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# DIVERSITY AND SYSTEMATIC ACCOUNT OF GENUS *ANABAENA* (Bory) IN RIVER GANGA AT KANPUR, UP, INDIA

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## ABSTRACT

The present study based on the systematic account of genus *Anabaena* (Bory) found in five sampling stations of river Ganga at Kanpur, between Bithoorghat to Jajmaughat, during the period from February 2018 to January 2019. During the present study 09 species of *Anabaena* (Bory) have been identified from different sampling stations of river Ganga at Kanpur. The identified species were *Anabaena ambigua* (Rao, C. B.), *Anabaena circinalis* Rabenhorst ex Born et Flah., *Anabaena fertilissima* (Rao, C. B.), *Anabaena flos-aquae* (Lyngb.) Brebission ex Bornet et Flahault. *Anabaena iyengarii* (Bharadwaja), *Anabaena iyengarii var. tenuis* (Rao, C.B.), *Anabaena oscillariodes* Bory ex Bornet et Flahault., *Anabaena sphaerica* Bornet et Flahault. and *Anabaena variabilis* (Kuetzing) ex Bornet et Flahault.

## INTRODUCTION

The cyanobacteria are most primitive and ancient group of photosynthetic organisms. They also known as Blue Green Algae and are primary source of oxygen for aquatic environments. Cyanobacteria inhabit miscellaneous aquatic environments ranging from Antarctic lakes and nutrient-poor oceans to highly nutrient rich lakes, ponds and rivers. In subtropical and tropical climates, cyanobacteria may dominate at any time, and may persist throughout the year (Wetzel, 1983; Huisman, *et al.,* 2005; Huisman and Hulot, 2005). They possess gas vacuoles, allowing buoyancy and facilitating the formation of blooms (Walsby, 1994). Cyanobacterial blooms are frequently toxic (Sivonen and Jones, 1999), thus, they pose health risks for humans and other domestic animals. They cause an aesthetic problem, and reduce the recreational value of water (Kuiper-Goodmann, *et al.,* 1999). Cyanobacteria gain a vital position in global nutrient cycling especially due to their inherent capacity to fix atmospheric $CO_2$ and $N_2$ through Rubisco and nitrogenase enzymes respectively (Sinha, *et al.*, 1995; 1997).

India is a rich biodiversity country of the world, having almost all kinds of climatic conditions, with a wide array of plants and microbes. The total 40,000 species of algae reported from all over the world and about 6500 species are found in India. Of these 1,500 species belong to 150 genera of cyanobacteria (Litavitis, 2002). It is very interesting that about 20 -30% of the total carbon fixed on the earth is attributed to cyanobacteria only.

In India the first identified cyanobacteria was *Calothrix indica* from Assam (Montagne, 1849) and Kirtikar (1886) was the first Indian to record any alga. Ghose made a series of

publications (1919, 1923, 1926, 1927a, b) and widely contributed to our knowledge on the Indian Blue-green algae. Bhardwaja (1933) has done extensive investigations on Indian blue-green algae. Bhardwaja (1935) and his co-researchers (Singh, RN, 1939a,b; Singh, VP, 1941; Rao, CB, 1936,1937, 1938a,b; Rao, CS, 1939, 1940; Parukutty, 1939, 1940) have further contributed to our knowledge on cyanobacterial flora of India. The present investigation deals the systematic account of genus *Anabaena* (Bory) from five sampling stations of River Ganga at Kanpur during the period February 2013 to January 2014.

## MATERIALS AND METHODS

The samples were collected from five different sampling stations (Bithoorghat, Ranighat, Sarsaiyaghat, Golaghat and Jajmaughat) of River Ganga at Kanpur at monthly intervals through the plankton net and simultaneously preserved in 5% formalin for further studies. Identification of different genera and species of cyanobacteria has been made by using standard texts and monographs *i.e.* Desikachary, 1959; Prescott 1962 etc. on the basis of their structures and measurements (Camera Lucida Diagrams).

## RESULTS

During the present studies the total 09 species of Anabaena have found from different sampling stations of river Ganga at Kanpur (Table 1) and their systematic enumeration have been given below.

**Table 01:** Occurrence of *Anabaena sp*. in different Ghats of River Ganga at Kanpur UP.

| S. No. | Species of Cyanobacteria | I | II | III | IV | V |
|---|---|---|---|---|---|---|
| 1. | *Anabaena ambigua* | + | + | + | - | + |
| 2. | *A. circinalis* | + | + | - | + | + |
| 3. | *A. fertilissima* | + | - | + | - | - |
| 4. | *A. flos-aquae* | - | - | + | + | + |
| 5. | *A. iyengarii* | + | + | - | + | + |
| 6. | *A. iyengarii var. tenuis* | + | + | + | + | + |
| 7. | *A. oscillariodes* | - | - | + | + | + |
| 8. | *A. sphaerica* | - | + | + | + | + |
| 9. | *A. variabilis* | + | + | + | + | + |

(I=Bithoorghat; II=Ranighat; III=Sarsayaghat; IV=Golaghat; V=Jajmaughat) (+ = present; - = Absent)

**SYSTEMATIC ENUMURATION**

DIVISION: CYANOPHYTA CLASS: CYANOPHYCEAE ORDER: NOSTOCALES FAMILY: NOSTOCACEAE
SUB-FAMILY: ANABAENAE GENUS: ***ANABAENA***
SPECIES: *A. ambigua, A. circinalis, A. fertilissima, A. flos-aquae, A. iyengarii,*
*A. iyengarii var. tenuis, A. oscillariodes, A. sphaerica, A. variabilis*

**Genus *ANABAENA* (Bory)**

Trichomes uniformly broad throughout or apices alone somewhat attenuated, sheath absent or more or less diffluent, forming a free, torn or floccose or soft mucilaginous thallus; heterocysts generally intercalary; spores single or in long series, formed from near the heterocysts or in between the heterocysts.

***Anabaena ambigua* (Rao, C. B.) Desikachary (1959) Pg. 400, Pl.76, Fig.2.**

**Figure 04**

Trichomes free or completely enclosed in a mucilaginous envelope or sheath, straight or bent, ends slightly tapering, end cells with rounded apices; cells barrel shaped with deep constrictions at the joints, septa indistinct; heterocysts at intervals, almost spherical; spores normally ellipsoidal or cylindrical with rounded ends.

**Dimension**: Cells 5-7µ broad and 3.5-5.5µ long; diameter of heterocyst 6.5-8.5µ; spore 8.5- 10.5µ broad and 13.5-15.6µ long.

***Anabaena circinalis* Rabenhorst ex Born et Flah. Desikachary (1959) Pg. 414, Pl.77, Fig.2.**

**Figure 08**

Thallus frothy floating; trichome mostly circinate, seldom straight, generally without sheath; cells barrel shaped or spherical, somewhat shorter than broad; heterocysts subspherical; spores cylindrical.

**Dimension**: Trichome 8.6-13.5µ broad; heterocyst 8.4-9.8µ broad; spore 16.8-17.6µ broad and 25-35µ long.

***Anabaena fertilissima* (Rao, C. B.) Desikachary (1959) Pg. 398, Pl.74, Fig.1.**

**Figure 02**

Trichomes single, straight or bent, with almost rounded end cells; cells barrel-shaped; heterocysts almost spherical; spores in long chains, often making the whole trichome sporogenous, adjoining the heterocysts but formed centrifugally, almost spherical, with a smooth hyaline outer wall.

**Dimensions:** Trichomes 4.6-5.5µ broad; cells 4.5-8.5µ long; heterocysts 6.5-8.5µ broad; spores 4.5-7.5µ broad and 3.5-8.5µ long.

***Anabaena flos-aquae* (Lyngb.) Brebission ex Bornet et Flahault. Desikachary (1959) Pg. 414-415.**

**Figure 09**

Thallus foamy, mucilaginous, lubricous, free-floating, bluish in colour; trichome circinate and without sheath; cells ellipsoidal or spherical, as long as broad; heterocyst ellipsoidal; spore colourless or yellowish, often surrounded by a wide gelatinous sheath.

**Dimension**: Trichome 4.5-7.5µ broad; cells 6-8µ long; heterocyst 5.5-8.7µ broad and 7.5-10.4µ long; spore 8.5-12.8µ broad and 22-38µ long.

***Anabaena iyengarii* (Bharadwaja). Desikachary (1959) Pg. 406, Pl.78, Fig.2.**

**Figure 07**

Trichome single or irregularly curved; end cells conical with rounded apex; cells barrel-shaped; heterocysts barrel-shaped, rarely spherical; spores ellipsoidal often in long or short chains, rarely single or on both sides of the heterocysts.

**Dimensions:** Trichome 5.5-6.5µ broad; cells 5.8-7.3µ long; heterocysts 7.5-8.5µ broad and 7.5- 9.7µ long; spores 8.5-10.0µ broad and 15.5-20.5µ long.

***Anabaena iyengarii var. tenuis* (Rao, C.B.) Desikachary (1959) Pg. 408, Pl.76, Fig.1.**

**Figure 05**

Thallus floccose, thin, pale blue-green; trichomes single, straight or irregularly curved; end cells conical with rounded apices; cells barrel-shaped; heterocysts more or less barrel shaped, sometimes spherical; spores ellipsoidal, or cylindrical, with rounded ends, single or in pairs on either side of a heterocysts.

**Dimensions:** Trichome 3.5-5.2µ broad; cells 3.5-6.5µ long; heterocysts 4.5-6.5µ broad and 6.5- 8.8µ long; spores 8.5-9.5µ broad and 10.5-18.5µ long.

***Anabaena oscillariodes* Bory ex Bornet et Flahault. Desikachary (1959) Pg. 417, Pl.71, Fig.7.**

**Figure 03**

Thallus gelatinous, dark green; cells barrel-shaped, end cells rounded; heterocysts spherical or oval; spores on both sides of the heterocysts; single or 2-3, at first oval, later rounded cylindrical. **Dimensions:** Trichomes 4.5-5.7µ broad; cells 4.2-5.4µ long; heterocysts 6.0-8.0µ broad and 6.5-9.6µ long; spores 8.3-9.6µ broad and 22-39µ long.

***Anabaena sphaerica* Bornet et Flahault. Desikachary (1959) Pg. 393.**

**Figure 01**

Thallus floccose, blue-green; trichomes moniliform, straight, arranged parallel, with an indistinct mucilaginous sheath; cells spherical or short barrel shaped; end cells rounded; heterocysts subspherical; spores on one or both sides of heterocyst, subspherical or oval.

**Dimension**: Trichome 5.5-6.5µ broad; heterocyst 6.5-7.5µ broad; spores 10-12µ broad and 13- 17µ long.

***Anabaena variabilis* (Kuetzing) ex Bornet et Flahault. Desikachary (1959) Pg. 410-411, Pl.71, Fig.5.**

**Figure 06**

Thallus mucilaginous, dark blue-green; trichomes without sheath, flexuous, slightly constricted at the cross walls, end cells conical, obtuse; cells barrel shaped; heterocysts oval or spherical; spores formed centrifugally, not contiguous with the heterocyst.

**Dimension**: Trichome 4.5-5.5µ broad; cells 3-6µ long; heterocyst 4-6µ broad and 7-8µ long; spore 7.5-9.5µ broad and 10-14µ long.

**Figures**: *Anabaena ambigua* (01), *Anabaena circinalis* (02), *Anabaena fertilissima* (03), *Anabaena flos-aquae* (04), *Anabaena iyengarii* (05), *Anabaena iyengarii* var. *tenuis* (06), *Anabaena oscillariodes* (07), *Anabaena sphaerica* (08), *Anabaena variabilis* (09).

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