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PHYSICOCHEMICAL ASPECTS AND PHYTOPLANKTON OF THE RIVER SHITALAKHYA RECEIVING PHARMACEUTICAL EFFLUENTS

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Abstract

Phytoplankton from a part of the Shitalakhya river receiving effluents from a pharmaceutical industry have been studied. A total of 78 taxa were identified of which 14 belonged to Cyanophyceae, 11 Chlorophyceae, 20 Euglenophyceae and 33 Bacillariophyceae. The water body was mostly alkaline (6.6 - 8.0) and showed a wide range of variation in conductivity (135 - 4768 µS/cm), DO (anoxia to 15 mg/l), free-CO_2 (3 - 29 mg/l), bicarbonate alkalinity (49 - 355 mg/l), BOD (8 - 1800 mg/l) at different locations. Pharmaceutical effluents appeared to affect diversity of phytoplankton. Three diatoms namely *Fragilaria brevistriata* Grun., *F. construens* (Ehr.) Grun. and *Navicula oblonga* Kütz. present in the area, are described as new for Bangladesh.

Introduction

Algae are good indicators for water quality (Palmer 1959, Patrick 1973, Hynes and Pentelow 1978, Trainor 1984). In Bangladesh, Islam and Zaman (1975), Islam *et al.* (1991), Khondker *et al*. (1990) and Begum and Hossain (1993) studied some running and stagnant freshwater habitats using phytoplankton species as indicators. In the country, most of the industries like textiles, pharmaceuticals, tanneries, paper mills and oil refineries are situated on the bank of rivers and discharge effluents directly into it. Besides, varieties of chemical fertilizers and residues of pesticides are also incorporated in the river systems via leaching and as wash outs. These pollutants inhibit the growth of aquatic flora and fauna. In Bangladesh, a very few reports do exist on the effects of industrial effluents on phytoplankton (Begum and Hossain 1993, Begum 2008). The present study was therefore undertaken to study the effects of pharmaceutical effluents on the phytoplankton diversity and abundance in the river Shitalakhya, Narayanganj, Bangladesh.

Material and Methods

The study was carried out in a part of the river Shitalakhya, Naryanganj, receiving effluents from pharmaceutical industry. Four stations along the stretch of the effluent channel were selected for carrying out the sampling. These were designated hereinafter S_1, S_2, S_3 and S_4 where S_1 is located near the point of release of effluents. Three replicates were taken from each station. Water samples were collected fortnightly from November, 1994 to October, 1995 at a depth of about 15-25 cm from each station between 9.00 and 10.00 a.m. pH and water temperature were measured *in situ* by using a CD-300 digital portable pH meter and a mercury centigrade thermometer, respectively. Dissolved oxygen (DO), BOD and free-CO_2 were measured following APHA (1976). Measurement of biocarbonate alkalinity (BA) was carried out after Gerrath and Denny (1979). For conductivity, a Blackman conductivity meter (Model No. 4070, range 0-20 mS) was used. For biological analyses collection, preservation and qualitative assessment of phytoplankton were done following Khondker *et al*. (1988) and Johansen (1940). Literatures consulted are shown in Table 2. Classification proposed by Bold and Wynne (1985) was followed.

Results and Discussion

Physicochemical variables in the four sampling stations are presented in Table 1. The pH range from 6.6 to 8.0, and desmids were not recorded, an observation similar to that of Khondker *et al.* (1990). On the contrary desmids were recorded in the pond where the pH ranged from 5.45 to 7.28 (Begum and Hassain 1993). Conductivity showed a wide variation in all the four stations ranging from 135 µS/cm in early September to 4768 µS/cm in early November. The value is about four times higher than that reported from a polluted pond (Khondker *et al.* 1990). Except S_1, the range of DO was lower than the values reported in polluted waters. As expected lowest range of BOD (8.0 -433.0 mg/l) was observed in S_1 (Table 1).

Table 1. Range of physicochemical variables recorded in four sampling stations of the Shitalakhya river, near a pharmaceutical industry.

Parameters	Sampling stations			
	S_1	S_2	S_3	S_4
Water temp. in ºC	24-40	22-42	20-42	18-38
pH	6.6-7.5	7.0-7.5	7.0-8.0	7.0-8.0
Conductivity (µS/cm)	272-489	292-645	292-683	135-4768
DO (mg/l)	3.0-15.0	0.0-8.0	1.3-10.0	0.0-8.0
Free CO_2 (mg/l)	7-23	7-21	3-25	5-29
Biocarbonate alkalinity (mg/l)	81-182	84-192	65.2-264	49-355
BOD (mg/l)	8-433	10-1620	14-1800	13-1300

S_1 = station of the river nearest to the point of direct discharge from the industry, S_2 = station about 50 feet away from S_1, S_3 = station about 150 feet away from S_2, S_4 = far from S_1.

Members of Bacillariophyceae were found to be dominant. More or less similar observations were made by Begum and Hossain (1993). Observation of euglenoid bloom in anoxic condition in the month of March is in agreement with the observation of Hegde and Bharati (1986), Hickmen and Pen (1997) and Begum and Hossain (1993). The taxa recorded in the present study along with their dimension and abundance in different stations are given in Table 2 in which the abundance of three species of *Merismopedia* and *Microcystis aeruginosa, Oscillatoria amphibia, O. ornata, O. subbrevis, Anabaena circinalis* and *A. flos-aquae* is evident. These species seem to be resistant to polluted environment. Begum and Hossain (1993) and Begum (2008) also observed more or less similar abundanc of these species in a pond receiving effluents from two textile industries. Similarly chlorophycean phytoplankton like *Eudorina elegans, Scenedesmus acuminatus, S. arcuatus* are common in this habitat. Previously Islam and Begum (1970) and Begum (2008) reported their abundance in polluted water bodies and textile industrial effluents, respectively. With a few exceptions, among all the groups of phytoplankton recorded, Euglenophyceae showed dominance in all the four stations (Table 2). Similar observation was also made earlier in two polluted ponds by Islam *et al.* (1990) and in textile industrial effluents by Begum and Hossain (1993). On the contrary lowest representation by the members of Chlorophyceae indicates that this group is more sensitive to the pollutants discharged by the pharmaceutical industry. Similar observation was made by Islam and Khatun (1966). The members of Bacillariophyceae appear to be best adaptated in the polluted habitat (Table 2) as indicated by 36 genera out of 78. Their lowest count was recorded when the pond water was anaerobic. The present investigation revealed that the effluents discharged from pharmaceutical industries are more harmful than those from the textile industries as indicated by only 78 taxa of phytoplanktonic algae compared to 308 taxa (Begum and Hossain 1993).

Table 2. List of the recorded phytoplankton together with their dimension, abundance and source of identification. l. = long; b. = broad, *+ = few; ++ = common; +++ = very common.

Species	Stations	Abun-dance*	Dimension (µm)	References
Class: Cyanophyceae; Order: Chroococcales; Family: Chroococcaceae				
Merismopedia elegans A. Br. in Kütz.	1, 2	+	Colonies 4.5-5.0 l., 3.0-4.0 b.	Islam and Aziz 1979
Merismopedia minima Beck in Beck and Zahlbruchner	1, 2	++	Cells 0.5-0.6 b., groups of 4 cells 2.0-3.0 (dia.)	Islam and Nahar 1967
Merismopedia punctata Meyen in Wiegmann	1, 2	++	Cells 1.5 l., 1.0 b.	Khondker *et al*. 2006
Microcystis aeruginosa Kütz.	1	++	Cells 3.0-7.0 (dia.)	Islam and Nahar 1967, Islam and Uddin 1977
Microcystis flos-aquae (Wittr.) Kirchner in Engler and Prantl	3, 4	++	Cells 3.0-7.0 (dia.)	Islam and Nahar 1967, Islam and Zaman 1975
Order: Oscillatoriales, Family: Oscillatoriaceae				
Oscillatoria amphibia Ag. *ex* Gom.	3	+++	Cells 5.0 l., 3.0 b.	Islam and Irfanullah 2005, Khondker *et al.* 2006, Begum 2008
Oscillatoria boryana Bory *ex* Gom.	3,4	++	Cells 2.0 l., 3.5-4.0 b.	Islam and Nahar 1967
Oscillatoria limnetica Lemm.	2,3	++	Cells 2.5-5.0 l., 1.5-2.0 b.	Aziz and Tanbir 1999, Islam and Irfanullah 2005, Begum 2008
Oscillatoria ornata Kütz. *ex* Gom.	2,3	+++	Cells 2.0-5.0 l., 7.0-9.0 b.	Islam and Nahar 1967, Islam and Irfanullah 2005
Oscillatoria sancta (Kütz.) Gom.	1, 3, 4	++	Cells 2.3-6.1 l., 9.2-16.0 b.	Aziz and Islam 1986, Begum 2008
Oscillatoria subbrevis Schmidle	1-3	+++	Cells 1.0-2.0 l., 5-6 b.	Islam and Khatun 1967, Islam and Irfanullah 2005, Begum 2008
Family: Nostocaceae				
Anabaena circinalis Rabenh. *ex* Born. *et* Flah.	3-4	+++	Trichome 5-8 b., Cells 7.0-10.0 l., 5.0-6.0 b., Heterocysts 7-11 b.	Begum 2008
Anabaena constricta *(Szafer) Geitler*	2, 3	++	Cells 2.5-11.4 l., 3.5-15.0 b.	Islam and Nahar 1967, Aziz and Islam 1986
Anabaena flos-aquae *(Lyngb.) Bréb. ex* Born. *et Flah.*	1-4	+++	Heterocysts 7.8 l., 6.0-7.0 b., Cells 5-6 b.	Islam and Nahar 1967, Begum 2008
Class: Chlorophyceae, Order: Vovlvocales, Family: Chlamydomonadaceae				
Chlamydomonas gloeogama Kors. in Pascher	3	+	Cells 14.0 l., 8.0 b.	Islam and Khondker 1997

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Species	Stations	Abun-dance*	Dimension (µm)	References
Family: Volvocaceae				
Pandorina morum (Müller) Bory	1	++	Colonies 30-41l., 20-33 b.; Cells 9.0-13.0 l., 6.6-10.0 b.	Islam and Khatun 1966, Begum 2008
Eudorina elegans Ehr.	1, 2	+++	Cells 7.0-11.7 (dia.)	Islam and Khatun 1966
Order: Chlorococcales, Family: Oocystaceae				
Chlorella vulgaris Beyerinck	1, 2	++	Cells 5.5-9.9 l., 4.5-13.0 b.	Islam and Khatun 1966, Islam and Begum 1970, Aziz and Tanbir 2003
Family: Scenedesmaceae				
Scenedesmus acuminatus (Lagerh.) Chodat	1-4	+++	Colonies 21.6 l.; Cells 14.8-20.2 l., 2.7-6.6 b.	Islam and Khatun 1966, Islam and Begum 1970, Islam and Zaman 1975
Scenedesmus arcuatus Lemm.	1-4	+++	Cells 6.6-14.3 l., 4.4-8.8 b.	Islam and Khatun 1966, Islam and Begum 1970, Begum 2008
Scenedesmus brasiliensis Bohlin	1, 4	+	Colonies 21-27 l., cells 11.0-22.3 l., 4.4-7.4 b.	Islam and Khatun 1966, Islam and Begum 1970
Order: Chlorellales, Family: Chlorellaceae				
Teträdron regulare Kütz.	1,2	+	Cells 15.5-57.4 l., 50.7 b. (with spine)	Islam and Begum 1970, Islam and Irfanullah 2005, Begum 2008
Teträdron trigonum (Nägeli) Hansgirg	1-4	+++	Cells 11.2-22.0 l., 8.6-22.0 b.	Islam and Begum 1970, Begum 2008
Family: Coelastraceae				
Closteriopsis longissima var. *tropica* West & West	1,2	++	Cells 97.9 l., 4.4 b.	Islam and Begum 1970
Actinastrum hantzschii Lagerh.	1-4	+	Cells 8.8-19.6 l., 2.2-4.2 b.	Islam and Khatun 1966, Islam and Begum 1970
Class: Euglenophyceae, Order: Eutreptiales, Family: Eutraeptiaceae				
Eutreptia sp.	3	+	Cells 22.8-42.75 l., 8.5-14.25 b.	Islam *et al*. 1991
Order: Euglenales, Family: Euglenaceae				
Euglena acus (Müller) Ehr.	1-4	+++	Cells 76.0-250.0 l., 5.7-14.3 b.	Islam and Khatun 1966, Islam *et al*. 1991
Euglena chlamydophora Mainx	1-4	+++	Cells 54.1 l., 17.1 b.	Islam *et al*. 1991
Euglena clara Skuja	4	++	Cells 61.0 l., 40.2 b.	Islam *et al*. 1991

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Species	Stations	Abun-dance*	Dimension (µm)	References
Order: Euglenales, Family: Euglenaceae				
Euglena granulata (Klebs) Fr. Schmitz	1	++	Cells 37.0-64.5 l., 22.8-28.5 b.	Islam and Khatun 1966, Islam *et al*. 1991
Euglena pisciformis Klebs	1	+++	Cells 24.0-82.0 l., 7.0-11.0 b.	Islam *et al*. 1991, Islam and Irfanullah 2005
Euglena proxima Dangeard	3	+	Cells 54.1 l., 14.2 b.	Islam *et al*. 1991
Euglena variabilis Klebs	2, 3	+++	Cell 76.75 l., 14.2-28.5 b.	Islam *et al*. 1991
Trachelomonas armata (Ehr.) Stein	1	+	Lorica 12-14 l., 21.0-29.6 b.	Islam and Moniruzzaman 1981, Islam and Irfanullah 2005
Trachelomonas hispida (Perty) Stein	1-4	+++	Lorica 21-36 l., 15-25 b.	Islam and Moniruzzaman 1981, Islam and Alfasane 2004, Islam and Irfanullah 2005
Trachelomonas hispida var. *coronata* Lemm.	2-4	++	Lorica 38 l., 22-25 b.	Islam and Moniruzzaman 1981
Trachelomonas hispida var. *punctata* Lemm.	1- 4	+++	Lorica 25-29 l., 17-26 b.	Islam and Moniruzzaman 1981, Islam and Irfanullah 2005
Trachelomonas mucosa var. *brevicollis* Skv.	1	+	Lorica 18.0 l., 14.5 b.	Islam and Moniruzzaman 1981
Trachelomonas oblonga Lemm.	1-4	+++	Lorica 11-16 l., 7.5-12.4 b.	Islam and Moniruzzaman 1981, Islam and Irfanullah 2005
Trachelomonas oblonga Lemm. fa. *ovata* Defl.	1	+	Lorica 17.7 l., 13.6 b.	Islam and Moniruzzaman 1981
Trachelomonas playfairii Defl.	1-4	+	Lorica 23-25 l., 16-18 b.	Islam and Moniruzzaman 1981
Trachelomonas rotunda Swir. *emend* Defl.	1-4	+++	Lorica 12.0-22.5 l., 14-25 b.	Islam and Moniruzzaman 1981
Phacus caudatus Hubn.	3	+	Cells 18.4-29.7 l., 8.5-18.2 b.	Islam *et al.* 1991, Islam and Irfanullah 2005
Phacus circumflexus Pochm.	2-3	+	Cells 76.9 l., 39.9b.	Islam *et al.* 1991, Islam and Alfasane 2002
Phacus curvicauda Swirenko	4	+++	Cells 30.4-80.0 l., 24.3-47.0 b.	Islam and Khatun 1966, Islam *et al*. 1991, Islam and Irfanullah 2005

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Species	Stations	Abun-dance*	Dimension (µm)	References
Class: Bacillariophyceae, Order: Centrales, Family: Melosiraceae				
Melosira granulata (Ehr.) Ralfs	1-4	+++	Cells 11.5-15.5 l., 8.0 b.	Islam and Aziz 1977, Islam and Irfanullah 2005
Melosira undulata (Ehr.) Kütz.	2	+	Cells 20-22 l., 19 b.	Islam and Aziz 1975
Melosira varians C. Ag.	1-3	++	Cells 2.0-49.98 l., 5.44-25.0 b.	Islam and Aziz 1975, Islam and Haroon 1975
Family: Coscinodiscaceae				
Coscinodiscus lacustris Grove Rattray.	1-3	++	Cells 33-34 dia.	Islam and Haroon 1975
Order: Pennales, Family: Fragilariaceae				
Fragilaria brevistriata Grun.	1-3	++	Cells 7-25 l., 3-5 b.	Germain 1981
Fragilaria capucina Desm.	2-4	+++	Cells 43.5 l., 4.3 b.	Islam and Haroon 1975
Fragilaria construens (Ehr.) Grun.	3, 4	++	Cells 14-16 l., 3-9 b.	Germain 1981
Fragilaria crotonensis Kitton	1	+	Cells 40-150 l., 70 b.	Germain 1981, Aziz and Tanbir 2003
Fragilaria virescens Ralfs	1-4	+++	Cells 42-79 l., 5-8 b.	Germain 1981, Nahar 2001 (Pers. Comm.)
Synedra acus Kütz., Kieselschal.	1-4	+++	Cells 148.8 l., 7.2 b. (at the middle)	Islam and Haroon 1975
Synedra tabulata (Ag.) Kütz.	1-4	+++	Cells 33-94 l., 4.0-5.5 b.	Germain 1981, Aziz and Ara 2000
Synedra ulna (Nitzch) Ehr.	1-4	+++	Cells 320-350 l., 6.6 b.	Islam and Chowdhury 1979, Islam and Irfanullah 2005
Synedra ulna var. *oxyrhynchus* (Kütz.) van Heurek	1-4	+++	Cells 120-126 l., 14 b.	Islam and Haroon 1975
Order: Eunotiales, Family: Eunotiaceae				
Eunotia lunaris (Ehr.) Grun.	1-4	+++	Cells 112.5 l., 7.2 b. (at the middle)	Islam and Haroon 1975
Family: Naviculaceae				
Gyrosigma acuminata (Kütz.) Rab.	1-4	+++	Cells 139-165 l., 22.5-25.0 b.	Aziz and Islam 1986
Gyrosigma acuminatum var. *lacustre* Meist.	1	++	Cells 72.60 l., 14.52 b.	Islam and Haroon 1975
Navicula cryptocephala Kütz.	2-4	++	Cells 25-35 l., 5-7 b.	Germain 1981, Begum and Hossain 1993
Navicula cuspidata Kütz.	1-4	+++	Cells 47.2-165.5 l., 16-32 b.	Germain 1981, Nahar 2001 (Pers. Comm.)
Navicula decussis Oestrup	1-4	+++	Cells 16-25 l., 6-7 b.	Germain. 1981, Begum and Hossain 1993
Navicula menisculus Schum.	1-2	+++	Cells 28 l., 6-7 b.	Islam and Haroon 1975, Begum and Hossain 1993

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Species	Stations	Abun-dance*	Dimension (µm)	References
Family: Naviculaceae				
Navicula oblonga Kütz.	1	++	Cells 70-220 l., 13-24 b.	Germain. 1981
Navicula placentula (Ehr.) Grun. var. *rostrata* Meyer	3, 4	+++	Cells 12.5-30.5 l., 8.5-10.0 b.	Germain. 1981, Aziz and Tanbir 1997
Navicula radiosa Kutz.	3, 4	+++	Cells 50-70 l., 7-8 b.	Germain. 1981, Aziz and Yasmin 1997
Pinnularia microstauron (Ehr.) Cleve	3,4	+++	Cells 60-90 l., 9-11 b.	Germain 1981, Aziz and Tanbir 2003
Pinnularia viridis (Nitzsch) Ehr.	1-3	+++	Cells 30-200 l., 8-25 b.	Germain 1981, Nahar 2001 (Pers. Comm.)
Family: Cymbellaceae				
Cymbella stuxbergii (Cl.) Cl.	1-4	+++	Cells 50.0-68.9 l., 18.0-21.7 b.	Islam and Haroon 1975, Islam and Hossain 1979
Gomphonema lanceolatum fa. *turris* (Ehr.) Hust.	1-4	+++	Cells 54.4-73.0 l., 12-15 b.	Islam and Haroon 1975
Gomphonema olivaceum (Hornemann) Kütz.	1-2, 4	++	Cells 45-48 l., 8.5-9.0 b.	Islam and Haroon 1975
Family: Bacillariaceae				
Nitzschia acicularis *W. Smith*	2-4	++	Cells 35-100 l., 3-5 b.	Germain 1981, Nahar 2001 (Pers. Comm.)
Nitzschia gracilis Hantz.	3,4	++	Cells 10-112 l., 4.0-5.52 b.	Germain 1981, Aziz and Ara 2000
Nitzschia intermedia Hantz. Grun.	1, 3-4	+++	Cells 40-130 l., 4-6 b.	Germain 1981, Begum and Hossain 1993
Family: Surirellaceae				
Suriella Robusta Ehr. var. *splendida* (Ehr.) Van Heurck.	1-2	++	Cells 73.5-140 l., 22-52 b.	Islam and Haroon 1975, Islam and Aziz 1977

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