



## RESEARCH ARTICLE

## Diversity of phytoplakton in Kamla river water between Jaynagar and Jhanjharpur

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### Abstract

Seasonal dynamics of phytoplankton populations and nutrient status of water were studied in sewage adopted river Kamla for a period of one year covering four seasons. Phytoplankton population and water analysis were studied using standard procedures. Maximum population density was observed in the winter season followed by spring, summer and rainy. Higher phytoplankton populations were found **near Kali mandir and old Durga mandir** which corresponded to the fluctuation of prevailing conductivity, turbidity, Dissolved Oxygen (DO), better organic load and Chemical Oxygen Demand (COD) content of the those habitats. A total of 37 species belonging to four different groups were recorded during the study period. *Spirogyra*, *Scenedesmus*, *Pediastrum*, *Navicula*, *Fragillaria*, *Oscillatoria*, *Euglena* and *Microspora* were the most abundant followed by *Chlamydomonas*, *Ulothrix*, *Nitzschia* and *Amphora*. Higher concentration of diatoms **near Kali mandir and old Durga mandir** indicates polluted zone of the river. *Oscillatoria*, *Spirulina*, *Fragillaria* and *Nitzschia* species at sewage affected sites can be used as an indicator of organic pollution in the river. Our findings highlighted the deterioration of water quality in the river due to urbanization and human activities. Proper biological and chemical treatment of domestic sewage and factorial effluents before discharge to river system is suggested.

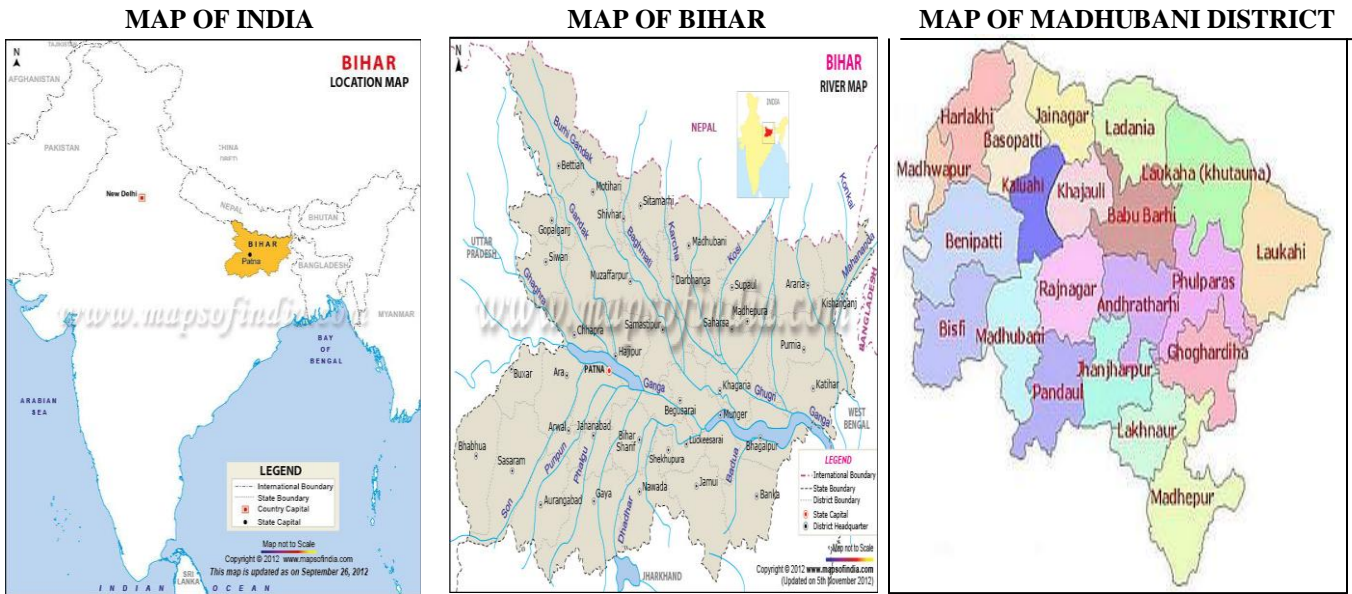
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### INTRODUCTION

Water is important component of all living beings. It also performs unique and indispensable activities in ecosystem, biosphere and biogeochemical cycles. The growth and diversity of aquatic microflora in river system is influenced by several physico-chemical and biological parameters. Planktons, particularly, phytoplankton were used as indicators of water quality (APHA, 2005).

Phytoplankton is the integral component of riverine ecosystem which determines the primary productivity of the system. They are the bio-indicators of water pollution. Its appearance, disappearance, density and pattern of distribution depend on biotic and abiotic factors (Komala, et al, 2013).

The present dissertation includes the data of one year **from Feb, 2014 to Jan, 2015** of study on various qualitative (taxonomic identification) and quantitative survey of phytoplankton and water analysis.



MAP SHOWING KAMLA RIVER ( STUDY AREA )

↑ (NORTH)

↓ Kamlia river



FIGURE-1 STUDY AREA LOCATION MAP

**MATERIALS AND METHODS**

The plankton samples were collected by a plankton net of standard bolting silk cloth No. 25 (Mesh size 0.03 - 0.04 mm.). Planktons were collected in every seasons from different zones of the sampling stations (S1 to s6 ) from 100 liters of water sample by a plastic bucket of 20 liters capacity through the plankton net. Finally, plankton sediment volume was adjusted to 30 ml. in the plankton net tube and preserved in 4% Formaldehyde solution. The samples were taken to the laboratory for qualitative and quantitative estimation under the binocular stereoscopic microscope

using a **Sedgwick rafter** type counting cell (1ml. capacity). After shaking the container containing the concentrated sub sample, 1 ml. was quickly drawn with a wide mouth pipette and poured in the plankton counting cell. All the organisms encountered were represented in absolute number. About ten counting of each sample were made and the data represented in the text were average values of the counting. The density of population of four major groups of algae viz. **Chlorophyceae, Bacillariophyceae, Cyanophyceae and Euglenophyceae** were estimated seasonally from **Feb, 2014 to Jan, 2015**. The percentage of occurrence of four groups was calculated every season by taking their value from density population ( **Reynolds et al, 2001**).

### Index of Similarity

The index of similarity between the study stations was calculated with the help of the following equation :-----

$$S = \frac{2c}{A+B} \times 100$$

Where, S = Czeckanovski's index of similarity

a = Number of species in a site A

b = Number of species in a site B

2c = Number of species common to A and B

## RESULTS

The phytoplankton composition of upstream and downstream was constituted mainly by **Chlorophyceae, Cyanophyceae, Bacillariophyceae and Euglenophyceae**. Variation in the qualitative and quantitative estimation of phytoplankton was noted seasonally with the bimodal fluctuation of individual group in Table-1 to 5 respectively ( **Saha, et al, 2000**).

**Table (1):-** Phytoplankton of the Kamla River in and around Jaynagar, Bihar

Chlorophyceae↓	Bacillariophyceae↓	Cyanophyceae ↓	Euglenophyceae↓
<i>Scenedesmus sp</i>	<i>Fragillaria construens</i>	<i>Oscillatoria animalis</i>	<i>Euglena acus</i>
<i>Scenedesmus quadricauda</i>	<i>Synedra incisa</i>	<i>Oscillatoria formosa</i>	<i>Phacus longicauda</i>
<i>Scenedesmus dimorphus</i>	<i>Nitzschia angustata</i>	<i>Synechocystis aquatilis</i>	<i>Euglena sp.</i>
<i>Chlamydomonas sp.</i>	<i>Nitzschia baccata</i>	<i>Microcystis aeruginosa</i>	
<i>Closterium sp.</i>	<i>Cymbella affinis</i>	<i>Anabaena ambigua</i>	
<i>Coelastrum microsporum</i>	<i>Amphora veneta</i>	<i>Anabaena variabilis</i>	
<i>Ulothrix zonata</i>	<i>Fragillaria leptostoeura</i>	<i>Arthrospira jenneri</i>	
<i>Microspora willeana</i>	<i>Navicula exilissima</i>	<i>Spirulina sp.</i>	
<i>Eudorina sp.</i>	<i>Navicula cuspidata</i>	<i>Spirulina major</i>	
<i>Pediastrum simplex</i>			
<i>Pediastrum duplex</i>			
<i>Spirogyra rivularis</i>			
<i>Spirogyra biformis</i>			
<i>Spirogyra singularis</i>			
<i>Euastrum binale</i>			
<i>Stigeoclonium tenue</i>			

**Table(2) : Floristic diversity of phytoplankton at six stations of the Kamla River**

S.No.	Name of Species	SS1↓	SS2↓	SS3↓	SS4↓	SS5↓	SS6↓
	Chlorophyceae↓	NH-104 bridge	Mahavir & Kali Mandir	Near old Durga Mandir	Navtoli	Kuarpatti	NH-57 Jhanjharpur
01	<i>Scenedesmus sp</i>	+	+	+	+	+	+
02	<i>Scenedesmus quadricauda</i>	+	+	+	+	+	+
03	<i>Scenedesmus dimorphus</i>	+	+	+	-	-	-
04	<i>Chlamydomonas sp.</i>	+	+	+	+	+	+
05	<i>Closterium sp.</i>	+	+	+	+	+	+
06	<i>Coelastrum microsporum</i>	+	+	+	+	+	+
07	<i>Ulothrix zonata</i>	+	+	+	+	+	+
08	<i>Microspora willeana</i>	+	+	+	+	+	+
09	<i>Eudorina sp.</i>	-	+	+	-	-	-
10	<i>Pediastrum simplex</i>	+	+	+	+	+	+
11	<i>Pediastrum duplex</i>	-	+	+	-	-	-
12	<i>Spirogyra rivularis</i>	+	-	-	+	+	+
13	<i>Spirogyra biformis</i>	+	-	-	+	+	+
14	<i>Spirogyra hollandiae</i>	-	-	-	+	+	+
15	<i>Euastrum binale</i>	+	-	-	+	+	+
16	<i>Stigeoclonium tenue</i>	-	+	+	-	-	-

[ + Present , - Absent ]

**Table(3) : Floristic diversity of phytoplankton at six stations of the Kamla River**

S.No.	Name of Species	SS1↓	SS2↓	SS3↓	SS4↓	SS5↓	SS6↓
	Euglenophyceae↓	NH-104 bridge	Mahavir & Kali Mandir	Near old Durga Mandir	Navtoli	Kuarpatti	NH-57 Jhanjharpur
01	<i>Euglena acus</i>	+	+	+	+	+	+
02	<i>Phacus longicauda</i>	-	+	+	+	-	-
03	<i>Euglena sp.</i>	+	+	+	+	-	-

[ + Present , - Absent ]

**Table(4) : Floristic diversity of phytoplankton at six stations of the Kamla River**

S.No.	Name of Species	SS1↓	SS2↓	SS3↓	SS4↓	SS5↓	SS6↓
	Bacillariophyceae↓	NH-104 bridge	Mahavir & Kali Mandir	Near old Durga Mandir	Navtoli	Kuarpatti	NH-57 Jhanjharpur
01	<i>Fragillaria construens</i>	+	+	+	+	+	+
02	<i>Synedra incisa</i>	+	+	+	-	-	-
03	<i>Nitzschia angustata</i>	+	+	+	+	+	+
04	<i>Nitzschia baccata</i>	-	+	+	-	-	-
05	<i>Cymbella affinis</i>	+	+	+	+	+	+
06	<i>Amphora veneta</i>	+	+	+	+	+	+
07	<i>Fragillaria construens</i>	+	+	+	+	+	+
08	<i>Navicula baccata</i>	+	+	+	+	+	+
09	<i>Navicula cuspidata</i>	+	+	+	+	+	+

[ + Present , - Absent ]

**Table(5) : Floristic diversity of phytoplankton at six stations of the Kamla River**

S.No.	Name of Species	SS1↓	SS2↓	SS3↓	SS4↓	SS5↓	SS6↓
	Cynophyceae↓	NH-104 bridge	Mahavir & Kali Mandir	Near old Durga Mandir	Navtoli	Kuarpatti	NH-57 Jhanjharpur
01	<i>Oscillatoria animalis</i>	+	+	+	+	+	+
02	<i>Oscillatoria formosa</i>	+	+	+	+	+	+
03	<i>Synechocystis aqualitis</i>	+	+	+	-	-	-
04	<i>Microcystis aeruginosa</i>	+	+	+	-	-	-
05	<i>Anabaena ambigua</i>	+	+	+	-	-	-
06	<i>Anabaena variabilis</i>	+	+	+	-	-	-
07	<i>Arthrospira jenneri</i>	+	-	-	+	+	+
08	<i>Spirulina sp.</i>	+	+	+	+	+	+
09	<i>Spirulina major</i>	-	+	+	-	-	-

[ + Present , - Absent ]

### PHYTOPLANKTON

In the present study, the phytoplankton community in fresh water was represented by members of **Chlorophyceae**, **Bacillariophyceae**, **Cyanophyceae** and **Euglenophyceae** as represented in Table -1 and their stationwise occurrence is depicted in Table 2-5. The phytoplankton comprised 37 species, of which 16 species belong to Chlorophyceae, 09 species to Bacillariophyceae, 09 species to Cyanophyceae and 3 species to Euglenophyceae. In the present study, the abundance of phytoplankton was highest during winter and spring season, which could be attributed to more stable hydrographical conditions prevailing during summer months. The abundance of phytoplankton was lowered during the rainy season when the water column was remarkably stratified to a large extent because of heavy rainfall, high turbidity caused by run-off, and decreased temperature and pH (Verma & Mohanty, 1994). Chlorophyceae, Cyanophyceae and Euglenophyceae were found to be most abundant in the summer season followed by the rainy, winter and spring seasons (Kumar & Chopra, 2012).

In the present investigation, the dominance of Bacillariophyceae like *Navicula*, *Nitzschia*, *Synedra* and *Fragilaria* was observed near NH-104 bridge, Kali Mandir and old Durga Mandir). Similar observations were registered by Rahaman, et al (2007) who gave a detailed account of dominant species of diatoms being used as indicators of water quality. In the present study, upstream Station- 1 green algal flora like *Spirogyra* and *Euastrum* were observed, which are indicators of comparatively less polluted water as supported by Venkateswararlu & Readdy (1985). The algal flora of polluted water bodies at Stations 1, 2 and 3 showed the dominance of blue green alga and diatoms like *Oscillatoria*, *Anabena*, *Microcystis*, *Navicula*, *Nitzschia*, *Synedra* etc throughout the investigation. Many green algae such as *Pandorina*, *Eudorina*, *Scenedesmus*, *Stigeoclonium*, *Chlamydomonas*, *Pediastrum*, *Closterium*, also occurred abundantly and frequently. The most pollution-tolerant species *Euglena*, *Oscillatoria*, *Navicula*, *Nitzschia*, *Stigeoclonium*, *Scenedesmus*, *Chlamydomonas*, were recorded at all the Stations, indicating the highest degree of organic pollution.

### DISCUSSION

Water quality parameters such as DO, pH, Temperature, Phosphate and Nitrate clearly influence the distribution of organisms and affect their density in a riverine system (Giri S.,2014). The major inorganic nutrients required by phytoplankton for growth and reproduction are Nitrogen (Nitrite, NO<sub>3</sub>- Nitrite, NO<sub>2</sub>-, or Ammonium, NH<sub>4</sub>+) and Phosphorus (as Phosphate PO<sub>4</sub><sup>3-</sup>). Diatoms and silicoflagellates also require Silica (SiO<sub>2</sub>) in significant amounts. Other inorganic and organic nutrients may be required in small amounts. All of those nutrients are the limiting

factors for phytoplankton productivity under good conditions. Temperature has a direct effect on certain chemical and biological activities of the organisms in aquatic media. The rise in temperature could be due to the fact that in winter the photoperiod is shorter and less intense than in summer (Wolf, et al, 2014). DO and pH are indicators of good quality water, indicating various favorable conditions for high primary and secondary phytoplankton production. Dissolved oxygen (DO) is fit for the survival of aquatic organisms and is also used to evaluate the degree of freshness of a river. Chloride occurs naturally in all types of waters. Moderate concentrations of chloride are an indicator of pollution due to organic wastes of animal or domestic origin. High values of chloride are troublesome in irrigation water and also harmful to aquatic life. Phosphate is a major nutrient for plankton growth, comparatively low values of phosphate were observed in the winter during the present investigation, which might be due to utilization of phosphate as nutrients by algae and other aquatic plants (Lewitus, et al, 1998). In the present study, the phytoplankton community in fresh water was represented by members of Chlorophyceae, Cyanophyceae, Bacillariophyceae and Euglenophyceae. Chlorophyceae was the dominant group of all the stations, followed by Bacillariophyceae, Cyanophyceae and Euglenophyceae. Near Kali Mandir and old Durga Mandir, the phytoplankton occurrence was in the order as **Cyanophyceae > Bacillariophyceae > Chlorophyceae > Euglenophyceae** throughout the study period.

Palmer (1969) made the first major attempt to identify and prepare a list of genera and species of algae tolerant to organic pollution. Palmer (1969) had shown that genera like *Oscillatoria*, *Euglena*, *Scenedesmus*, *Chlamydomonas*, *Navicula*, *Nitzschia* and *Stigeoclonium* were the species found in organically polluted water as supported by Jafari & Gunale (2006). Similar observations were recorded in the present investigation. It has been reported by Saha, et al (2000) that *Oscillatoria*, *Euglena*, and *Chlorella* are typical inhabitants of heavily polluted waters and that *Euglena* and *Oscillatoria* are highly pollution-tolerant genera. Moreover, species like *Euglena sp.* and *Oscillatoria sp.* were also recorded with very high grade points on Palmer's scale. The pollution tolerance of *Stigeoclonium tenue* was already documented. This species is an indicator of organic pollution and tolerance to heavy metals, which is recorded in

the present investigation. *Stigeoclonium tenue* was also observed near Kali mandir and old Durga mandir, which can be attributed to the inflow of domestic sewage. In the present investigation, near NH-104 bridge, Kali mandir and old Durga mandir phytoplankton were found abundant throughout the study and, even more interestingly, with a greater number of genera and species of pollution-tolerant algae with high Palmer's grade points, clearly indicating a high degree of pollution. The planktonic forms *Pandorina*, *Scenedesmus*, *Navicula*, *Chlorella*, *Spirulina*, *Anabaena*, *Eudorina*, and *Closterium* were observed in the present study as indicators of organic pollution-tolerant species. In the present investigation, the trend of increase in organic pollution from Station-3 towards the downstream of the Kamla River was observed, as was also supported by results of physico-chemical analysis of water. Cyanophyta dominance and sometimes bloom are among the most visible symptoms of accelerated eutrophication of a water body. It was also reported during the rainy season mostly in ponds and rivers in Asia, where phytoplankton least amount can be observed during the wet months.

## CONCLUSION

It can be concluded that river **Kamla at Madhubani district** is polluted and rapidly turning towards eutrophication. Its water has become unsuitable for human consumption. Proper biological and chemical treatment of domestic sewage before discharge to river system is suggested.

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## REFERENCES

**Giri & Singh, 2014.** Risk assessment, statistical source identification and seasonal fluctuation of dissolved metals in the Subarnarekha River, plateau. Environmental Monitoring and Assessment, 147(1-3): 83-92.

**Rakib & Bhuiyan, 2014.** Arsenic Contamination: Food Toxicity and Local Perception. International Journal of Scientific Research in Environmental Sciences, 2(1): 1-7

**Komala, et al, 2013.** An assessment of Plankton diversity and abundance of Arkavathi River with reference to pollution. *Advances in Applied Science Research*, 4(2): 320-324.

**Wolf, et al, 2013.** An exploration of multilevel modeling for estimating access to drinking water and sanitation. *Journal of Water and Health*, 11(1):64-77

**Rai , et al, 2012.** A study of the sewage disposal on water quality of Harmu River in Ranchi city Jharkhand, India. *International Journal of plant, animal and environmental science*, 2 (1): 102-106.

**Kumar & Chopra, 2012.** Monitoring of physicochemical and microbial characteristics of municipal wastewater at treatment plant, Haridwar city (Uttarakhand) India. *Journal of Environmental Science and Technology*, 5(2): 109-118.

**Rahaman, et al, 2007.** Study of Euglenophytes and its impact on fish growth in Bangladesh. *Algae*, 22:185-192.

**Jafari & Gunale, 2006.** Hydrobiological study of algae of an urban freshwater river. *J. Appl.Sci. Environ. Manag.*, 10: 153-158.

**APHA 2005,** Standard methods for the examination of water and waste water. 21st Edn., **APHA, AWWA, WPCF, Washington, D.C., USA**

**Reynolds, et al, 2001.** The Ecological basis for simulating Phytoplankton responses to environmental change (Protech). *Ecological modeling*,140:271-291

**Saha, et al, 2000.** Diversity of phytoplankton of sewage pollution brackish water tidal ecosystems. *Environ. Biol.*, 21: 9-14.

**Lewitus, A.J., et al ,1998.** Seasonal variation in the regulation of phytoplankton by nitrogen and grazing in a salt-marsh estuary. *Limnology and Oceanography*, 43(4):636-646.

**Verma & Mohanty, 1994.** Evaluation of water quality on the St. Joseph River. (Michigan and Indiana, USA) by 3 methods of algal analysis. *Hydrobiol.*, 48: 145-173.

**Venkateswararlu & Reddy, 1985** Algae as biomonitors in river ecology. *Sym.Biomonitoring State. Environ.*, 183-189.

**Palmer CM.** Composite rating of algae tolerating organic pollution. *British Phycol. Bulletin*.**1969**, 5: 78-92.