15-26.7 mg/L. Boyd (1982) suggested that free carbon di oxide between 1 and 10mg/L is good for fish health and fish culture. The value of EC in $\mu\text{S/cm}$ ranged from 7,645-11,754. High values of EC show that a large amount of ionic substances are present in water (Kabir *et al.* 2002). According to WHO standards 1998 for irrigation water, the EC condition of river water was within permissible limit as 700-3000 $\mu\text{S/cm}$. CO_2 and EC value was exceeded the permissible limit in present study.

Phytoplankton population of study area was enumerated and identified up to genera. The highest number of cells/L was found Kalurghat in July and lowest was found in Sadarghat in April. The number of phytoplankton species in one liter was ranged from 14×10^3 - 34×10^3 cells/L. The present study is more similar to Razzaque *et al.* (1995) in Haltibeel (11.70 to 47.70 cells/L). Division bacillariophyceae had the highest number of species (06). The major groups of phytoplankton were identified in Meghna River by Hossain *et al.* (2016) namely Bacillariophyceae, Chlorophyceae, Cyanophyceae, Dinophyceae, Euglenophyceae, Myxophyceae and Xanthophyceae. Present study is more similar to this research. But the genera of Myxophyceae and Xanthophyceae were not identified.

The zooplankton communities in Karnaphuli river in sixth month of sampling were composed of 4 genera 3 divisions which were more or less similar to findings reported by Hossain *et al.* 2016 who observed 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 Meghna river. Division rotifera had the highest number of species (2). The maximum species found in Kalurghat in April. The total number of zooplankton ranged from low density 2 individuals/ml in Kaptai during May and September, 9 individual/ml in Boraichuri and Fisheryghat during April and September respectively. Sharif and Hoque (2017) total of 25 major taxa of zooplankton were identified from the Karnaphuli river of which 23 taxa during monsoon, 20 taxa during post monsoon and 20 taxa during pre-monsoon. According to Saha and Hossain (2002) most abundant phytoplankton and zooplankton in Sadubeel were *Chorella*, *Scenedesmus*, *Spyrogyra*, *Ulothrix*, *Navicula*, *Synedra*, *Phacus*, *Closterium*, *Oedogonium*, *Cyclotella*, *Amphora*, *Oscillatoria*, *Cymbella*, *Pinnularia*, etc. and *Cyclops* and *Diaptomus*, *Bosmia*, *Daphnia*, *Moina*, *Brachionus*, *Keratella*, etc. respectively which is more similar to present study.

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