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Phytoplankton Community of Boalia Khal Tributary of the Halda River, Chattogram, Bangladesh

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Cover Page Footnote

The authors are grateful to the department of Zoology, University of Chittagong for providing a vast array of laboratory facilities.

PHYTOPLANKTON COMMUNITY OF BOALIA KHAL TRIBUTARY OF THE HALDA RIVER, CHATTOGRAM, BANGLADESH

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ABSTRACT

Boalia Khal is one of the important tributaries of the River Halda. The productivity of the Boalia Khal tributary of the Halda River mainly depends on the phytoplankton diversity. A study was conducted for two years period from January 2017 to December 2018 to identify the phytoplankton community of the Boalia Khal tributary. A total of 61 species of phytoplankton under 37 genera belonging to 8 classes were recorded. The dominant group of phytoplankton was 25 species of Diatoms (40.98 %) followed by 18 species of Green Algae (29.5 %), 9 species of Euglenophytes (14.75 %), 7 species of Blue Green Algae (11.48 %), and 2 species of Dinoflagellates (3.28 %). Therefore, the Boalia Khal is a productive ecosystem with a diverse group of phytoplankton species.

Keywords: Blue green algae, diatom, euglenophytes, green algae, Halda river.

INTRODUCTION

In Bangladesh, Halda is the only River from where naturally fertilized eggs of Indian major carp (*Labeo rohita, Labeo calbasu*, *Gibelion catla*, and *Cirrhinus mrigala*) are collected every year. It is one of the most important suitable and productive water bodies for fish, Gangetic dolphins, and other aquatic lives in Bangladesh (Islam et al., 2021). Numerous small and large tributaries are the water source of the Halda River. Boalia Khal is one of the most important tributaries of the River Halda. It is a suitable water body for finfish and shellfish, especially for giant freshwater shrimp (*Macrobrachium rosenbergii).* Local people use its water for different purposes including irrigation, bathing, fishing, washing utensils, and discharging household wastes (Islam et al., 2021). It also receives agricultural, urban, and poultry wastes throughout the year directly and also through ten canals at different points, namely Fatika Khal, Charia Khal, Char Jura, Baissa Jura, Konijje Khal, Seranger Jura, Gura Chora, Zillani Chora, Kabir Khal, and Noa Khal (Islam et al., 2021). The water quality and productivity of any water body mainly depend on phytoplankton diversity. Phytoplankton is free-floating unicellular, filamentous and colonial autotrophic forms of aquatic habitat, whose movement is more or less dependent on water currents (Millman et al., 2005). They are the major primary producer in many aquatic systems forming the first trophic level in the food chain and are the important food source for other organisms and the sources of oxygen in the aquatic systems (Akomeah et al., 2010; Gupta and Dey, 2012). They do not only serve as food for aquatic animals but also play an important role in maintaining the biological balance and quality of the aquatic ecosystem (Benarjee and Narasimha, 2013; Pandey and Poddar, 2004). No research work on the phytoplankton community has yet been found in the Boalia Khal tributary of the Halda River. So, the present study was chosen to identify the phytoplankton community and also know the water quality and productivity of the Boalia Khal tributary (canal).

MATERIALS AND METHODS

Study Area

Boalia Khal is a feeding canal of the River Halda. It is originated from the hills of western parts of Hathazari Upazilla after traversing in a zigzag fashion about for 15 km, it meets with the western side of the Halda river (22°31´3.88" N; 91°50´18.71" E) about 200 yards north of Sarta Ghat bridge on Chattogram-Rangamati highway (Islam et al., 2021). The study was carried out at the three sampling stations of Boalia Khal for two years period from January 2017 to December 2018 to identify the phytoplankton community (Figure 1).

Collection and Preservation of Phytoplankton Samples

Phytoplankton samples were collected from three sampling stations of the Boalia Khal tributary at regular monthly intervals from January 2017 to December 2018 by using 20 µm mesh size plankton net. After collection, phytoplankton samples were immediately preserved in the field with a 5 % formalin solution.

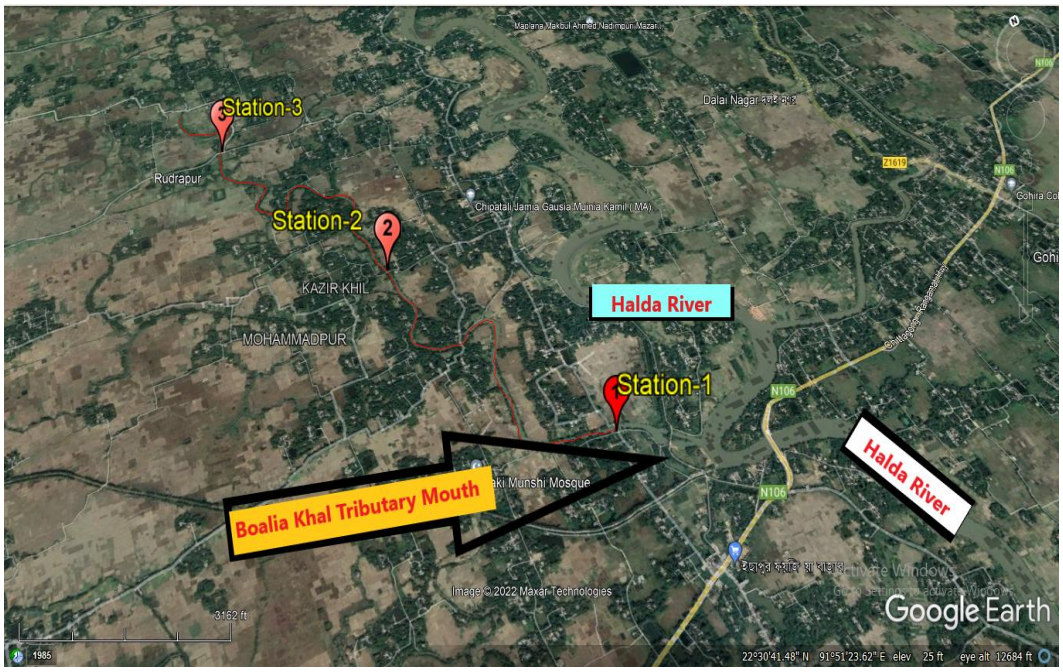

Figure 1: Map showing the three sampling stations of the Boalia Khal tributary of the Halda River.

Table 1: Name, location, and geographical position of the three sampling stations of the Boalia Khal Tributary of the Halda River

Sampling Station	Name of Sampling Station	Location	Latitude	Longitude
Station-1	Chandgazi Bridge	Downstream	22° 31’ 3.88’N	91°50’18.71´E
Station-2	Loharpul Bridge	Midstream	22°31’52.16´N	91°49’50.33´E
Station-3	Zillanibazar Bridge	Upstream	22°32’38.04N	91°49’24.9’/E

Table 2: Total numbers and composition of phytoplankton in the Boalia Khal tributary of the Halda River from January 2017 to December 2018.

Group	Class	Genus	Species	Total No.	Percentage of the Class
Blue Green Algae	**Cyanophyceae**	*Phormidium*	*favosum*	7	11.48%
		Spirulina	*platensis*		
		Oscillatoria	*incerta*		
			limosa		
			princeps		
		Anabaena	*circinalis*		
		Microcystis	*flosaquae*		
Green Algae	**Chlorophyceae**	*Pediastrum*	*duplex*	8	13.11
			simplex		
			boryanum		
		Ankistrodesmus	*falcatus*		
		Scenedesmus	*opoliensis*		
		Eudorina	*elegans*		
		Volvox	*aureus*		
			globator		
	Zygnematophyceae	*Spirogyra*	*varians*	8	13.11
		Zygnema	*circumcarinatum*		
		Closterium	*setaceum*		
			praelongum		
			acerosum		
			moniliferum		
		Cosmarium	*etenoideum*		
		Micrasterias	*americana*		
	Ulvophyceae	*Ulothrix*	*aequalis*	1	1.64
	Trebouxiophyceae	*Pachycladella*	*zatoriensis*	1	1.64
Dinoflagellates	**Dinophyceae**	*Ceratium*	*furca*	2	3.28
			hirundinella		
Diatom	**Bacillariophyceae**	*Cyclotella*	*atomus*	25	40.98
			meneghiniana		
		Nitzschia	*longissima*		
			morphotype		
			seriata		
		Synedra	*famelica*		
			ulna		
		Gyrosigma	*acuminatum*		
		Navicula	*tripunctata*		
		Tabellaria	*flocculosa*		
			fenestrata		
		Pinnularia	*gibba*		
			viridis		
			streptoraphe		
		Coscinodiscus	*radiatus*		

contd....

		Surirella	*elegans*		
			robusta		
			splendida		
			tenera		
		Triceratium	*favus*		
		Melosira	*varians*		
		Fragilaria	*crotonensis*		
		Cylindrotheca	*closterium*		
		Aulacoseira	*granulata*		
		Cymbella	*lanceolata*		
Euglenophytes	**Euglenophyceae**	*Phacus*	*longicauda*	9	14.75
			acuminatus		
			cordatus		
		Euglena	*acus*		
			sociabilis		
			gracilis		
			viridis		
		Lepocinclis	*acus*		
		Strombomonas	*octocostata*		
Total : 5	8	37	61	61	100%

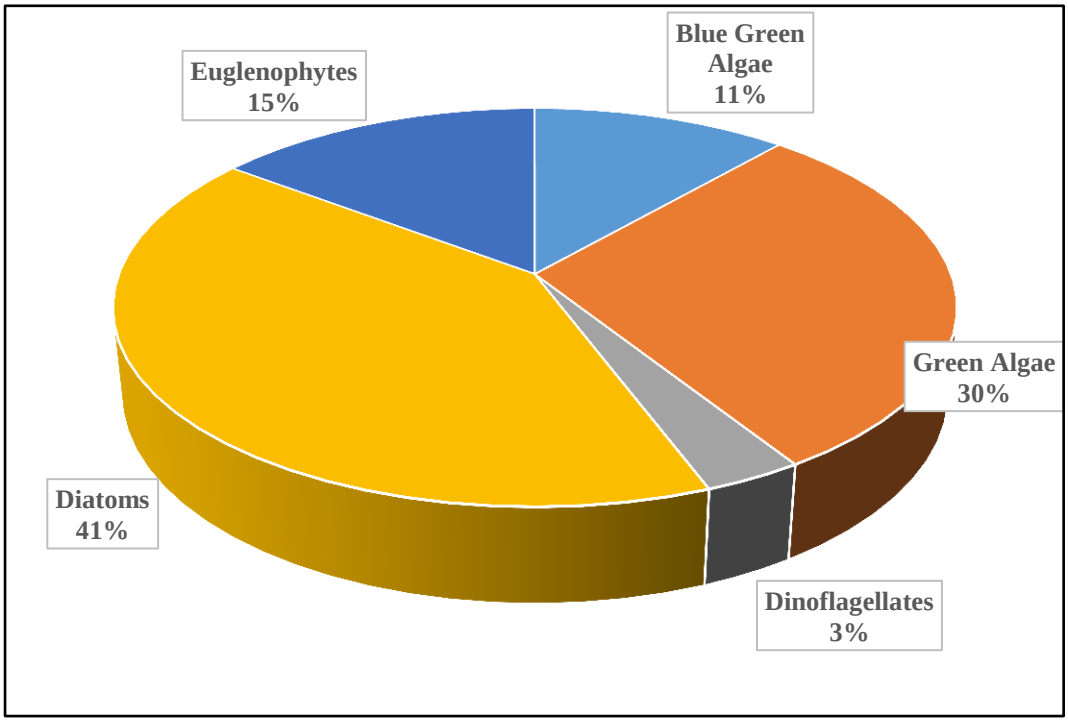

Figure 2: Percentages of different groups of phytoplankton in the Boalia Khal from January 2017 to December 2018.

Analysis and Identification of Phytoplankton Samples

1ml phytoplankton sample was taken in Sedgwick-Rafter counting chamber and identified by using a binocular compound microscope (XSZ-107BN, China). Identification of various genera and species of phytoplankton was done with the help of the following books: Davis (1955), Needham and Needham (1962), Prescott (1975), Bellinger and Sigee (2010), and Sharma (2011).

RESULTS AND DISCUSSION

During two years study period from January 2017 to December 2018, a total of 61 species of phytoplankton belonging to 37 genera were identified. The identified phytoplankton species were classified into 8 classes under 5 groups i.e. Diatoms (Bacillariophyceae), Green Algae (Chlorophyceae, Zygnematophyceae, Ulvophyceae, and Trebouxiophyceae), Blue Green Algae (Cyanophyceae), Euglenophytes (Euglenophyceae), and Dinoflagellates (Dinophyceae). The maximum density of phytoplankton was recorded during the winter period (November – January) and the minimum density was recorded during the post-monsoon period (August-October) in the Boalia Khal tributary of the Halda River.

Twelve different types of physicochemical parameters of the water of Boalia Khal tributary, i.e. air temperature, water temperature, transparency, total dissolved solids (TDS), electrical conductivity (EC), pH, dissolved oxygen (DO), free carbon dioxide (freeCO_2), calcium (Ca^{++}), total hardness (TH), total alkalinity (TA), and biochemical oxygen demand (BOD_5), were analyzed during the study period.

The phytoplankton showed a significant positive relationship with the Zooplankton ($r=0.78$, $P<0.01$), Air temperature ($r=0.57$, $P<0.1$), and Water temperature ($r=0.51$, $P<0.1$) and an inverse significant relationship with pH ($r=-0.72$, $P<0.01$) in the Boalia Khal tributary.

Table 2 shows the number and percentages of the phytoplankton family and Figure 2 shows the percentages of different groups of phytoplankton in the Boalia Khal tributary of the Halda River during the study period from January 2017 to December 2018.

Diatom (Bacillariophyta)

In the present study, diatom was the most dominant group which comprises 40.98 % of the total phytoplankton species. A total of 25 species of diatoms under 15 genera were recorded. The dominant genera were *Surirella* (4 sp.) followed by *Nitzschia* (3 sp.), *Pinnularia* (3 sp.), *Cyclotella* (2 sp.), *Synedra* (2 sp.), *Tabellaria* (2 sp.), *Gyrosigma* (1 sp.), *Navicula* (1 sp.), *Coscinodiscus* (1 sp.), *Triceratium* (1 sp.), *Melosira* (1 sp.), *Fragilaria* (1 sp.), *Cylindrotheca* (1 sp.), *Aulacoseira* (1 sp.), and *Cymbella* (1 sp.).

Similar results (dominant diatom group) were also reported by Islam et al., (2021) in the Halda River, Hossen et al., (2021) in the Kirtankhola River, Zhang et al., (2021) in the M River, Ahmad-Al-Nahid et al., (2020) in the Halda River, Lewaru et al., (2019) in the Karst River, Haque et al., (2015) in Sangu River, and Patra and Azadi (1987) in the Halda River. Islam et al., (2021) recorded the following genera; *Cyclotella, Nitzschia, Gyrosigma, Tabellaria, Pinnularia, Triceratium, Fragilaria, Cylindrotheca, Aulacoseira, Melosira, Coscinodiscus, Surirella, Cymbella, Navicula,* and *Synedra* in the Halda River which is very similar to the present study. Patra and Azadi (1987) recorded the following genera i.e. *Cyclotella, Melosira, Coscinodiscus, Surirella, Cymbella, Navicula, Synedra, Ulothrix, Spirogyra, Zygnema, Closterium, Microcystis, Oscillatoria,* and *Anabaena* in the Halda River which is similar to the present study. The occurrence of more diatoms is a confirmation of acidic pH and

the high nutritional status of the water. *Microcystis, Spirulina, Oscillatoria, Anabaena,* and *Pediastrum* are indicators of eutrophic water and therefore water of high nutrient content (Islam et al., 2021).

Green Algae (Chlorophyta)

Green algae were the second dominant group which comprises 29.50 % of the total phytoplankton species. A total of 18 species of green algae under 12 genera were recorded. Identified green algae divided into four classes i.e. Chlorophyceae, Zygnematophyceae, Ulvophyceae, and Trebouxiphyceae. Among the green algae, Zygnematophyceae and Chlorophyceae were the dominant classes each representing 13.11 % of the total phytoplankton species. A total of 8 species of Chlorophyceae under 5 genera were recorded where *Pediastrum* (3 species) was the dominant genus followed by *Volvox* (2 species), *Ankistrodesmus* (1 species), *Scenedesmus* (1 species), and *Eudorina* (1 species). A total of 8 species of Zygnematophyceae under 5 genera were recorded where *Closterium* (4 species) was the dominant genus followed by *Spirogyra* (1 species), *Zygnema* (1 species), *Cosmarium* (1 species), and *Micrasterius* (1 species). The class Ulvophyceae comprises 1.64 % of the total phytoplankton species and contains 1 species under the genus *Ulothrix*. The class Trebouxiophyceae comprises 1.64 % of the phytoplankton species contains 1 species under the genus *Pachycladella*.

Similar findings (second dominant group) were also reported by Islam et al., (2021) in the Halda River, Zhang et al., (2021) in the M River, Kumar and Khare (2015) in the Yamuna River, and Eyo et al., (2013) in the Great Kwa River. The dominant group of Chlorophyceae was reported by Sulawesty and Aisyah (2020) in Lake Tempe, Uthirasamy et al., (2020) in the Cauvery River, Dixit and Sharma (2019) in the Gomti River, IIoba and Ikomi (2018) in the Ethiope River, Jabeen and Barbhuiya (2018) in the Manas River, and Sarwade and Kamble (2014) in the Krishna River. Islam et al., (2021) reported 24 species of green algae under 18 genera; *Pediastrum, Ankistrodesmus, Scenedesmus, Eudorina, Volvox, Spirogyra, Zygnema, Mougeotia, Closterium, Cosmarium, Micrasterias, Desmidium, Pleurotaenium, Staurastrum, Euastrum, Docidium, Pachycladella*, and *Ulothrix* from the Halda River which was close to the present study. Boalia Khal is an important tributary of the Halda River, hence similar phytoplankton genera were found in the Halda River. Raghavendra and Vijayakumara (2017) reported 21 species of Chlorophyceae representing the following genera i.e. *Cosmarium, Closterium, Desmidium Euastrum, Micrasterias, Pediastrum, Spirogyra, Staurastrum, Ulothrix,* and *Zygnema* in the Bhadra Wildlife sanctuary.

Euglenophytes (Euglenophyta)

Euglenophytes comprise 14.75 % of the total phytoplankton species. A total of 9 species of Euglenophytes under 4 genera were recorded. The dominant genus was *Euglena* (4 species) followed by *Phacus* (3 species), *Lepocinclis* (1 species), and *Strombomonas* (1 species). Islam et al., (2021) reported 9 species of Euglenophytes under 4 genera i.e. *Euglena* (4 species), *Phacus* (3 species), *Lepocinclis* (1 species), and *Strombomonas* (1 species) in the Halda River which is similar to the present findings. Hossen et al., (2021) reported 12 species of Euglenophytes under 5 genera i.e. *Lepocinclis* (1 sp.) *Euglena* (5 sp.), *Euglenocapsa* (1sp.), *Phacus* (2 sp.), and *Trachelomonas* (3 sp.) in the Kirtankhola River, Ekhator and Alika (2016) reported 15 species of Euglenophytes under 5 genera i.e. *Lepocinclis* (6 sp.) *Euglena* (1), *Phacus* (1), *Strombomonas* (3 sp.), and *Trachelomonas* (4 sp.) in the Osse River, Sakset and Chankaew (2013) reported 5

genera of Euglenophytes i.e. *Lepocinclis*, *Euglena, Phacus, Strombomonas*, and *Trachelomonas* in the Pak Phanang River Basin. Islam et al., (2020) reported 3 genera of Euglenophytes i.e. *Euglena*, *Phacus*, and *Trachelomonas* in the Kishoreganj Haor, and IIoba and Ikomi (2018) reported 7 species of Euglenophytes under 4 genera i.e. *Lepocinclis, Euglena, Strombomonas*, and *Trachelomonas* in Ethiope River due to different ecological and geographical condition of the different water bodies.

Blue Green Algae (Cyanophyta)

Blue green algae comprise 11.48 % of the total phytoplankton species. A total of 7 species of blue green algae under 5 genera were recorded. The dominant genus was *Oscillatoria* (3 sp.) followed by *Phormidium* (1 sp.), *Spirulina* (1 sp.), *Anabaena* (1 sp.), and *Microcystis* (1 sp.). Similar findings were reported by Islam et al., (2021) in the Halda River. Islam et al., (2021) reported 10 species of blue green algae under 6 genera *Oscillatoria* (4 sp.), *Spirulina* (2 sp.), *Phormidium* (1 sp.), *Anabaena* (1 sp.), *Microcystis* (1 sp.), and *Merismopedia* (1 sp.) in the Halda River which is very close to the present study. Islam et al., (2020) reported 3 genera of blue green algae i.e. *Oscillatoria*, *Anabaena*, and *Microcystis* in the Kishoreganj Haor, Raghavendra and Vijayakumara (2017) reported 8 species of blue green algae under 7 genera i.e. *Aphanocapsa* (2 sp.), *Anabaena* (2 sp.), *Arthospira* (1 sp.), *Chrococcus* (1 sp.), *Microcystis* (1 sp.), *Oscillatoria* (1 sp.), and *Spirulina* (1 sp.) in this wetland, Ekhator and Alika (2016) reported 11 species of blue green algae under 8 genera *Oscillatoria* (4 sp.), *Lemmermanniella* (1 sp.), *Anabaena* (1 sp.), *Microcystis* (1 sp.), *Coelosphaerium* (1 sp.), *Lyngbya* (1 sp.), *Tychonema* (1 sp.), and *Merismopedia* (1 sp.) in the Osse River, and Sakset and Chankaew (2013) reported 7 genera of blue green algae i.e. *Oscillatoria* (1 sp.), *Chrococcus* (1 sp.), *Anabaena* (1 sp.), *Microcystis* (1 sp.), *Dimorphococcus* (1 sp.), *Spirulina* (1 sp.), and *Merismopedia* (1 sp.) in Pak Phanang River Basin due to different ecological conditions.

Dinoflagellates (Dinophyta)

Dinoflagellate is the very least dominant group of phytoplankton which comprises 3.28 % of the total phytoplankton species (Figure 2). A total of 2 species of dinoflagellates under the genus *Ceratium* was recorded. The least dominant group of dinoflagellate was also reported by Islam et al., (2021) in the Halda River, Sulawesty and Aisyah (2020) in Tempe Lake, and Dixit and Sharma (2019) in the Gomti River. Islam et al., (2021) reported 3 species of dinoflagellates under 2 genera; *Ceratium* and *Dissodinium* in the Halda River, and Ahmad-Al-Nahid et al., (2020) reported 2 genera (*Ceratium* and *Alexandrium*) of dinoflagellates from the Halda River which is almost similar to the present study. Haque et al., (2015) reported 7 species of dinoflagellates under 5 genera (*Dinophysis, Prorocentum, Balechina, Gymnodinum,* and *Gonyaulax*) in the Sangu River due to different ecological and geographical conditions.

The number of phytoplankton recorded at present is less than the study conducted by Islam et al., (2021) in the Halda River which represented 74 species of phytoplankton under 47 genera. Halda River is a large water body that represents more phytoplankton diversity than the small water body Boalia Khal tributary.

CONCLUSION

The present study represented 61 species of phytoplankton under 37 genera belonging to 8 classes from the Boalia Khal tributary of the Halda River. Bacillariophyceae was the most dominant class of phytoplankton with 25 species under 15 genera, and the dinophyceae was the least dominant class with 2 species

under 1 genus. Therefore, it can be concluded that the water quality of the Boalia Khal tributary is eutrophic and betamezosaprobic leveled.

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CONFLICT OF INTEREST

The authors declare that there is not any conflict of interest regarding the publication of this manuscript.

AUTHORS CONTRIBUTION

The supervisor and co-supervisor of this research work were Prof. MA Azadi and Prof. Munira Naseeruddin respectively**.**

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