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# Unravelling Seasonal Diversity of Algal Flora of River Yamuna in Delhi Region

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## ABSTRACT

River Yamuna, which flows through the national capital region of Delhi, India, is an important wetland ecosystem of national and mythological significance. Thirty eight samples of periphyton and phytoplankton were collected in four different seasons i.e., winter, spring, summer and monsoon from five sites of Yamuna River. A total of 74 species under 47 genera of algae were recorded from four major groups Chlorophyta, Bacillariophyta, Euglenineae and Cyanophyta. Most of the species are cosmopolitan and tropical in distribution. Phytoplankton diversity was found variable in different seasons and collection sites. *Kirchneriella*, *Hydrodictyon*, *Crucigenia, Spirogyra, Mougeotia, Melosira, Cyclotella, Navicula, Oscillatoria* and *Microcystis* are the most dominant genera in the Yamuna River in Delhi.

## INTRODUCTION

The algal diversity from the lakes is apparently well studied, but similar studies of algal diversity in rivers are not extensively done. The temperate rivers and their algae are much more studied than tropical rivers (Rojo et al. 1994, Yolanda 2002). Most studies focus on the algal species richness during one season, but do not cover the entire seasonal variability. River Yamuna (Fig. 1A) originates from Yamunotri glacier situated at lower Himalayas in Uttrakhand State and flows through the national capital region of Delhi, which is an important wetland ecosystem. Although several studies have been undertaken on various aspects of the river, but not much information is available about the algal flora of Yamuna. This study is a pioneer in the seasonal phycological investigation of this river of national importance. Changes in the structure of phytoplankton community were evaluated by comparing data collected from five different sites of River Yamuna in Delhi region. The phytoplankton groups observed in this study are Chlorophyceae, Bacillariophyceae, Cyanophyceae and Euglenineae. The aim of this study was to evaluate the seasonal diversity and heterogeneity of algae at different locations of the river because of the rapidly increasing sewage and industrial effluents on the aquatic ecosystem of the River Yamuna.

## MATERIALS AND METHODS

Five different collection sites in River Yamuna were selected for the research study (Fig. 1B). The first collection site was at Hiranki (28°47'28.95' N, 77°11'51.77' E), the second site at Wazirabad (28°42'44.59'N, 77°14'13.30'E) and third site near Inter State Bus Terminus, ISBT (38°39'45'N, 77°14'43'E). The fourth and fifth collection sites were selected near Nizamudin railway station (28°35'12.34'N, 77°16'3.24'E) and Okhla village (28°34'0.18'N, 77°17'40.87'E) respectively. Thirty eight water samples were collected during the four seasons in the year 2010 namely winter, spring, summer and monsoon from five different selected sites of River Yamuna covering a distance of more than 22.2 km in Delhi. The geographical position of the sites was taken with the help of Garmin GPSMAP 76CSX global positioning system. The collection of water samples from site 4 near the Nizammudin railway station, during monsoon season, could not be done because the site was not accessible due to heavy flooding. The water samples were filtered through two layered muslin cloth to remove large particles and debris (Stockner et al., 1990) and preceded for microscopic studies. Slides were prepared from the filtered water samples and observed under microscope using Primo Star Zeiss microscope (USA) with a digital camera (Canon, Japan), 14.7 megapixel attached to it. Simultaneously, pictures of the algal species observed under the microscope were taken. The algal species examined under a microscope were identified with the help of standard books and monographs (Fritsch 1935, 1945, Desikachary 1959, Guiry 2010).

## RESULTS AND DISCUSSION

In 38 samples of phytoplankton and periphyton from the five different sites of River Yamuna, 74 species were

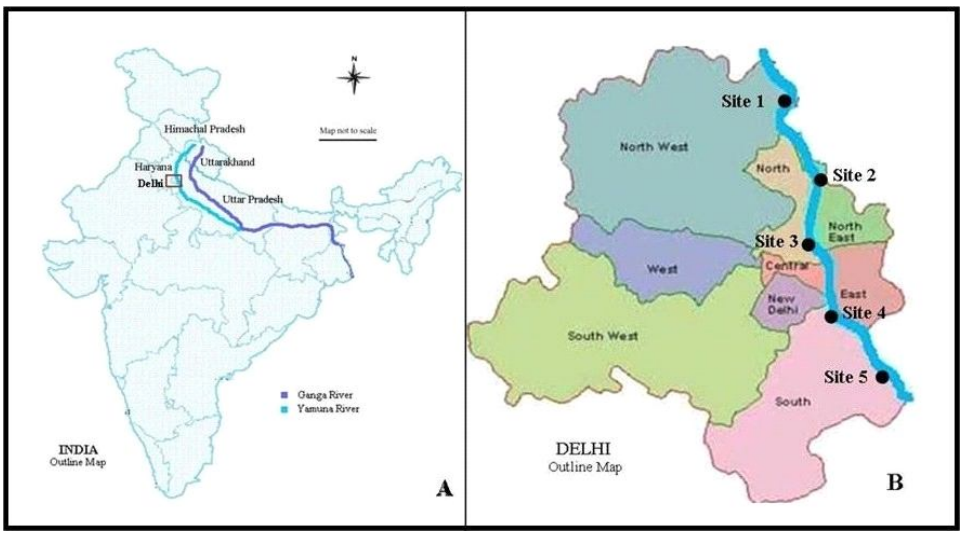


Fig. 1: A. Map of study area showing location of River Yamuna, B. sampling sites in Delhi region.

identified (Table 1) which comprised of 35 species (47 %) of Chlorophyceae, 20 species of Bacillariophyceae (27 %), 17 species of Cyanophyceae (23 %) and only 2 species of Euglenineae (2.7 %) (Chopra et al. 2016, Chopra 2010). Many species observed are common in the water bodies of the tropical and temperate parts of the world. Out of the 35 species of green algae, species of *Sphaerocystis*, *Pediastrum*, *Coelastrum*, *Scenedesmus*, *Spirogyra* and *Mougeotia* were prominent. Out of 20 species of diatoms, species of *Cyclotella*, *Melosira*, *Navicula* and *Synedra* were dominant. Species of *Gomphosphaeria*, *Oscillatoria* and *Anabaena* were observed dominant out of the 17 species of blue green algae. Euglenineae comprised of only two genera *Euglena* and *Phacus*. Mahadik & Jadhav (2014) recorded similar result with 75 species under 42 genera from Ujani reservoir, India. Jafari et al. (2006) observed 18 genera belonging to Chlorophyceae, 11 genera of Bacillariophyceae, 6 genera of Cyanophyceae and 3 genera belonging to Euglenineae from river Mutha, Pune. Tare et al. (2003) studied algal diversity near Kannauj-Kanpur stretch of river Ganga. Solanki & Shukla (2016) collected and identified 30 algal taxa from River Narmada. Algal biodiversity in River Yamuna in Agra and Allahabad region was done, but no work has been recorded on the seasonal diversity of algae in Delhi region. Chakrabarty et al. (1959) studied the phytoplankton and the physico-chemical conditions of the

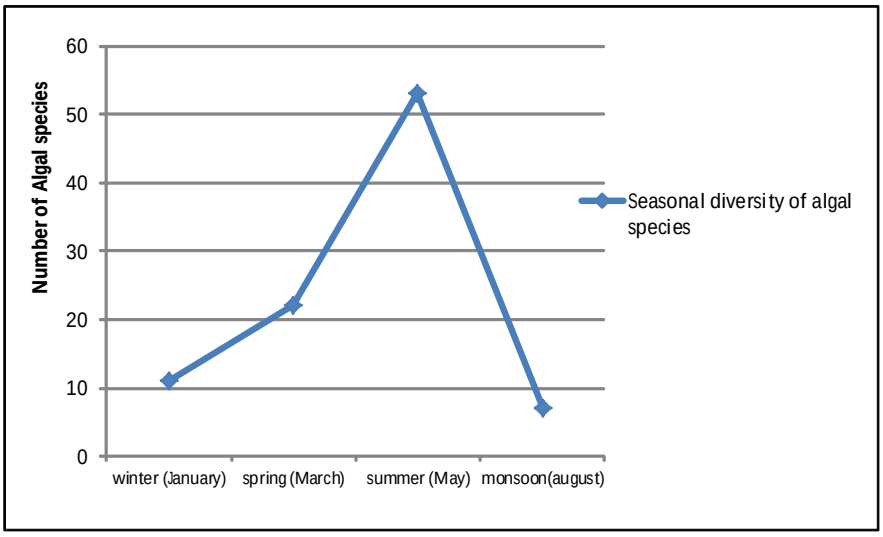


Fig. 2: Diversity of algal species in different seasons.

Table 1: Distribution of species of algae at five sites of Yamuna River. The four rows of symbols represent the presence (+) and absence (-) of different algal taxa in different seasons at all five sites. winter (W), spring (Sp) summer (S) and monsoon (M).

| Taxa | SITE 1<br>W Sp S M | SITE 2<br>W Sp S M | SITE 3<br>W Sp S M | SITE 4<br>W Sp S M | SITE 5<br>W Sp S M |
|---|---|---|---|---|---|
| *Chlamydomonas pseudopertyi* | - - - - | - - - - | - - + - | - - + - | - - - - |
| *Chlorogonium* sp. | - - - - | - + - - | - + - - | - - - - | - - - - |
| *Sphaerocystis schroeteri* | - - + - | - - - - | - - - - | - - - - | - + - - |
| *Sphaerocystis* sp. | - - + - | - - - - | - - - - | - - - - | - + - - |
| *Eremosphaera* sp. | - - + - | - - - - | - - - - | - - - - | - - - - |
| *Chlorella parasitica* | - - - - | - - - - | - - + - | - - - - | - - - - |
| *Golenkinia radiata* | - - - - | - - - - | - - - - | - - - - | - - + - |
| *Chodatella* sp. | - - - - | - - - - | - - - - | - - + - | - - - - |
| *Oocystis elliptica* | - - - - | - - + - | - - - - | - - - - | - - - - |
| *Actinastrum hantzschii* | - - - - | - - - - | - - + - | - - - - | - - - - |
| *Kirchreriella lunaris* | - - - - | - - - - | - + - - | - - - - | - + - - |
| *Dictyosphaerium pulchellum* | - - - - | - + - - | - - - - | - - - - | - - - - |
| *Hydrodictyon reticulatum* | + - - - | + - - - | - - - - | - - - - | - - - - |
| *Pediastrum duplex* | - - - - | - + - - | - - - - | - - - - | - - - - |
| *Pediastrum simplex* | - - - - | - - + - | - - - - | - - - - | - - - - |
| *Coelastrum microsporum* | - - - - | - + - - | - - - - | - - - - | - - - - |
| *Coelastrum* sp. | - - - - | - + - - | - - - - | - - - - | - - - - |
| *Crucigenia lauterborneii* | - - - - | - - - - | - - + + | - - + - | - - - - |
| *Scenedesmus quadricauda* | - - - - | - - - - | - + - - | - - - - | - - - - |
| *Scenedesmus acuminatus* | - - - - | - - - - | - - + - | - - - - | - - - - |
| *Scenedesmus obliquus* | - - - - | - - - - | - - + - | - - - - | - - - - |
| *Geminella* sp. | - - - - | - - - - | - - + - | - - - - | - - - - |
| *Cladophora fracta* | - + - - | + - - - | - - - - | - - - - | - - - - |
| *Cladophora glomerata* | + + + - | - + - - | - - - - | - - - - | - - - - |
| *Oedogonium* sp. | - - + - | + - - - | - - - - | - - - - | - - - - |
| *Spirotaenia conolensata* | - + + - | - - - - | - - - - | - - - - | - - - - |
| *Spirogyra flavenscens* | - + + - | - - + - | - - - - | - - - - | - - - - |
| *Spirogyra ellipsospora* | + + - - | - + - - | - - - - | - - - - | - - - - |
| *Spirogyra varians* | - + - - | - + - - | - - - - | - - - - | - - - - |
| *Zygnema* sp. | - - - - | - + - - | - - - - | - - - - | - - - - |
| *Mougeotia scalaris* | + - - - | + - - - | - - - - | - - - - | - - - - |
| *Mougeotia* sp. | + - - - | - - - - | - - - - | - - - - | - - - - |
| *Closterium moniliferum* | - - + - | - - + - | - - - - | - - - - | - - - - |
| *Cosmarium bioculatum* | - - - - | - - - - | - - - - | - - + - | - - - - |
| *Ecballocystis iyengarii* | - - - - | - - - - | - - - - | - - - - | - - + - |
| *Cyclotella meneghiniana* | - - - - | - - + - | - - - - | - - - - | - - - - |
| *Cyclotella* sp. 1 | - - - - | - + + - | - - - - | - - - - | - - - - |
| *Cyclotella* sp. 2 | - - - - | - - + - | - - - - | - - - - | - - - - |
| *Melosira* sp. 1 | - - - + | - - + - | - - - - | - - - - | - - + - |
| *Melosira* sp. 2 | - - - - | + - + - | - - - - | - - - - | + - + - |
| *Melosira* sp. 3 | - - - - | + - + - | - - - - | - - - - | + - + - |
| *Aulocosira* sp. | - - - - | - - + - | - - - - | - - - - | - - - - |
| *Synedra ulna* | - - - + | - - - - | - - - - | - - - - | - - - - |
| *Synedra minuscule* | - - - + | - - - - | - - - - | - - - - | - - - - |
| *Synedra* sp. 1 | - - + - | - - - - | - - - - | - - - - | - - - - |
| *Synedra* sp. 2 | - - - - | - - + - | - - - - | - - - - | - - - - |
| *Cocconeis placentula* | - - - - | - + - - | - - - - | - - - - | - - - - |
| *Gyrosigma* sp. | - - - - | + - - - | + - - - | - - - - | - - - - |
| *Navicula radiosa* | - - - - | - - + - | - - - - | - - - - | - - - - |
| *Navicula pelliculosa* | - - + - | - - - - | - - - - | - - - - | - - - - |
| *Navicula lanceolata* | - - - - | - - + - | - - - - | - - - - | - - - - |
| *Navicula andium* | - - - - | - - + - | - - - - | - - - - | - - - - |
| *Cymbella amphicephala* | - - - - | - - + - | - - - - | - - - - | - - - - |
| *Rhoicosphenia curvata* | - - - - | - + - - | - - - - | - - - - | - - - - |
| *Cylindrotheca clostereium* | - - + - | - - - - | - - - - | - - - - | - - - - |
| *Euglena viridis* | - - + + | - - - - | - - - - | - + - - | - - - - |

*Conti. Table...*

*...Table cont.*

| | | | | | |
|---|---|---|---|---|---|
| *Phacus orbicularis* | - - - - | - - - - | - - - - | - - - - | - - + - |
| *Gomphosphaeria* sp. 1 | - - - - | - - + - | - - + - | - - - - | - - - - |
| *Gomphosphaeria* sp. 2 | - - - - | - - + - | - - + - | - - - - | - - - - |
| *Gomphosphaeria* sp. 3 | - - - - | - - + - | - - + - | - - - - | - - - - |
| *Merismopedia convulata* | - - - - | - - - - | - - + - | - - - - | - - - - |
| *Microcystis aeruginosa* | - - - - | - - - - | - - + - | - - + - | - - + - |
| *Microcystis protocystis* | - - - - | - - - - | - - - - | - - - - | - - + - |
| *Oscillatoria teneius* | - - - - | - - - - | - - - - | - + + - | - - + - |
| *Oscillatoria princeps* | - - - - | - - - - | - - - - | - - + - | - - + - |
| *Oscillatoria redekei* | - - - - | - - - - | - - - - | - - + - | - - + - |
| *Oscillatoria brevis* | - - - - | - - - - | - - - - | - - - - | - - - + |
| *Oscillatoria* sp. | - - - - | - - - - | - - - - | - - + - | - - + - |
| *Phormidium fragile* | - - - - | - - - - | - + - - | - - + - | - - - - |
| *Spirulina platensis* | - - - - | - - - - | - - - - | - - - - | - - + - |
| *Anabaena* sp. | - - - - | - - + - | - - - - | - - - - | - - - - |
| *Anabaena spiroides* | - - - - | - - - - | - - + + | - - - - | - - - - |
| *Cylindrospermum* sp. | - - - - | - - - - | - - - - | - - - - | - - + - |
| *Pseudoanabaena* sp. | - - - - | - - - - | - - - - | - - - - | - - + - |

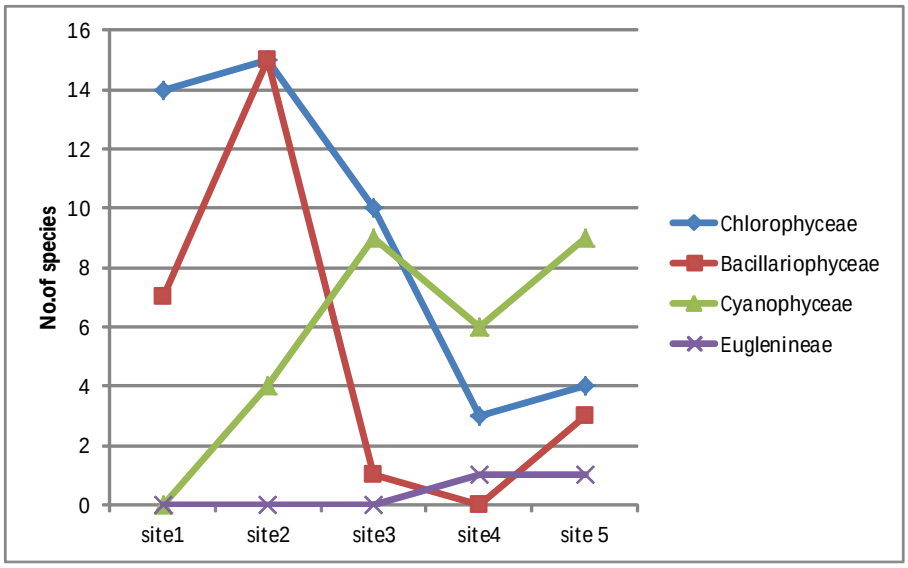


Fig. 3: Distribution of different algal groups at five different sites of River Yamuna.

River Yamuna at Allahabad. Sengar & Sharma (1982) recorded 11 genera of the order Chlorococcales from Yamuna River at Agra. In the present study, the highest number of species was recorded in summer with 53 species as compared to spring with 22 species, winter with 11 species and monsoon with 7 species. This shows that the seasonal diversity of algal species varies with different season (Fig. 2). Similar studies on seasonal variation of the phytoplankton diversity were done by Waghmare & Kulkarni (2015) in Lendi River, Maharashtra and by Bhatnagar & Bhardwaj (2013) in Chambal River at Kota barrage, Rajasthan, India. In the present work, maximum number of 36 algal species were found at site 2 (Wazirabad) followed by site 1 (Hiranki) with 21 algal species and site 5 (Okhla village) with 19 algal species. The least number of 11 algal species were found at site 4 (near Nizammudin), and 18 algal species at site 3 (ISBT). The members of Chlorophyceae were dominated at site 1 (Hiranki), site 2 (Wazirabad) and site 3 (near ISBT). Green algae were seen the least at site 4 (near Nizammudin) and site 5 (Okhla village) of the river. Cyanophyceae dominated at site 3 (near ISBT), site 4 (near Nizammudin) and site 5 (Okhla village). Diatoms are dominant at site 2 (Wazirabad) followed by site 1 (Hiranki). Members of Euglenineae were present at site 4 (near Nizammudin) and site 5 (Okhla village) (Fig. 3). Algae in the Yamuna River inhabit all the aquatic habitats of the water column and are most dominant in the illuminated surface zone.

During the present study, freshwater algal biodiversity of River Yamuna in different seasons was recorded, and it was observed that the number of algal species was highest in summer, followed by spring, winter and monsoon seasons. The present study is the first attempt to explain the seasonal algal diversity of River Yamuna in Delhi region. The data presented in this study will help in creating the framework for further studies of river algal diversity which will be very beneficial for limnological studies and consequent conservation of the rivers.

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