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Checklist of Phytoplankton in the Halda River, Chattogram, Bangladesh

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ABSTRACT

Halda River is a renowned natural spawning ground of major carps due to the unique physicochemical and biological properties of its water. The productivity of the Halda ecosystem depends mainly on the plankton diversity. A 2- year- study was conducted (Jan. 2017- Dec. 2018) to identify the phytoplankton community of the Halda River. A total of 74 species of phytoplankton were recorded, which represent 47 genera and belong to 8 classes. The dominant class of phytoplankton was 28 species of Bacillariophyceae (37.84%) followed by 14 species of Zygnematophyceae (18.92%), 8 species of Chlorophyceae (10.81%), 10 species of Cyanophyceae (13.51%), 9 species of Euglenophyceae (12.16%), 3 species of Dinophyceae (4.05%), 1 species of Ulvophyceae (1.35%), and 1 species of Trebouxiophyceae (1.35%). Thus, the River Halda is a productive water body with diversified groups of phytoplankton.

INTRODUCTION

The River Halda, known as the Bangabandhu Fisheries heritage of Bangladesh, is a famous natural breeding ground for the Indian major carps (Rui, Catla, Mrigal, and Kalibaus). It is one of the most important productive water bodies for fishes, dolphins, and other aquatic lives in Bangladesh. The water quality and productivity of any water body depend mainly on the plankton community. Phytoplankton is free-floating unicellular, filamentous and colonial autotrophic form of aquatic habitat, whose movement is more or less dependent on water currents **(Millman *et al.*, 2005)**. Phytoplankton is the major primary producer in many aquatic systems, forming the first trophic level in the food chain. Moreover, it serves as an important food source for other organisms and the source of oxygen in the aquatic systems **(Akomeah *et al.*, 2010; Gupta & Dey, 2012)**. Furthermore, it does 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 **(Pandey & Poddar, 2004; Benarjee & Narasimha, 2013)**. Phytoplanktons are bioindicators of water quality. It is worth noting that, some algae such as *Microcystis*, *Anabaena*, *Aphanizomenon and Cylindrospermopsis* produce toxins. Hence, a bloom of the above genera may cause a risky health situation **(Cook *et al.*, 2004)**. They can cause odor, alter the taste of water and cause discoloration or form large mats that can interfer with boating, swimming and fishing **(Borgh, 2004)**. Some research works were conducted on the checklist of

phytoplankton, among which the following studies were detected: **Alika and Akoma (2012)** in the Okhuo River, **Ansa *et al.* (2015)** in the Forcados River, and **Jyoti *et al.* (2019)** in the Chandloi River. Nevertheless, no checklist on phytoplankton has yet been found in the Halda River. Consequently, the present study was organized to identify the phytoplankton communities and address the water quality and productivity of the Halda River.

MATERIALS AND METHODS

Study area

Tidal River Halda is one of the important tributaries of the River Karnafully. To identify the phytoplankton communities, the present study was conducted in the Halda River for two years period (from January 2017 to December 2018). Three sampling stations were selected from upstream to downstream to identify the overall phytoplankton community in the Halda River.

Collection and preservation of phytoplankton samples

During a two-year-study; from January 2017 to December 2018, phytoplankton samples were collected from the surface water at regular monthly intervals from three sampling stations of the Halda River, using a 20µm mesh size plankton net. After collection, the phytoplankton samples were preserved in a 5% formalin solution.

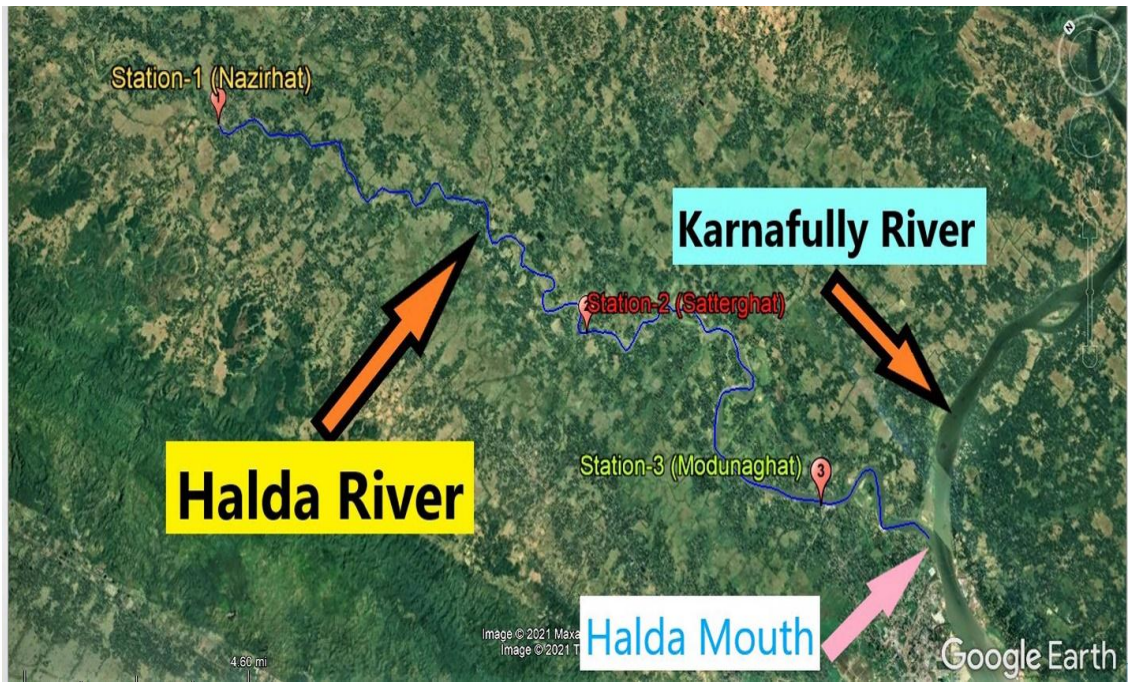


Fig. 1. A map showing the three sampling stations along the River Halda

Table 1. Sampling stations, names, and geographical locations of the three stations of the Halda River

Sampling station	Name of the sampling station	Location	Latitude	Longitude
Station-1	Nazirhat	Upstream	22°37′59.38"N	91°47′32.71"E
Station-2	Satterghat	Midstream	22°30′48.05"N	91° 50′45.60"E
Station-3	Modunaghat	Downstream	22°26′2.55"N	91°52′16.82"E

Analysis and identification of phytoplankton samples

For the analysis of phytoplankton, only 1ml sample was taken in the Sedgwick-Rafter counting chamber and identified by using a binocular compound microscope (XSZ-107BN, China). Identification of various genera and species of phytoplankton were defined following the descriptions of **Davis (1955)**, **Needham and Needham (1962), Prescott (1975), Bellinger and Sigee (2010), Sharma (2011)** and **Seamer (2019)**.

RESULTS

During the current study period, a total of 74 species of phytoplankton, representing 47 genera were recorded (Table 2 & Photomicro graph). 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)

Diatom

In the present study, Diatom was the most dominant group which comprises 37.84% of the total phytoplankton species (Fig. 2). A total of 28 species of diatoms were recorded to represent 17 genera that belong to Bacillariophyceae (Table 2). The dominant genus was *Surirella* (5 species) followed by *Nitzschia* (3 species), *Pinnularia* (3 species), *Cyclotella* (2 species), *Synedra* (2 species), *Tabellaria* (2 species), *Gyrosigma* (1 species), *Navicula* (1 species), *Coscinodiscus* (1 species), *Triceratium* (1 species), *Melosira* (1 species), *Fragilaria* (1 species), *Cylindrotheca* (1 species), *Aulacoseira* (1 species), *Cymbella* (1 species), *Asterionella* (1 species) and *Frustulia* (1 species) (Table 2). Similar findings (dominant diatom group) were also reported in the following studies, including: **Patra and Azadi (1987)** in the Halda River, **Ansa *et al.* (2015)** in the Forcados River, **Haque *et al.* (2015)** in the Sangu River, **Trivedi and Karode (2015)** in the Kshipra River, **Kaur and Singh (2017)** in the Sutlej River, and **Ahmad-Al-Nahid *et al.* (2020)** in the Halda River. **Patra and Azadi (1987)** recorded the following genera *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. **Ahsan (2012)** reported the following genera of phytoplankton: *Synedra, Spirogyra, Closterium, Microcystis, Oscillatoria, Anabaena, Spirulina, Pediastrum, Ulothrix, Tabellaria, Navicula,* and *Nitzschia* from the Padma, Meghna, and Tetulia River which similar to the findings of the present study. The occurrence of more diatoms is an indication of the acidic pH and the high nutrient status of the water. *Microcystis, Spirulina, Oscillatoria, Anabaena,* and *Pediastrum* are indicators of eutrophic waters, thus they reflect the high nutrient contents in water.

Table 2. Total numbers and composition of phytoplankton in 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*	10	13.51
		Spirulina	*platensis*		
			maxima		
		Oscillatoria	*incerta*		
			limosa		
			princeps		
			brevis		
		Anabaena	*circinalis*		
		Microcystis	*flosaquae*		
		Merismopedia	*tenuissima*		
Green Algae	Chlorophyceae	*Pediastrum*	*duplex*	8	10.81
			simplex		
			boryanum		
		Ankistrodesmus	*falcatus*		
		Scenedesmus	*opoliensis*		
		Eudorina	*elegans*		
		Volvox	*aureus*		
			globator		
	Zygnematophyceae	*Spirogyra*	*varians*	14	18.92
			minuticrassoidea		
		Zygnema	*circumcarinatum*		
		Mougeotia	*scalaris*		
		Closterium	*setaceum*		
			praelongum		
			acerosum		
		Cosmarium	*etenoideum*		
		Micrasterias	*americana*		
		Desmidium	*swartzii*		
		Pleurotaenium	*ehrenbergii*		
		Staurastrum	*gracile*		
		Euastrum	*crassum*		
		Docidium	*ehrenbergii*		
	Ulvophyceae	*Ulothrix*	*aequalis*	1	1.35
	Trebouxiophyceae	*Pachycladella*	*zatoriensis*	1	1.35

Dinoflagellates	Dinophyceae	*Ceratium*	*furca*	3	4.05
			Hirundinella		
		Dissodinium	*Elegans*		
Diatoms	Bacillariophyceae	*Cyclotella*	*atomus*	28	37.84
			meneghiniana		
		Nitzschia	*longissima*		
			morphotype		
			seriata		
		Synedra	*famelica*		
			ulna		
		Gyrosigma	*acuminatum*		
		Navicula	*tripunctata*		
		Tabellaria	*flocculosa*		
			fenestrata		
		Pinnularia	*gibba*		
			viridis		
			streptoraphe		
		Coscinodiscus	*radiatus*		
		Surirella	*elegans*		
			robusta		
			splendida		
			tenera		
			minuta		
		Triceratium	*favus*		
		Melosira	*varians*		
		Fragilaria	*crotonensis*		
		Cylindrotheca	*closterium*		
		Aulacoseira	*granulata*		
		Cymbella	*lanceolata*		
		Asterionella	*formosa*		
		Frustulia	*maoriana*		
Euglenophytes	Euglenophyceae	*Phacus*	*longicauda*	9	12.16
			acuminatus		
			cordatus		
		Euglena	*acus*		
			sociabilis		
			gracilis		
			viridis		
		Lepocinclis	*acus*		
		Strombomonas	*octocostata*		
Total : 5	8	47	74	74	

Green Algae

The green algae was the second dominant group which comprises 32.43% of the total phytoplankton species (Fig. 2). The present work recorded a total number of 24 species of green algae under 18 genera (Table 2). Identified green algae were divided into four classes i.e. Chlorophyceae, Zygnematophyceae, Ulvophyceae and

Trebouxiphyceae. Zygnematophyceae was the dominant class representing 18.92% of the total phytoplankton species (Table 2). A total of 14 species under 11 genera were recorded, where *Closterium* (3 species) was the dominant genus followed by *Spirogyra* (2 species), *Zygnema* (1 species) and *Cosmarium* (1 species) etc (Table 2). Chlorophyceae was the second dominant class comprising 10.81% 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). The class Ulvophyceae comprises 1.35% of the total phytoplankton species, containing 1 species under the genus *Ulothrix*. The class Trebouxiophyceae comprises 1.35% of the phytoplankton species and contains 1 species under the genus *Pachycladella*.

Similar findings (second dominant group) were also reported in the studies of **Eyo *et al.* (2013)** in the Great Kwa River, **Kumar and Khare (2015)** in the Yamuna River, and **Esenowo *et al.* (2017)** in the Nwaniba River. Chlorophyceae was the dominant group reported by **Sarwade and Kamble (2014)** in the Krishna River, **Jabeen and Barbhuiya (2018)** in the Manas River**, Dixit and Sharma (2019)** in the Gomti River, and **Uthirasamy *et al.* (2020)** in the Cauvery River. **Ahmad-Al-Nahid *et al.* (2020)** reported only 3 genera (*Spirogyra*, *Chlorella*, and *Ulothrix*) of green algae from the Halda River; a finding which is less than that determined in the present study due to the short term study (3 months) and the restricted sampling to the downstream of the River.

Blue green algae

The blue green algae comprises 13.51% of the total phytoplankton species (Fig. 2). This study recorded 10 species of blue green algae under 6 genera that belong to Cyanophyceae (Table 2). The dominant genus was *Oscillatoria* (4 species), followed by *Spirulina* (2 species), *Phormidium* (1 species), *Anabaena* (1 species), *Microcystis* (1 species) and *Merismopedia* (1 species) (Table 2). **Patra and Azadi (1987)** reported that Cyanophyceae was the second dominant group of phytoplankton with the following genera: *Microcystis, Oscillatoria, Lyngbya, Anabaena, Nostoc,* and *Rivularia* in the Halda River. The dominant Cyanophyceae was also postulated in the studies of **Ahsan *et al.* (2012)** in the Halda River, **Kamola *et al.* (2013)** in the Arkavathi River, and **Kumar and Khare (2015)** in the Yamuna River due to different ecological and geographical variations. **Eni *et al.* (2014)** reported 5 species of blue green algae under 4 genera (*Anabaena, Anacystis, Oscillatoria* and *Phormidium*) from the Calabar River. **Jyoti *et al.* (2019)** identified 7 species of blue green algae under the genera (*Anabaena, Oscillatoria, Oocystis, Aphanacaps, and Chlorococcus*) in the Chandloi River.

Euglenophytes

Euglenophytes comprise 12.16% of the total phytoplankton species (Fig. 2). A total number of 9 species of Euglenophytes representing 4 genera and belonging to the class Euglenophyceae were recorded in the present study(Table 2). The dominant genus was *Euglena* (4 species), followed by *Phacus* (3 species), *Lepocinclis* (1 species) and *Strombomonas* (1 species) (Table 2). **Eyo *et al.* (2013)** reported 4 species

of Euglenophytes under 2 genera (*Euglena*, and *Phacus*) from the Great Kwa River. Whereas, **Uthirasamy *et al.* (2014)** reported 6 species of Euglenophytes under 2 genera (*Euglena*, and *Phacus*) from the Curvery River. On the other hand, **Kumar and Khare (2015)** recorded 3 species of Euglenophytes under the genera *Euglena* and *Phacus* in the Yamuna River, and **Dixit and Sharma (2019)** reported 3 species of Euglenophytes under the genera *Euglena* and *Phacus* in the Gomti River.

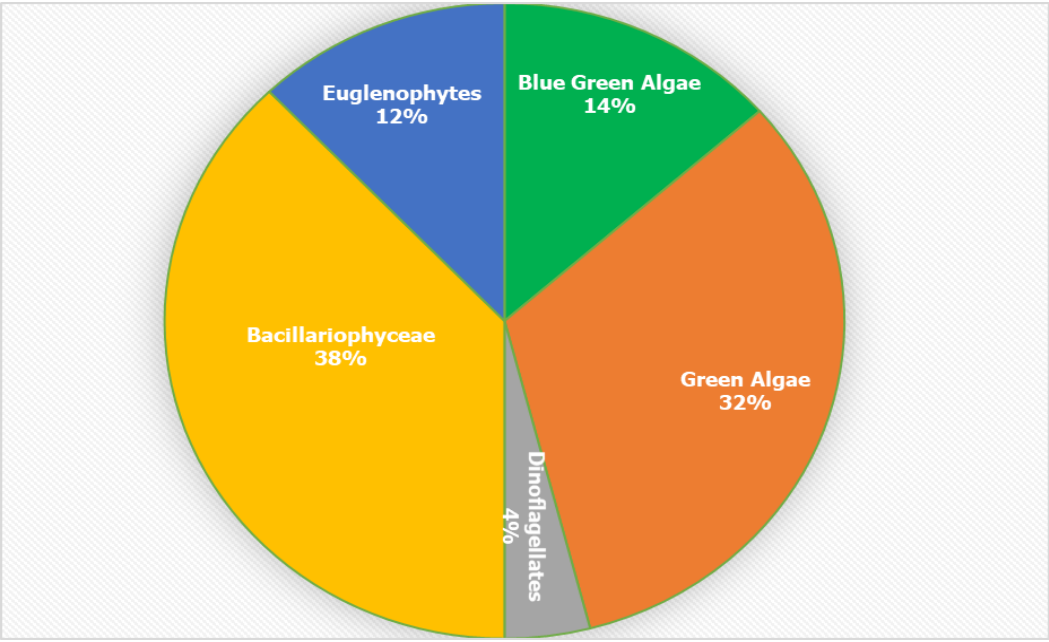
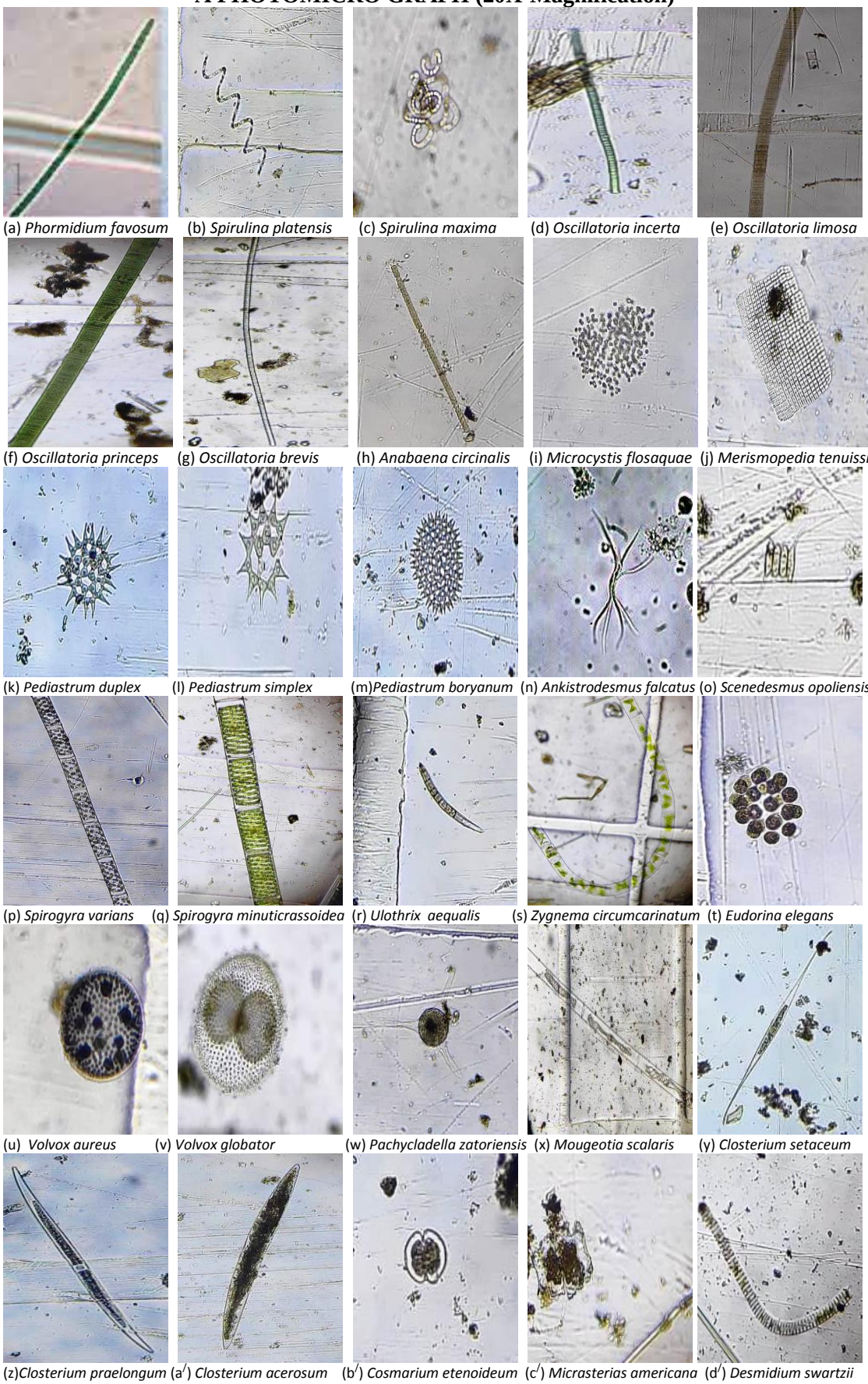


Fig. 2. Percentages of different groups of phytoplankton in the Halda River from January 2017 to December 2018

Dinoflagellates

Dinoflagellate is the least dominant group of phytoplankton, comprising 4.05% of the total phytoplankton species (Fig. 2). Only 3 species of dinoflagellates were identified under 2 genera that belong to the class Dinophyceae (Table 2). The dominant genus was *Ceratium* (2 species), followed by *Dissodinium* (1 species) (Table 2). The least dominant group of dinoflagellate was also determined in some studies, including: **Eyo *et al.* (2013)** in the Kwa River, **Esenowo *et al.* (2017)** in the Nwaniba River, **Dixit and Sharma (2019)** in the Gomti River, and **Jyoti *et al.* (2019)** in the Chandloi River. **Ahmad-Al-Nahid *et al.* (2020)** assessed 2 genera (*Ceratium* and *Alexandrium*) of dinoflagellates from the Halda River. While, **Eni *et al.* (2014)** postulated 2 genera (*Gymnodinium* and *Girodinium*) of dinoflagellates from the Calabar River, and **Haque *et al.* (2015)** defined 7 species of dinoflagellates under 5 genera (*Dinophysis, Prorocentum, Balechina, Gymnodinum, and Gonyaulax*) in the Nwaniba River.

A PHOTOMICRO GRAPH (20X-Magnification)



(a) *Phormidium favosum* (b) *Spirulina platensis* (c) *Spirulina maxima* (d) *Oscillatoria incerta* (e) *Oscillatoria limosa*

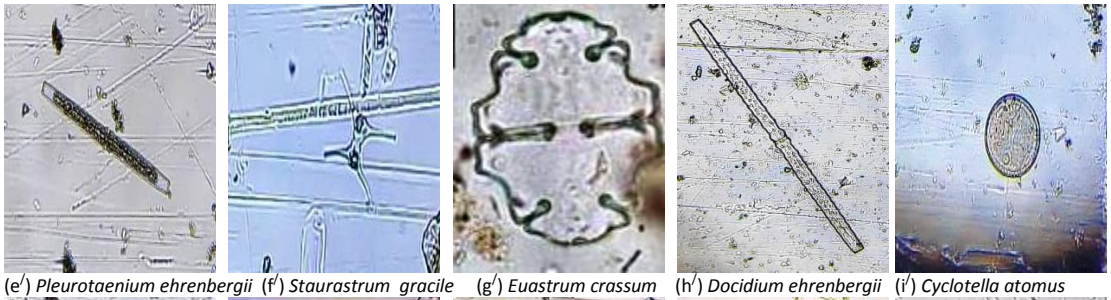
(f) *Oscillatoria princeps* (g) *Oscillatoria brevis* (h) *Anabaena circinalis* (i) *Microcystis flosaquae* (j) *Merismopedia tenuissima*

(k) *Pediastrum duplex* (l) *Pediastrum simplex* (m)*Pediastrum boryanum* (n) *Ankistrodesmus falcatus* (o) *Scenedesmus opoliensis*

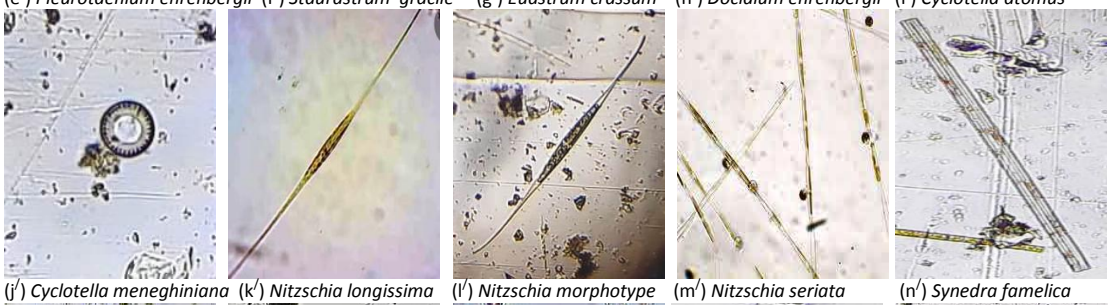
(p) *Spirogyra varians* (q) *Spirogyra minuticrassoidea* (r) *Ulothrix aequalis* (s) *Zygnema circumcarinatum* (t) *Eudorina elegans*

(u) *Volvox aureus* (v) *Volvox globator* (w) *Pachycladella zatoriensis* (x) *Mougeotia scalaris* (y) *Closterium setaceum*

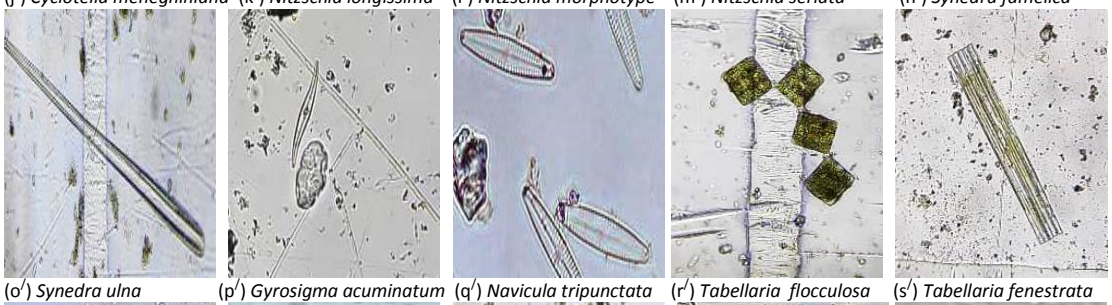
(z)*Closterium praelongum* (a′) *Closterium acerosum* (b′) *Cosmarium etenoideum* (c′) *Micrasterias americana* (d′) *Desmidium swartzii*



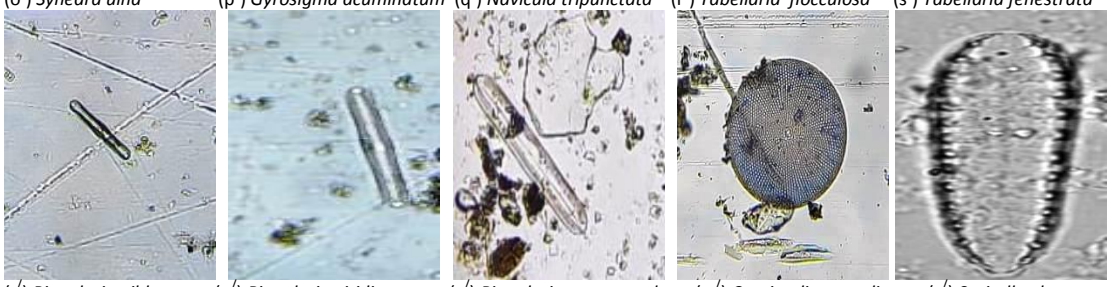
(e′) *Pleurotaenium ehrenbergii* (f′) *Staurastrum gracile* (g′) *Euastrum crassum* (h′) *Docidium ehrenbergii* (i′) *Cyclotella atomus*



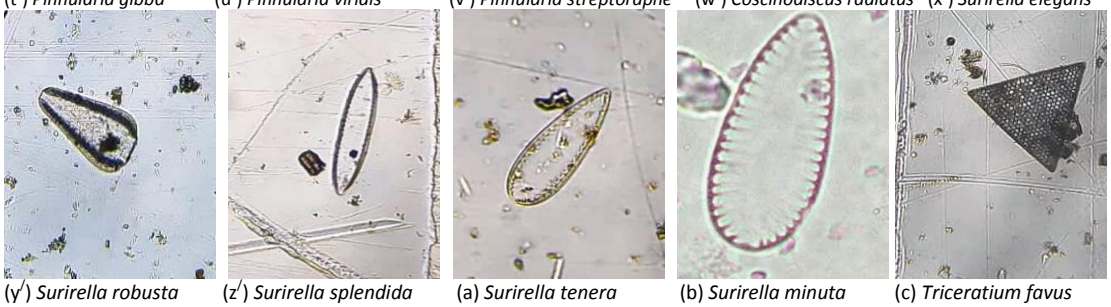
(j′) *Cyclotella meneghiniana* (k′) *Nitzschia longissima* (l′) *Nitzschia morphotype* (m′) *Nitzschia seriata* (n′) *Synedra famelica*



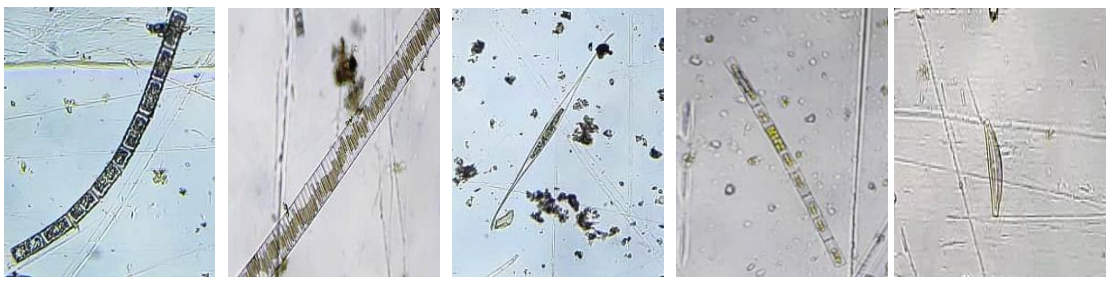
(o′) *Synedra ulna* (p′) *Gyrosigma acuminatum* (q′) *Navicula tripunctata* (r′) *Tabellaria flocculosa* (s′) *Tabellaria fenestrata*



(t′) *Pinnularia gibba* (u′) *Pinnularia viridis* (v′) *Pinnularia streptoraphe* (w′) *Coscinodiscus radiatus* (x′) *Surirella elegans*



(y′) *Surirella robusta* (z′) *Surirella splendida* (a) *Surirella tenera* (b) *Surirella minuta* (c) *Triceratium favus*



(d) *Melosira varians* (e) *Fragilaria crotonensis* (f) *Cylindrotheca closterium* (g) *Aulacoseira granulata* (h) *Cymbella lanceolata*

(i) *Asterionella formosa* (j) *Frustulia maoriana* (k) *Ceratium furca* (l) *Ceratium hirundinella* (m) *Dissodinium elegans*

(n) *Phacus longicauda* (o) *Phacus acuminatus* (p) *Phacus cordatus* (q) *Euglena acus* (r) *Euglena sociabilis*

(s) *Euglena gracilis* (t) *Euglena viridis* (u) *Lepocinclis acus* (v) *Strombomonas octocostata*

CONCLUSION

The current study identified 74 species of phytoplankton under 47 genera and belonging to 8 classes from the Halda River. The Bacillariophyceae (Diatom) was the most dominant class of phytoplankton with 28 species under 17 genera, and the Dinophyceae was the least dominant class with 3 species under 2 genera. The water quality of the Halda River is eutrophic and betamezosaprobic leveled. Thus, it can be concluded that the River Halda is a productive ecosystem with diverse groups of phytoplankton which would help boosting fish productivity by increasing the zooplankton mass.

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