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Research Article

Spatiotemporal abundance and distribution of phytoplankton in the Halda River, Chittagong, Bangladesh

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Abstract: Seasonal variability of phytoplankton species composition, abundance and physic-chemical factors influencing phytoplankton dynamics were investigated in the Halda River, Chittagong, Bnagladesh. Samples were collected from three selected stations like Sattar ghat (Station 01), Moduna ghat (Station 02) and mouth of the Halda River near Kalurghat old bridge (Station 03) during monsoon and post monsoon. The average number of phytoplankton density were 8745 cells/litter, 10445 Cells/liter and 10715 cells/litter at station 01, station 02 and station 3 respectively. The phytoplankton abundance were higher in post monsoon (10853 cells/litter) compared to monsoon (9083 cells/litter). Total 20 genera were identified from the Halda River during this study. The highest count recorded for *Coscinodiscus sp* followed by *Thalassiosira sp*. Correlation of phytoplankton with some selected water parameters were also studied.

Keywords: Phytoplankton, temporal and spatial distribution, Halda River, Bangladesh.

INTRODUCTION

The Halda River is one of the important river of Chittagong district that fed by several hilly streams including 12 important tributaries (Azadi, 2004). This river has become the effecters of development providing fresh water supply for irrigation, agriculture, fish farming and livestock rearing, transportation and waste assimilation provision (Kabir *et al.*, 2013). Halda River has a unique feature since it is one of the natural breeding ground of major carps in Bangladesh (Kibria *et al.*, 2009). Moreover, naturally-produced fertilized eggs of major carps are collected and hatched in the mud-made scoop on the river bank (Azadi, 1983; Azadi, 2004; Patra & Azadi, 1985; Arshad-Ul-Alam and Azadi 2016). Total annual indirect and non-use values of the Halda River are estimated to be worth USD 761,977 (Kabir *et al.*, 2013).

To understand the structure and functioning of any aquatic ecosystem, first of all we should know about phytoplankton (autotrophic organism), as it is the primary producer and occupies the first position of the food chain. Phytoplankton includes all the passively floating plants of the sea, river, estuary and lake (Sverdrup *et al.*, 1970). The main components of phytoplankton are diatoms and dinoflagellates.

Yamazi (1972) mentioned that phytoplankton are the important source upon which all aquatic fauna depends for the energy necessary for their existence. Another study by Wickstead (1965) mention that the phytoplankton forms a very important constituent and generally considered as the best index of the aquatic habitat. In comparison to many other biological organism phytoplankton are relatively homogeneously mixed throughout the water column. As this microscope organisms depend on light and nutrients, they populate the euphotic zone. They optimize their residence in the photic zone by a number of mechanisms: controlling buoyancy using gas vacuoles, migration using flagella, area/volume ratio to from resistance and metabolic processes.

Phytoplankton are an important water quality indicator because of their sensitivity to environmental changes, and short life span. Phytoplankton is also a useful indicator of high nutrient concentrations in water because of its propensity to multiply rapidly. Under the right conditions, phytoplankton can undergo rapid population growth, or blooms (Sournia, 1974).

Phytoplankton constitutes 95% of the total marine production. So they form the vital source of energy at the first trophic level. Temperature is the most

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important factor in controlling the growth of phytoplankton was emphasized by many researchers (Goldinan, 1977). The main difference between primary productions in the open ocean is eaten almost entirely by zooplankton whereas on land only about 10 percent of plant material is eaten by herbivores. Variation in phytoplankton community composition depends on the availability of nutrients, temperature, light intensity and on other limnological factors. Normally phytoplankton follows a fairly recognizable annual of cycle of growth, but sometimes the synchrony in their normal annual cycle is disrupted by explosive growth of some species (Vaulot, 2001). The main objectives of the present research was to study abundance, distribution and seasonal fluctuation of phytoplankton in the Halda River.

MATERIALS AND METHODS

Study Area

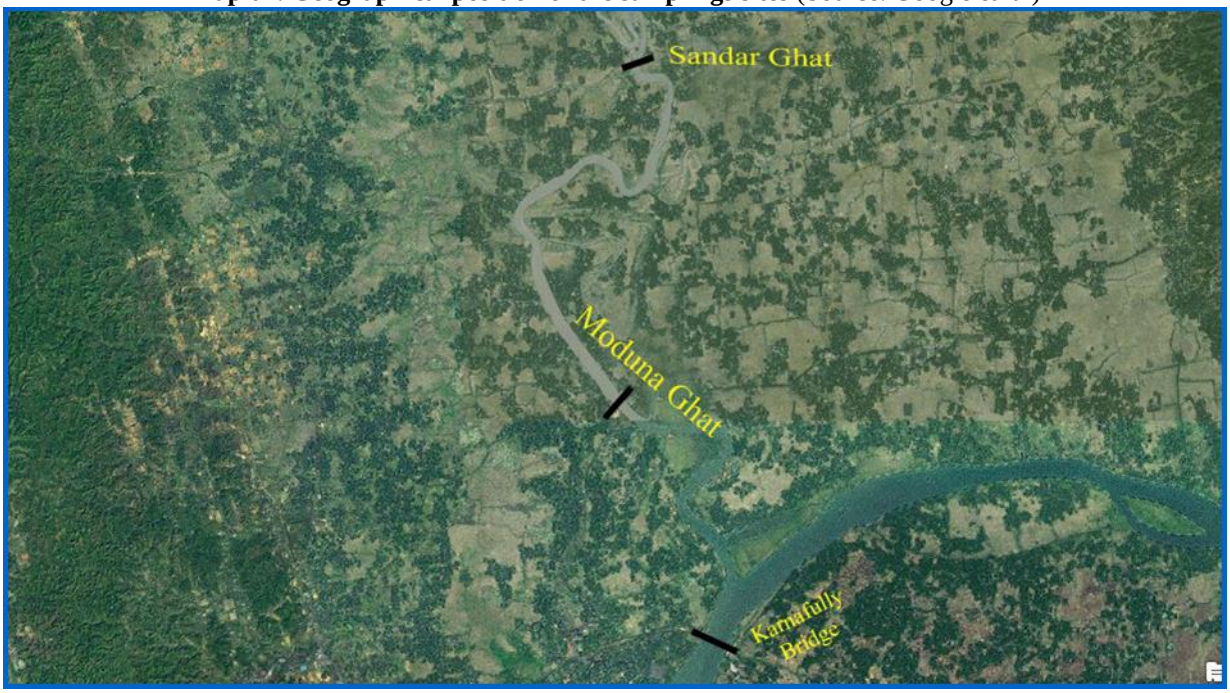
Halda River originates from Badnatali Hill ranges in Ramgarh Upazila in the Chittagong Hill Tracts and located in the South-Eastern part of Bangladesh. It flows through Fatikchari upazila, Hathazari upazila, Raozan upazila and Chittagong Kotwali thana and falls into the Karnafully River near Kalurghat old bridge.

Samples were collected from three selected stations like Sattar ghat, Moduna ghat and mouth of the Halda River near Kalurghat old bridge during monsoon and post monsoon. Details of the study sites are in table 01 and map 01.

Table 01: Sampling station with geographical position

Station No.	Station Name	Latitude	Longitude
01	Sattar Ghat	22.395759	91.898842
02	Moduna Ghat	22.434171	91.872875
03	Mouth of the Halda River	22.324687	91.853195

Map 01: Geographical position of the samplings sites (Source: Google earth)



Physicochemical parameters of water

Collection and determination

During the present study hydrological parameters like water temperature, Dissolved Oxygen (DO) and transparency was measured. Water samples were collected through a mechanized boat during high tide at monsoon and post monsoon from the sampling sites. Water temperature was determined in situ using a thermometer. Dissolved oxygen (DO) was measured by titration methods followed by APHA (1976). Secchi depth was measured by Secchi disc.

Phytoplankton

Collection, preservation and volume reduction

The collection of phytoplankton was done from each station by using 1000 ml plastic bottles from the water surface. Collected samples were preserved in situ with 2% formalin and the bottle were labeled and bought to the laboratory of Institute of Marine Sciences, University of Chittagong for analysis. In the laboratory, concentration of phytoplankton in the water sample were increased by gradual siphoning of water from different size of measuring cylinder (1000 ml, 500 ml, 250 ml, 100 ml, 50 ml, 25 ml) after settlement, at least 24 hours for each phase. The whole procedure was done

by siphoning with medical saline pipe. At the end of the last phase of settlement at 25 ml measuring cylinder, the samples were concentrated to 10 ml by careful filtration decantation as mentioned by Boney (1975) and Venrick, (1978), and token to a screw cap vial.

Identification and enumeration

The concentrated samples were shaken and 1ml of homogenous samples was taken on sedge wick Rafter cell. A cover slip was place carefully to avoid incorporation of air bubble. Then the Rafter cell was placed under the microscope for identification and counting. This process was performed twice for each sample. The abundance of phytoplankton was expressed as cell numbers per litre of water. Phytoplankton species identification was carried out according to the guides and findings of Easter (1943), Subramanyan (1946), Davis (1955), Yamayi (1972, 1974), Newell (1973), Islam and Aziz (1975), Mizuno (1976), Wickstead (1979), Chowdhury (1980), Zafar (1986), Rahman (1997), Tomas (1997), Noori (1999), Islam (2001), Sharif (2002) and Saeedullah (2003).

RESULTS AND DISCUSSION

Environmental factors

During the study period water temperature of 3 stations varied from 23°C to 25°C in the particular day of investigation (Table 02). During monsoon water temperature was 23°C, 24°C and 24°C at stations 01, 02 and 03 respectively. Water temperature was 24°C, 24°C and 25°C at 3 station 01, 02 and 03 respectively during post monsoon. Saeedullah (2003) observed water temperature ranged between 18°C to 31°C in the Maghna River.

The amount of dissolved oxygen (DO) varied between 4.99 ml/liter to 7.14 ml/liter during the study period (Table 02). DO was 4.99 ml/liter 6.42 ml/liter, 5.70 ml/liter at station 01, 02 and 03 respectively during the monsoon. During post monsoon DO was 5.33 ml/liter at station 01, 5.00 ml/liter at station 02 and 7.14ml/liter at station 03. Chowdhury (1995) reported DO concentration was 4.63 ml/liter in Moheskhali channel during Post-monsoon whereas Rahman (1997) recorded that DO in the Naaf River Estuary was 4.5 ml/liter.

Water transparency varied between 26.0 cm to 30.1 cm during the study period (Table 02). During monsoon water transparency was recorded 26.0 cm at station 01 and 29.3 cm at station 02 and 30.0 cm at station 03. Water transparency was 29.0 cm, 30.1 cm and 31.0 cm at station 01, 02 and 03 respectively. Saeedullah (2003) recorded 205.0 cm water transparency during pre-monsoon in the Maghna River and lowest transparency was 30.0 cm during monsoon, assuming that the transparency was governed by the monsoon and seasonal activities.

Table 02: Physicochemical parameters of water at stations during the study period

Water Temperature (°C)						Dissolved Oxygen (ml/l)						Water Transparency (cm)					
Monsoon			Post Monsoon			Monsoon			Post Monsoon			Monsoon			Post Monsoon		
St-1	St-2	St-3	St-1	St-2	St-3	St-1	St-2	St-3	St-1	St-2	St-3	St-1	St-2	St-3	St-1	St-2	St-3
23	24	24	24	24	25	4.99	6.42	5.70	5.33	5.00	7.14	26	29.3	30	29	30.1	30

Phytoplankton composition

In the present study the count of phytoplankton ranges between 7350 to 10160 cells/liter during monsoon where as it was 8745 to 10715 cells/liter during post monsoon. The lowest count was 7350 cells/liter during monsoon at station 01. The highest count was 10715 cells/liter during post monsoon at station 03. The highest count recorded for *Coscinodiscus sp* followed by *Thalassiosira sp*. Detail phytoplankton composition is illustrated by table 03, and figure 02 & 03.

Table 03: Average phytoplankton count during monsoons and post monsoon at 03 stations

Station Name	Monsoon	Post Monsoon	Average
Station 01 (Sattar ghat)	7350 cells/liter	10140 cells/liter	8745 cells/liter
Station 02 (Moduna ghat)	10160 cells/liter	10730 cells/liter	10445 cells/liter
Station 03 (River mouth)	9740 cells/liter	11690 cells/liter	10715 cells/liter

Table 04: Correlation matrix between water parameters and number of phytoplankton

	Water Temperature	Dissolved Oxygen	Water Transparency	Total Count
Water temperature	1.000			
Dissolved Oxygen	-0.6922 (p = 057)	1.0000		
Water transparency	0.6934 (p = 0)	-0.6741 (p = 0.067)	1.000	
Total count	0.5040 (p = 0.203)	0.1964 (p = 0.641)	0.1138 (p=0.789)	1.0000

Correlation matrix between ecological parameters and number of phytoplankton is tabulated at table 04. A non-significant negative correlation was observed between dissolved oxygen and water temperature (r=0.69, p=0.057). Similar result was observed between water transparency and dissolved

oxygen (r=0.67, p=0.067). In contrast positive and significant correlation was observed between water transparency and water temperature (r=0.69, p=0.00). The co-efficient of correlation between total count and water temperature was found positive (r=0.50) though the correlation was insignificant (p=0.20). A very low degree of correlation was observed between total count and dissolved oxygen, (r=0.19, p=0.64) and total count and transparency (r=0.11, p=0.78).

Significant positive correlation was observed only between water transparency and water temperature. This result seems to be unique. Because the data was collected during monsoon to past monsoon period where flash-flood run off from the upstream which brings low sediment through temperature rises gradually.

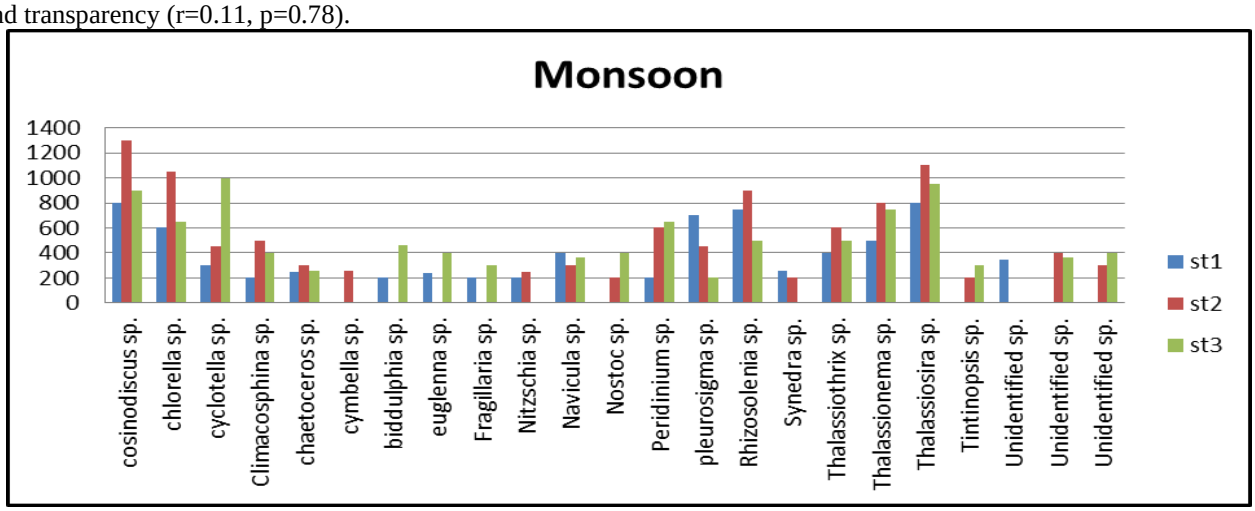


Figure 02: Showing the phytoplankton genera alone with total number of cells/Liter during Monsoon at station 01, 02 and 03

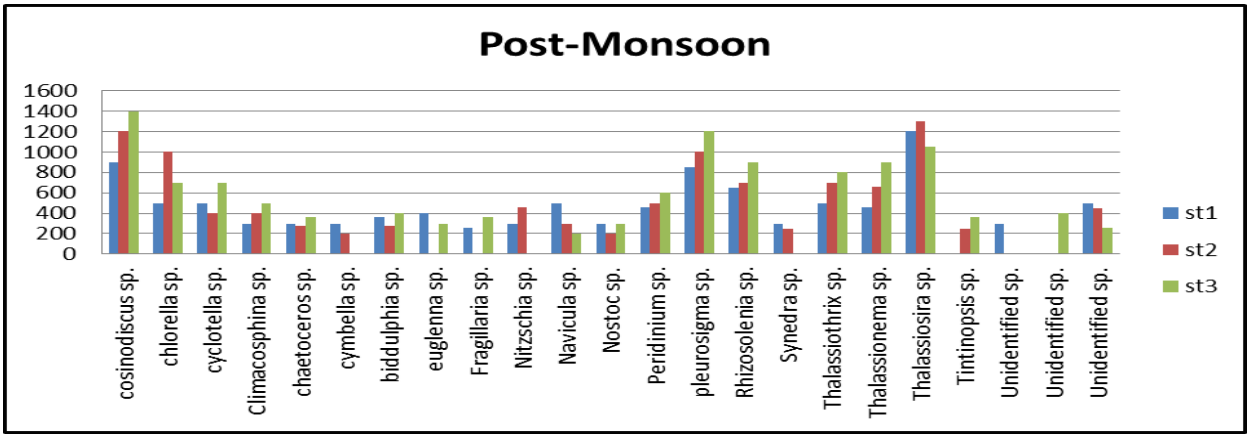


Figure 03: Showing the phytoplankton genera alone with total number of cells/Liter during Post-monsoon at station 01, 02 and 03

During the present study 20 phytoplankton genera were identified. The highest abundance of phytoplankton was 11690 cells/liter at station 03 during post monsoon and the lowest abundance was 7350 cells/liter at station 01 during monsoon. During monsoon the average abundance was 7350 cells/liter, 10160 cells/liter and 9740 cells/liter at station 01, 02 and 03 respectively. While the average no of phytoplankton during post monsoon was 10140 cells/liter, 10730 cells/liter and 11690 cells/liter at station 01, 02 and 03 respectively. Abundance of phytoplankton was higher during post monsoon than monsoon. Among the identified genera *Cosinodiscus sp* was more dominant compared to other species on both station during the study period.

Present findings comply with the study of Islam and Aziz (1975), who reported 29 genera and 76 species of phytoplankton from North-Eastern part of Bay of Bengal belonging to different classes viz. *Vacullariphyceae* (23 genera, 64 species), *Dinophyceac* (4 genera,10 species) and *Cyanphyceae* (2 genera, 2 species). Salam (1977) studied on the benthic and planktonic algae of the Karnafully estuary and recorded 111 species under 57 genera of which *Chorophyta* was the main dominant group (48.46%) followed by *Bacullariophyta* (35.24%) and he also studied the occurrence and periodicity of phytoplankton and benthic algae. Islam and Aziz (1975) identified 42 species of phytoplankton from the Karnafully River Estuary belonging to different classes viz. *Cholorophyceae* (6 genera, 12 species),

Euglenophyceae (1 genera, 1 species), *Chrysophyceae* (1 genera, 1 species), *Bacillariophyceae* (9 genera, 17 species), *Dinophyceae* (2 genera, 5 species), and *Cyanophyceae* (4 genera, 6 species).

Sharif *et al.*, (2017) studied phytoplankton population of the Karnafully River Estuary with emphasis on the seasonal fluctuation of various physico-chemical parameters, and mentioned the highest production to be in pre-monsoon and the lowest during monsoon. Lowest composition was also observed during our monsoon period.

Noori (1999) studied the micronutrients and standing crop of phytoplankton in the coastal waters of Cox's Bazar and found similar result. Allen (1936, 1939) mentioned that distribution and function of surface diatoms is dependent on various seasons in Panama. Mizuno (1976) mentioned that the environmental factor influence the seasonal and spatial variation of phytoplankton.

Subramanyan (1946) provided account of 170 forms of diatoms from Bay of Bengal near Madras coast. From Arabic Sea of the west coast of India he also listed 336 species of plankton and showed their frequency of occurrence. Nanzeen (1980) worked on the influence of hydrological factors and the seasonal abundance of phytoplankton in Kinjhir Lake, Pakistan where he showed the influence of different physico-chemical parameters on pond fertility such as temperature, P^H, O_2, NO_2, NO_2 etc on phytoplankton growth abundance as well as lack productivity. Salam (1977) did a research on estuarine phytoplankton and recorded about 111 species of plankton under 57 genera in Karnafully River Estuary. Rahman (1977) identified 25 species of phytoplankton under 22 genera form the Naaf River Estuary of which *Bacillariophyta* was the dominant group (64%) followed by the *Chlorophyta* (20%). Noori (1999) studied the micronutrient and standing crop of phytoplankton in the coastal water of Cox's Bazar.

In Buriganga River, Islam and Haroon (1975) studied on physical, chemical and biological aspect where they showed topical fresh water phytoplankton abundance. Sharif (2002) made investigation on quantitative distribution of plankton and benthos at 5 different station of the Meghna River Estuary during monsoon and post monsoon. He recorded 22 genera of phytoplankton from the study area during monsoon and 21 genera of phytoplankton were identified during post monsoon, which is very much relevant to this present findings. Saeedullah (2003) identified 23 genera of *Bacillariophyta*, 90 genera of *Chlorophyta*, 30 genera of *Cyanophyta* showing the seasonal variation of phytoplankton at 5 different station of Meghna Estuary with some biodiversity indices and correlation. Chowdhury (2005) studied on biodiversity with reference to occurrence, abundance and distribution of phytoplankton in the Karnaphuli River estuary which is similar to this present study.

CONCLUSION

This study showed results on the species composition, and spatial distribution and abundances of the phytoplankton in the Halda River. Current findings concluded that the river of Halda is well diversified in term of phytoplankton. Physicochemical parameters of water (water temperature, DO, water transparency) were important to phytoplankton community dynamics. Seasonal differences in the relationship between the environment and phytoplankton community should be considered during management of Halda River.

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