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Research Article

DIVERSITY OF CYANOBACTERIA FROM BARASAT, KOLKATA, WEST BENGAL, INDIA

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ABSTRACT
Cyanobacteria or blue-green algae are one of the most successful life forms in the world. They can thrive in any conditions ranging from fresh water, saline water, brackish water and even in polluted water bodies of urban areas. As they are important primary producers, they play significant role in biogeochemical cycles. Although many works have been done on the biodiversity of cyanobacteria, reports of cyanobacteria from Kolkata and adjacent areas are scarce. Knowledge of cyanobacterial diversity is important for better understanding of the ecosystems of these areas. Thus, the present study deals with cyanobacterial diversity in Barasat, Kolkata. Thirty Cyanobacterial taxa belonging to eleven genera have been reported. Out of these genera *Microcystis* and *Phormidium* show dominance and the species recorded are being reported first time from this area.

Keywords: *Diversity, Cyanobacteria, Barasat, Kolkata*

INTRODUCTION
Cyanobacteria also known as blue-green algae are autotrophs and amongst the most successful and oldest life forms present (Schopf, 2000; Gademan and Portman, 2008). These organisms are important primary producers and play significant roles in biogeochemical cycles of nitrogen, carbon and oxygen (38% of the annual oxygen production on earth) (Karl *et al*., 2002; DeRuyter and Fromme, 2008). Favourable environmental and economic aspects and largely unharnessed potentials make cyanobacteria a promising future resource (Sharma *et al.*, 2011). Cyanobacteria are promising tool for the removal of heavy metals from single as well as from multimetal containing waste waters (Mehta and Gaur, 2005). They are considered to be one of the potential organisms which can be useful to mankind in various ways (Thajuddin and Subramaniam, 2005). Cyanobacteria are a highly diverse group, largely unexplored and untapped therefore, provide an opportunity for discovery of novel biochemicals and its use by mankind (Skulberg, 2000; Rosenberg *et al.*, 2008). Whilst the rate of discovery of natural products from other microbes is decreasing, the potential of Cyanobacteria still remains largely unexplored (Sharma *et al.*, 2011). The exploration of Cyanobacteria or blue-green algae in and around Kolkata is yet to receive much attention. The investigation on algae in Kolkata and adjacent areas are reported by Biswas (1925, 1926, 1932 a, b); Sen and Gupta (1987, 1993); Santra (1987), Chakraborty *et al.*, (2010), Ghosh *et al.*, (2012) and Talai-Mukhorpadhyay and Naskar (2013). The works on Cyanobacteria in Kolkata are rather scanty. The objective of this study was to investigate the diversity of Cyanobacteria in Barasat, Kolkata.

MATERIALS AND METHODS
The study area Barasat is the district head quarter of North 24-parganas district as well as one of the oldest town of West Bengal, India. Barasat is located at a distance of about 25Km from Kolkata and on the northern side of Kolkata which comes under greater Kolkata. Barasat town is 34.50 sq. km with 32 wards. The climate of Barasat is Tropical, Monsoon June to September, Winter November to February and humid during Summer Temperature 40°C in May (Max) and 10°C in Jan (Min), relative humidity between 55% in March and 98% in July, rainfall 1579mm (normal), population density of 1480 persons per sq.km. Barast town with latitude 88°48'N and langitute 22°70'E.
The algal samples were collected during summer and winter (2010-2012) from different spots (figure 1) as epipelic, epiphytic and planktonic forms. The sampling spots were 20 in numbers (Figure 1) which was

one km distance from one spot to another spot. The samples were preserved in 4% formaldehyde solution. The samples were deposited to the PG Dept. of Botany, Barasat Govt. College. The documentation was performed by preparing slides and observed under compound microscope. The camera lucida drawings and measurement were made for identification. Identification have been made upto the species level following monograph and literature of Desikachary (1959); Hamad (2008); Islam and Irfanullah (2005) and Talai-Mukhopadhyay and Naskar (2013).

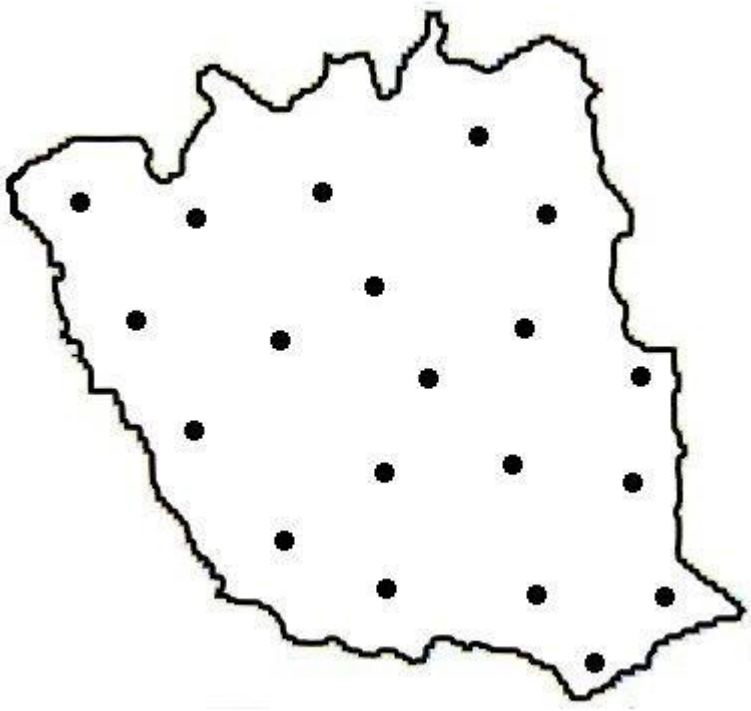

Figure 1: Map of Barasat indicating the sites of collection of algae

RESULTS AND DISCUSSION

Results

In all 30 Cyanobacterial taxa were documented. The algae are shown in figure 2. These taxa are described below.

1. ***Microcystis bengalensis*** Banerji

Desikachary 1959, p.89, pl. 19, figs 5,6

Colonies irregularly branched, margins of mucilage indistinct, cells sapherical, gas vacuoles with the cells, 2.7 – 7µ diameter.

2. ***M. protocystis*** Crow.

Desikachary 1959, p.91, pl. 20, figs 4

Talai-Mukhopadhyay and Naskar, 2013, p.3, fig 1

Colonies irregular and diffuse, mucilage of colony not clearly delimited, cells spherical, 3.2 – 6.3µ in diameter with gas vacuoles.

3. ***M. flos-aquae*** (Wittr.) Kirchner

Desikachary 1959, p.94, pl. 17,18, figs 11

Colonies elongate or slightly spherical, cells 3 – 7.2µ in diameter with gas vacuoles.

4. ***M. pulverea*** (Wood) Forti

Desikachary 1959, p.96

Colonies rounded to ellipsoidal, colonial mucilage distinct; cell ellipsoidal or spherical and closely arranged, 2-3.1µ broad, no gas vacuoles.

5. ***M. orissica*** West, W.

Desikachary 1959, p. 97, pl. 20, fig 2

Colony almost round or ellipsoidal, mucilage distinct, cells short ellipsoidal, 0.6-0.8µ in diameter.

6. ***M. aeruginosa*** Kütz.

Desikachary 1959, p. 17, pl. 17, fig 1, 2, 6 and pl. 18, fig. 10

Colonies round, colonial mucilage hyaline, cells 3-7 µ in diameter, spherical and gas vacuoles present.

7. ***Chroococcus minor*** (Kütz) nag

Desikachary 1959, p. 105, pl. 24, fig. 1

Thallus slimy and gelatinous, dirty blue-green, cells spherical, 2.9-4.1 µ in diameter, singly and in pairs, sheath colourless.

8. ***Aphanocapsa pulchra*** (Kütz.) Rabenh

Desikachary 1959, p. 132, pl. 21, fig 2

Thallus homologous, blue-green, cells saphерical, 3.2-4.6 µ diameter, loosely arranged.

9. ***A. banaresensis*** Bharadwaja

Desikachary 1959, p. 133, pl. 22, fig 8.

Cells oval or spherical, 4.1-6.3 µ in diameter, sheath thick, hyaline, closely adpressed to the cells, almost thick 1 µ.

10. ***Aphanothece pallida*** (Kütz.) Rabenh

Desikachary 1959, p. 140-141, pl. 22, fig 3

Thallus gelatinous, soft, brownish, cells oblong or cylindrical, 3-7.8 µ broad.

11. ***Johannesbaptistia pellucida*** (Dickie) Taylor et Drouet.

Desikachary 1959, p. 165, pl. 32, figs 14-19.

Filaments straight, blue-green, cells discoid, arranged in a single series, hyaline mucilage. cells 3.7-5.1 µ broad and 2.4-3.8 µ long.

12. ***Oscillatoria obscura*** Bruhl et Biswas

Desikachary 1959, p. 207

Trichome 4µ broad, apex attenuated, rounded, blue-green not constricted at the cross walls, cells about 1/6 as long as broad.

13. ***O. laete-virens*** (Crouan) Gomont

Desikachary 1959, p. 213, Hamed 2008, p.12, pl. III, fig.9

Trichome yellowish green, straight, constricted at the cross walls, 3.2-5.1µ broad, apices attenuated, cells nearly as long as broad, 2.4 – 5.1µ long.

14. ***O. princeps*** Vaucher ex Gomount

Desikachary 1959, p. 210, pl. 37, figs 1,10,11,13,14

Hamed 2008, p.12, pl III, fig. 15.

Trichomes blue-green or brownish, 15-57µ broad, cells 1/12 – 1/5 as long as broad, 3.6 -7.2 µ long, end cells flatly rounded.

15. ***Phormidium fragile*** (Meneghni) Gomount

Desikachary 1959, p.253, pl. 44, figs. 1-3.

Trichomes constricted at the cross walls, ends attenuated, 1.3-2.4 µ broad, cells quardrate, 1.2-3.1 µ long.

16. ***P. angustissimum*** W. et G.S. West

Desikachary 1959, p.253

Thrichomes bent, ends not attenuated, 0.5-0.8µ broad, cells cylindrical, 2-7 mostly, 4-5 times as long as broad.

17. ***P. foveolarum*** (Mont.) Gumont

Desikachary 1959, p.254

Trichome dark-green, cross walls constricted, cells almost quadrate, shorter than broad, 0.9-1.9µ long, end cell rounded.

18. ***P. molle*** (Kütz.) Gomont
Desikachary 1959, p.255, pl. 59, figs. 8
Trichome straight, light blue-green, constricted at the cross walls, cells cylindrical, shorter or longer than broad, 3.2-7.9µ long, end cell rounded.
19. ***P. abronema*** Skuja
Desikachary 1959, p.257
Filaments coiled, trichome 3.2-4.6 broad, end cell attenuated slightly, constricted at the cross walls, cells barrel-shaped, ¾ - 2 times as long as broad, end cells conical.
20. ***P subincrustatum*** Fritsch et Rich
Desikachary 1959, p.267
Trichomes 5.1-6.6µ broad, ends not attenuated, not constricted at the cross walls, end cells rounded to conical.
21. ***P. autumnale*** (Ag.) Gomont
Desikachary 1959, p.276, pl. 44, figs. 24,25
Trichomes blue-green, cross walls not constricted, cells quadrate, ½ as long as broad, 2.1-5.1µ long, end cell rounded with calyptra.
22. ***Lyngbya spiralis*** Geitter
Desikachary 1959, p.289, pl. 48, fig. 1
Trichome blue-green, 4.6-5.1µ broad, cells 1/3 to ½ as long as broad, 1.5-2.6µ long, outer wall not thickened.
23. ***L. heironymusii*** Lemm
Desikachary 1959, p.297, pl. 48, fig. 4
Islam and Irfanullah, 2005, p. 36, pl.1, fig. 4
Filaments 12-15.1µ broad, sheath firm, cells 10.7-12.8µ broad, 2.3-3.9µ long, end cell broadly round.
24. ***L. lachneri*** (Zimmermann) geitler
Desikachary 1959, p.281
Filaments attached, hyaline sheath, trichome 2.4-3.5µ broad, cross-walls constricted, cells 1.5-3.1µ long
25. ***L. lutea*** (Ag.) Gom.
Desikachary 1959, p.310, pl. 52, figs. 9
Filaments coiled, yellowish brown, colourless sheath, trichome not constricted, 2.6-6.1µ broad, cells quadrate to 1/3 times as long as broad, 1.5-5µ long, end cell with calyptra.
26. ***Anabaena sphaeria*** Bornet et Flahault
Desikachary 1959, p.393
Trichomes moniliform, straight, 5.1-6.2µ broad, cells spherical to short barrel-shaped, heterocysts subspherical to oval, 8.1-12.2µ broad, 12.1-18.1µ long.
27. ***A. variabilis*** Kutzing ex Born. et Flah.
Desikachary 1959, p.410, pl. 71, fig. 5
Trichome 4.1-6.1µ broad, cells barrel shaped, 2.5-6.1µ long, heterocysts oval, 6.1µ broad, 8.1µ long.
28. ***A. flos-aquae*** (Lyngb) Brib. ex Born. et Flah
Desikachary 1959, p.414
Trichomes 4.1 - 8.2µ broad, cells as long as broad or longer, 6-9µ long, heterocysts 4 - 9.2µ broad, 6.1 - 10.1µ long.
29. ***Camptylonemopsis minor*** Desikachary
Desikachary 1959, p.444, pl. 84, figs. 1-5
Filaments 3.8 – 7.8µ broad, sheath thin, trichome with heterocysts, 2.7 – 5.3µ broad, cells spherical 3.8 - 9.1µ long, heterocysts intercalary 3.8 – 6.8µ broad, 5.1 – 10.4µ long.
30. ***Scytonema dilatatum*** Bharadwaja
Desikachary 1959, p.465, pl. 89, fig. 5

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Filaments curves, entangled 14.2 – 18.7µ broad, trichomes broadening towards apices. 8.3 - 9.4µ broad, cells quadrate, heterocysts ellipsoidal, 5.3 – 11.4µ broad, 5.3 – 18.2µ long.

Discussion

The present study area represents a unique habitat of Cyanobacteria. A total 30 species of Cyanobacteria under 11 genera was recorded.

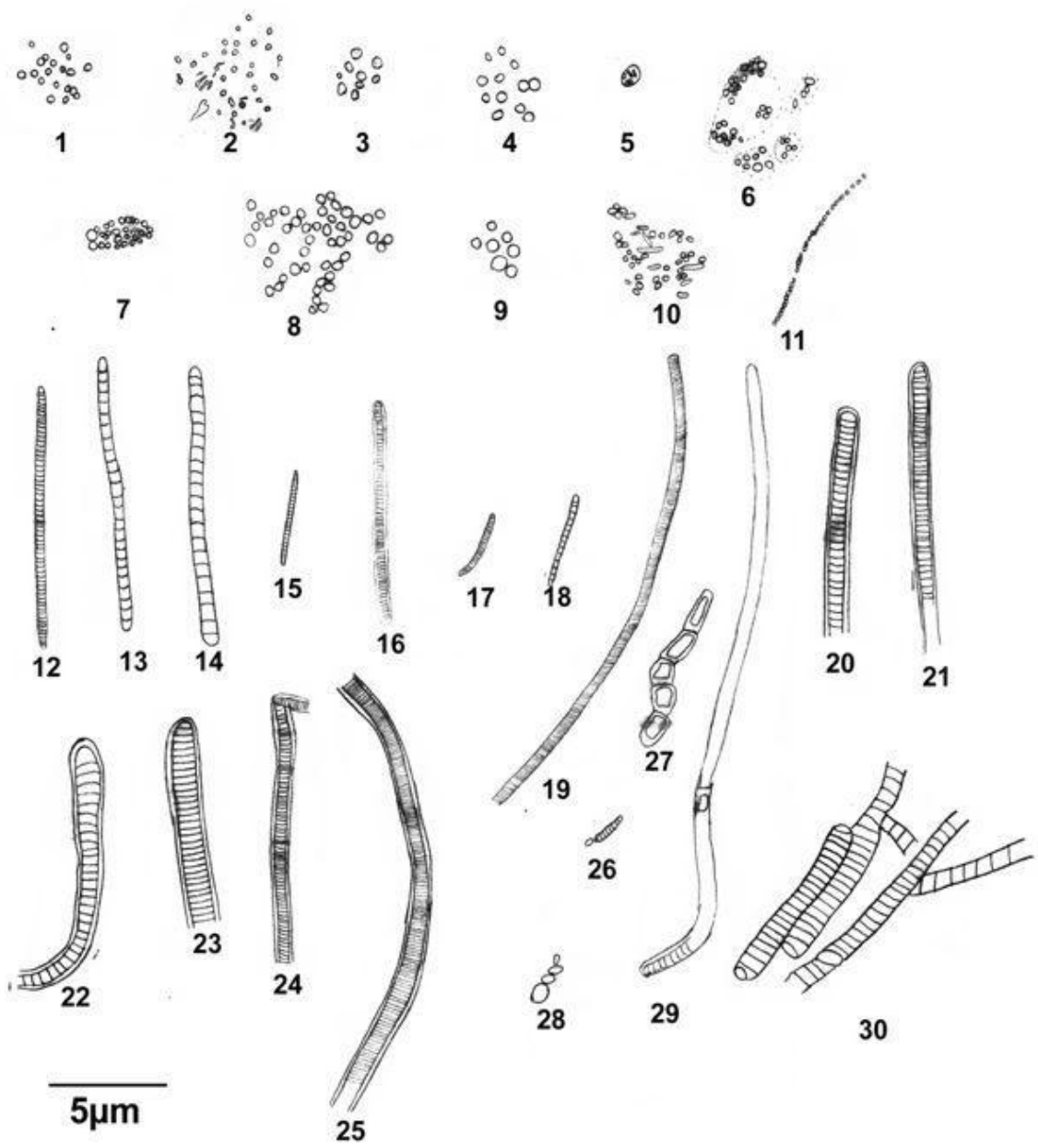

Figure 2: Name of algae found in this study. 1) *Microcystis bengalensis*, 2) *M. protocystis*, 3) *M. flos-aquae*, 4) *M. pulverea*, 5) *M. orissica*, 6) *M. aeruginosa*, 7) *Chroococcus minor*, 8) *Aphanocapsa pulchra*, 9) *A. banaresensis*, 10) *Aphanothece pallida*, 11) *Johannesbaptistia pellucida*, 12) *Oscillatoria obscura*, 13) *O. laete-virens*, 14) *O. princeps*, 15) *Phormidium fragile*, 16) *P. angustissimum*, 17) *P. foveolarum*, 18) *P. molle*, 19) *P. abronema*, 20) *P. subincrustatum*, 21) *P. autumnale*, 22) *Lyngbya spiralis*, 23) *L. heironymusii*, 24) *L. lachneri*, 25) *L. lutea*, 26) *Anabaena sphaeria*, 27) *A. variabilis*, 28) *A. flos-aquae*, 29) *Camptylonemopsis minor* and 30) *Scytonema dilatatum*

The relative abundance of the taxa are noticed where the genera *Microcystis* and *Phormidium* were maximum.The genera *Lyngbia, Oscillatoria* and *Anabaena* were next to the number as compare to *Microcystis* and *Phormidium*. The other genera *viz. Chrococcus, Aphanocapsa, Aphanothece, Johannesbaptistia, Camptylonemopsis* and *Scytonema* represent few. In this investigation all genera are from fresh water habitats and it is worthy to mention that the genera *viz. Camptylonemosis* and *Scytonema* were not recorded from saline habitat but other genera recorded in this study were found to grow in saline habitat (Naskar and Naskar, 2010). In general, it is difficult to strictly segregate Cyanobacteria in to saline and fresh water species (Thajuddin and Subrammaniam, 2005) where high percentages of species which were originally reported from fresh water sources by Desikachary (1959) were also marine.

The identified Cyanobacteria in this investigation are microscopic, although large colonies or mats are quite conspicuous. Colonies or masses of various shapes of cells are arranged in rows resulting in flat plate or spherical colonies which are enclosed in gelatinous sheath. Filamentous forms produce a row of cells, referred to as trichome. The trichome with the enclosing sheath is known as a filament. Some filamentous species are differentiated by cell structures and form heterocysts.

Cyanobacteria are considered as organisms of academic curiosity or as organisms of nuisance value. Therefore, in tropical countries like India, it is imperative to understand and preserve the diversity of Cyanobacteria in yet unexplored habitats but also to gainfully exploit it for various applications including pollution abatement.

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