Research Article

Diversity of Non-Heterocystous Filamentous Cyanobacteria from Freshwater Bodies of Bidhannagar, North 24 Parganas, West Bengal

Harisankar Dey*, Sandip Chakraborty

PG Department of Botany, Ramakrishna Mission Vivekananda Centenary College (Autonomous), Rahara, Kolkata, West Bengal, INDIA.

Submission Date: 11-11-2020; Revision Date: 30-11-2020; Accepted Date: 07-12-2020

ABSTRACT

Cyanobacteria are morphologically diverse group of pioneer oxygenic phototrophic prokaryotes with characteristics in common to both bacteria and algae that originated 3.5 billion years ago and distributed in all possible biotopes of the world. They are ubiquitous found in clean and polluted waters of lakes, ponds and reservoirs, in fresh or salt waters and in stagnant or flowing waters. Whereas some cyanobacteria are unicellular, others grow as chains of cells termed trichome's or filaments. Bidhannagar subdivision is a high density of population around 6,500/km^2, situated in the district of North 24 Parganas, West Bengal with a vast area of about 33.10 km^2 and giving rises many freshwater ponds, drains and canals which are the main reservoirs of different types of microalgae and cyanobacteria. An attempt has been made to study the diversity of non-heterocystous filamentous cyanobacteria from freshwater bodies of Bidhannagar subdivision in the district of North 24 Parganas, West Bengal (Figure 1 A- C). During this investigation around 140 samples were collected randomly from free floating and stagnant freshwater ponds, drains and canals of different municipalities (Figure 1C-G) during the year 2019. In this study altogether 32 non-heterocystous filamentous cyanobacterial forms belonging to 4 genera were characterized and enumerated (Figure 2-3 and Table 1). Most of them occur in free floating, submerged and attached forms (Figure 1D-G). The most common and dominant cyanobacterial genera were *Oscillatoria* representing 28 species followed by *Spirulina* 2 and *Phormidium*, *Lyngbya* each with 1 species.

Key words: Diversity, Cyanobacteria, Freshwater, Bidhannagar, West Bengal.

Correspondence:
Dr. Harisankar Dey
Assistant Professor, PG Department of Botany, Ramakrishna Mission Vivekananda Centenary College (Autonomous), Rahara, Kolkata-700118, West Bengal, INDIA.

Phone no: +91-8981232212
Email: harisankardey@gmail.com

INTRODUCTION

Cyanobacteria are extraordinarily diverse group of Gram-negative, oxygenic photosynthetic prokaryotes that originated 3.5 billion years ago and distributed in all possible biotopes of the world. Due to their occurrence in diverse habitats, these organisms are excellent materials for investigation by Ecologists, Physiologists, Biochemists, Microbiologists and Biotechnologists. In many environments, cyanobacteria are the primary producers at the base of the food web of the ecosystem, viz. marine waters; hypersaline; brackish waters; soda lakes, freshwater, paddy fields, soils; deserts, cave walls, hot springs, Polar Regions and other extreme environments. In India, as well as in many countries, the importance of cyanobacteria has been realized since long. Cyanobacteria possess a number of unique biological characteristic and they are considered to be one of the potential organisms which can be useful to mankind in various ways, cyanobacteria have tremendous potential in environmental management as soil conditioners, biofertilizers, biomoniters of soil fertility, water quality, amelioratory agents aiding in the reclamation of saline and user lands and rehabilitation of degraded ecosystems through biosorption of metals, feeds for animals and protein supplements, production of biofuels, production of NH_3 for scrubbing the excess

SCAN QR CODE TO VIEW ONLINE

www.ajbls.com

DOI: 10.5530/ajbls.2020.9.58

atmospheric CO_2 and other gases causing the Green house effects, production of hydrogen, production of hydrocarbon, production of various secondary metabolites, vitamin, toxin and other therapeutic substances.[1-5] In India many workers have been worked on systematic survey and quantitative enumeration of freshwater cyanobacteria.[6-16]

Literature reveals that very little works has been done on the systematic survey and quantitative enumeration of freshwater cyanobacteria in West Bengal. Cyanobacteria from freshwater bodies of West Bengal were studied by very few workers.[17-21] But no extensive work has been done to study the diversity of cyanobacteria from freshwater habitats in the district of North 24 Parganas, West Bengal.

Bidhannagar subdivision is a high density of population around 6,500/km^2, situated in the district of North 24 Parganas, West Bengal with a vast area of about 33.10 km^2 and giving rises many freshwater ponds, drains and canals which are the main reservoirs of different types of microalgae and cyanobacteria. As no detailed information is available on freshwater cyanobacterial diversity of this district of West Bengal, an attempt has been made to study the diversity of non-heterocystous filamentous cyanobacteria from freshwater bodies of Bidhannagar subdivision in the district of North 24 Parganas, West Bengal.

MATERIALS AND METHODS

Study Area

The studies were conducted from different freshwater bodies of Bidhannagar subdivision in the district of North 24 Parganas, West Bengal (Figure 1 A - C) during the year 2019. Bidhannagar subdivision is situated in the district of North 24 Parganas, West Bengal with covering a vast area of about 33.10 km^2 and giving rise many municipal freshwater ponds, drains and canals which are the main reservoirs of different types of microalgae and cyanobacteria.

Sample Collection, Isolation and Identification

Cyanobacterial samples were collected from different freshwater bodies of Bidhannagar subdivision in the district of North 24 Parganas, West Bengal (Figure 1D - G). The sampling were done randomly from both the free floating and attached to the surface of the substratum. Sampling were done with the help of fine forceps, scalpel, sampling bottles and clean polythene bags, then immediately brought to the laboratory assigned with numbers and collection date for record in the field note book before they are processed. At the sampling sites we also measured water pH by universal pH paper and temperature by thermometer. Temporary slides were prepared for each sample for identification (Figure 1H) and were observed under trinocular research microscope with attachment of digital camera and computer with software (Olympus CH20i and Carl Zeiss Primo Star Microscope). The samples were identified based on their morphological features like colour of thallus, cell shape and cell size (Figure 2 and 3) following the standard monographs.[22-28]

Purification, Maintenance and Preservation of the Samples

Pure culture was obtained by serial dilution and agar plate methods.[29] The samples were maintained by culturing in freshly prepared BG-11±N medium (Figure 1I) both in solid and liquid culture.[30] A part of each collected cyanobacterial samples were preserved in 4% formaldehyde solution and were also deposited in the Phycology laboratory, P.G. Department of Botany, Ramakrishna Mission Vivekananda Centenary College for future references.

RESULTS

Cyanobacterial diversity from freshwater habitats of district North 24 Parganas, West Bengal, more specifically

A, B & C : Maps showing different collection sites of Bidhannagar Subdivision, (W. B)
D, E, F & G: Mode of occurrences & distributions of different freshwater cyanobacteria.
H : Isolation and identification of freshwater filamentous cyanobacteria.
I : Maintenance and preservation of pure culture both in liquid and solid medium.

Figure 1: Map of study sites, mode of occurrence, Identification and Pure Culture.

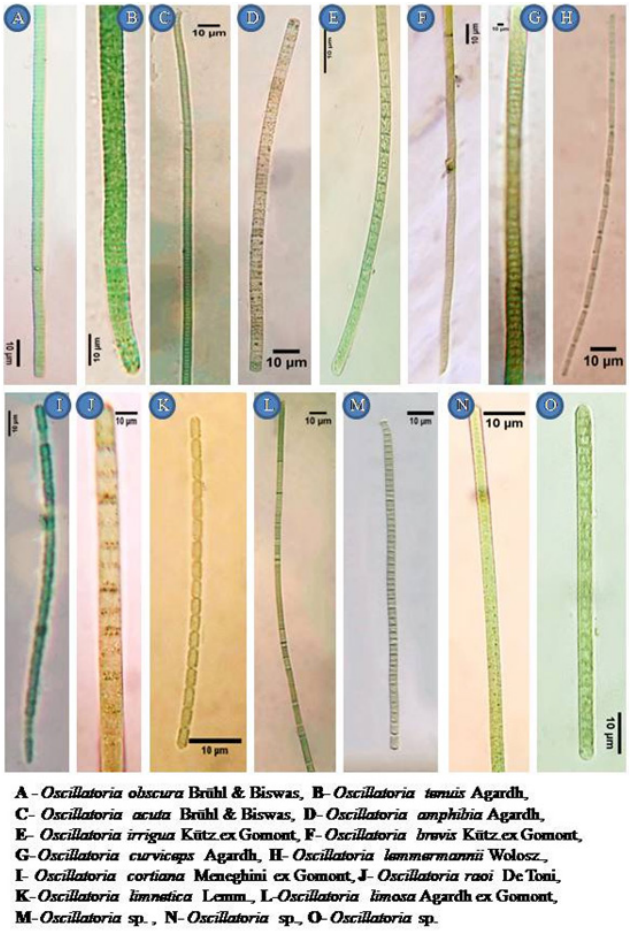
Table 1: Enumeration and mode of occurrence of freshwater filamentous cyanobacteria.

Sl. No.	Figure	Cyanobacterial type	Mode of occurrence
01	Figure 2-A	*Oscillatoria obscura* Brühl and Biswas	Free floating
02	Figure 2-B	*Oscillatoria tenuis* Agardh	Substratum attached
03	Figure 2-C	*Oscillatoria acuta* Brühl and Biswas	Submerged
04	Figure 2-D	*Oscillatoria amphibia* Agardh	Free floating
05	Figure 2-E	*Oscillatoria irrigua* Kütz. ex Gomont	Substratum attached
06	Figure 2-F	*Oscillatoria brevis* Kütz. ex Gomont	Attached with soil
07	Figure 2-G	*Oscillatoria curviceps* Agardh	Free floating
08	Figure 2-H	*Oscillatoria lemmermannii* Wolosz.	Submerged, soil attached
09	Figure 2-I	*Oscillatoria cortiana* Meneghini ex Gomont	Attached with substratum
10	Figure 2-J	*Oscillatoria raoi* De Toni	Attached with substratum
11	Figure 2-K	*Oscillatoria limnetica* Lemm.	Free floating
12	Figure 2-L	*Oscillatoria limosa* Agardh ex Gomont	Submerged, soil attached
13	Figure 2-M	*Oscillatoria* sp.	Free floating
14	Figure 2-N	*Oscillatoria* sp.	Submerged, soil attached
15	Figure 2-O	*Oscillatoria* sp.	Attached with substratum
16	Figure 3-A	*Oscillatoria pseudogeminata* Schm.	Free floating
17	Figure 3-B	*Oscillatoria* sp.	Submerged
18	Figure 3-C	*Oscillatoria princeps* Vaucher	Free floating
19	Figure 3-D	*Oscillatoria amoena* Kützing ex Gomont	Submerged, soil attached
20	Figure 3-E	*Oscillatoria splendida* Greville	Free floating, submerged
21	Figure 3-F	*Oscillatoria subbrevis* Schmidle	Submerged, soil attached
22	Figure 3-G	*Oscillatoria chalybea* Gardner	Attached with soil
23	Figure 3-H	*Oscillatoria* sp.	Free floating
24	Figure 3-I	*Oscillatoria claricentrosa* Gardner	Free floating, submerged
25	Figure 3-J	*Oscillatoria terebriformis* Agardh	Submerged
26	Figure 3-K	*Oscillatoria* sp.	Free floating
27	Figure 3-L	*Lyngbya major* Meneghini ex Gomont	Attached with soil
28	Figure 3-M	*Spirulina major* Kützing ex Gomont	Submerged, soil attached
29	Figure 3-N	*Spirulina subsalsa* Oersted ex Gomont	Free floating
30	Figure 3-O	*Phormidium anomala* Rao C.B.	Free floating
31	Figure 3-P	*Oscillatoria* sp.	Submerged
32	Figure 3-Q	*Oscillatoria* sp.	Attached with substratum

the freshwater bodies of Bidhannagar subdivision remains unexplored. An attempt has been made to study the diversity of non-heterocystous filamentous cyanobacteria from freshwater bodies of Bidhannagar subdivision in the district of North 24 Parganas, West Bengal (Figure 1A-C). During this investigation around 140 samples were collected randomly from free floating and stagnant water ponds, drains and canals of different municipalities (Figure 1C- G) during the year 2019. The pH and temperature of water bodies were measured from free floating, stagnant ponds, drains and canals of different municipalities that ranges from 6.8 to 8.0 and 25°C to 37°C respectively. In this study altogether 32 non-heterocystous filamentous cyanobacterial forms belonging to 4 genera were characterized and enumerated (Figure 2-3 and Table 1). Most of them occur in free floating, submerged and attached forms (Figure 1D - G). The most common and dominant non-heterocystous filamentous cyanobacterial genera were *Oscillatoria* representing 28 species followed by *Spirulina* 2 and *Phormidium*, *Lyngbya* each with 1 species.

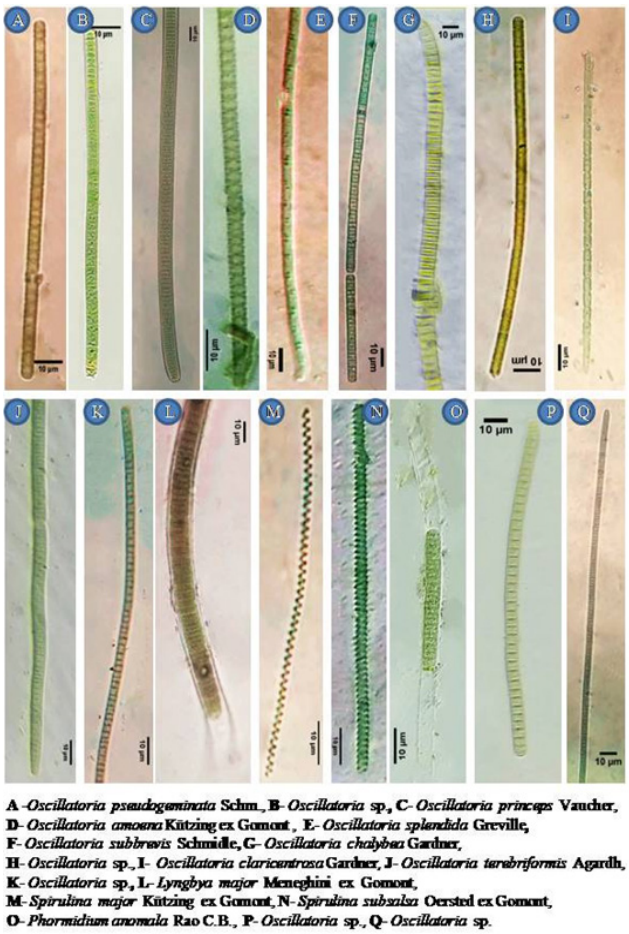
DISCUSSION

Cyanobacteria and microalgae are the main primary producers in all kinds of water bodies, enrichments of the microalgal nutrients in water through organic effluents



A - *Oscillatoria obscura* Brühl & Biswas, B- *Oscillatoria tenuis* Agardh,
C- *Oscillatoria acuta* Brühl & Biswas, D- *Oscillatoria amphibia* Agardh,
E- *Oscillatoria irrigua* Kütz.ex Gomont, F- *Oscillatoria brevis* Kütz.ex Gomont,
G- *Oscillatoria curviceps* Agardh, H- *Oscillatoria lemmermannii* Wolosz.,
I- *Oscillatoria cortiana* Meneghini ex Gomont, J- *Oscillatoria raoi* De Toni,
K- *Oscillatoria limnetica* Lemm., L- *Oscillatoria limosa* Agardh ex Gomont,
M- *Oscillatoria* sp., N- *Oscillatoria* sp., O- *Oscillatoria* sp.

Figure 2: Microphotographs of Freshwater Filamentous Cyanobacteria.



A- *Oscillatoria pseudogeminata* Schm., B- *Oscillatoria* sp., C- *Oscillatoria princeps* Vaucher,
D- *Oscillatoria amoena* Kützing ex Gomont, E- *Oscillatoria splendida* Greville,
F- *Oscillatoria subbrevis* Schmidle, G- *Oscillatoria chalybea* Gardner,
H- *Oscillatoria* sp., I- *Oscillatoria claricentrosa* Gardner, J- *Oscillatoria terebriformis* Agardh,
K- *Oscillatoria* sp., L- *Lyngbya major* Meneghini ex Gomont,
M- *Spirulina major* Kützing ex Gomont, N- *Spirulina subsalsa* Oersted ex Gomont,
O- *Phormidium anomala* Rao C.B., P- *Oscillatoria* sp., Q- *Oscillatoria* sp.

Figure 3: Microphotographs of Freshwater Filamentous Cyanobacteria.

like domestic sewage, urban runoff, industrial effluents and farm water are the main nutritional resources for growth of cyanobacteria and other microalgae in municipal area. Among all the environmental factors municipal wastewater and soil pH is found to be an important property that determines the more abundance of cyanobacteria. All the sampling sites harbour of cyanobacteria during different seasons. The occurrence of cyanobacterial population may be due to favourable growing habitats. Among different physico-chemical properties, soil water pH is a very important factor in growth, establishment and diversity of cyanobacteria, which have generally been reported to prefer neutral to slightly alkaline pH for optimum growth.[31] In the present investigation it was recorded that in all the sampling sites the pH were almost neutral indicating favourable condition for growth of cyanobacteria.

In the present study almost all the freshwater bodies of Bidhannagar subdivision in the district of North 24 Parganas showed neutral to slightly alkaline pH which is the main important factors for abundance of numerous filamentous non-heterocystous cyanobacteria strains. These were reported to be common occurrence in freshwaters as planktonic forms and sometime grow in abundant forming so called algal blooms. In many instances waterlogged fields provide an ideal habitat for these cyanobacteria. In many instances it have been reported that acidic pH decreases cyanobacterial population and there are few reports on the existence of cyanobacteria at low pH.[32] As suggested, cyanobacteria favour neutral to alkaline pH for its optimum growth. Similar, result has also been reported on abundance from Indian rice fields.[33] Despite the preference for neutral to alkaline environments, acidic soil do exhibit low cyanobacterial diversity.

CONCLUSION

Cyanobacteria are a fascinating group of Gram-negative, oxygenic photosynthetic prokaryotes that distributed in all possible biotopes of the world. The systematic survey and quantitative enumeration of filamentous cyanobacteria from freshwater bodies of West Bengal were studied. In the present investigation

the filamentous non-heterocystous cyanobacteria from freshwater bodies of Bidhannagar subdivision in the district of North 24 Parganas, West Bengal was studied and a total of 32 members of cyanobacterial species were recorded. The most common and dominant cyanobacterial genera were *Oscillatoria* representing 28 species followed by *Spirulina* 2 and *Phormidium, Lyngbya* each with 1 species. Due to their occurrence in diverse habitats and possess a number of unique biological characteristics they are considered to be one of the potential organisms which can be useful to mankind in various ways. For wider exploitation and success the coordinated strategic research efforts in the laboratory and at field level are highly essential.

ACKNOWLEDGEMENT

The authors are also thankful to the Principal, Ramakrishna Mission Vivekananda Centenary College (Autonomous), Rahara, Kolkata, West Bengal for providing necessary laboratory facilities for carrying out the work.

FUNDING

The corresponding author is very much thankful to DHESTBT, Govt. of West Bengal for funding.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

ABBREVIATIONS

BG: Blue Green; **DHESTBT:** Department of Higher Education Science & Technology and Biotechnology.

REFERENCES

1. Singh RN. Reclamation of usar lands in India through blue- green algae. Nature. 1950;165(4191):325-6.
2. Singh RN. Role of blue green algae in nitrogen economy of Indian agriculture. Indian Council of Agricultural Research, New Delhi. 1961.
3. Borowitzka MA. Microalgae as sources of pharmaceuticals and other biologically active compounds. J Appl Phycol. 1995;7(1):3-15.
4. Rai LC, Singh S, Pradhan S. Biotechnological potential of naturally occurring and laboratory growth Microcystis in biosorption of Ni^{2+} and cd^{2+}. Curr Sci. 1998;74:461-4.
5. Thajuddin N, Subramanian G. Cyanobacterial biodiversity and potential applications in biotechnology. Curr Sci. 2005;89(1):47-57.
6. Subhashini D, Kaushik BD. Amelioration of sodic. Soils with blue-green algae. Australian J Soil Res. 1981;19(3):361-6.
7. Singh PK, Bisoyi RN. Blue Green Algae in rice fields. Phykos. 1989;28(1-2):181.
8. Saikia P, Bordoloi RPM. Blue green algal flora from the rice fields of Assam. Phykos. 1994;33(1-2):53-7.
9. Singh NI, Singh NS, Devi GA, Singh SM. Cyanobacterial flora of rice field soils of Tripura. Phykos. 1997;36(1-2):121-6.
10. Adhikary SP. Cyanobacteria germplasm of Orissa state maintained at the Department of Botany, Utkal University. Plant Sci Res. 1998;20:57-63.
11. Ahmed SU, Kalita MC, Deka M, Hazarika SBM. Distributi-onal pattern of blue green algae in rice field soils of Nagaon sub-division. Phykos. 1999;38(1-2):101-7.
12. Digambar RB, Srinivas D, Padmaja O, Rani K. Blue-green algae of rice fields of South Telangana region, Andhra Pradesh. Indian Hydrobiology. 2008;11(1):9-83.
13. Dey HS, Bastia AK. Cyanobacterial Flora from rice growing areas of Mayurbhanj. Plant Sci Res. 2008;30(1-2):22-6.
14. Dey HS, Bastia AK. Taxonomic Enumeration of Nostocacean Cyanobacteria from Rice Field Soils of Northern Orissa, India. Journal of Seaweed Research and Utilisation. 2012;34:191-204.
15. Dey HS, Tayung K, Bastia AK. Occurrence of Nitrogen-Fixing Cyanobacteria in Local Rice Fields of Orissa, India Ecoprint. 2010;17:77-85.
16. Deep PR, Bhattacharyya S, Nayak B. Cyanobacteria in Wetlands of the Indusrtialized Sambalpur District of India. Aquatic Biosystems. 2013;9(1):14.
17. Pal TK, Santra SC. Contribution to the Cyanophyceae of Murshidabad. Phykos. 1982;21:150-2.
18. Sikdar J, Keshri JP. The genus *Oscillatoria* vaucher (Oscillatoriales: Cyanoprokaryota) in West Bengal, India. Int J Cur Res Rev. 2014;6(21):47.
19. Mondal D, Pal J. Diversity of Cyanophyceae in the Mirik Lake of Darjeeling Himalaya, India. International Journal of Science and Research. 2014;3(12):2080-3.
20. Roy S, Debnath M, Ray S. Cyanobacterial flora of the geothermal spring at Panifala, West Bengal, India. Phykos. 2014;44(1):1-8.
21. Mukhopadhyay ST, Naskar N. Diversity of cyanobacteria from Barasat, Kolkata, West Bengal, India. IJIRR. 2015;107-13.
22. Desikachary TV. Cyanophyta. Indian Council of Agric Res New Delhi. 1959;686.
23. Anand N. Hand book of blue-green algae. Pub Bishen Singh Mahendra Pal Singh, Dehra Dun. 1989;77.
24. Anagnostidis K, Komarek J. Modern approach to the classification system of Cyanophytes, 3-Oscillatoriales. Arch Hydrobiol Suppl. 1988;80:327-472.
25. Anagnostidis K, Komarek J. Modern approach to the classification system of Cyanophytes, 5-Stigonematales. Arch Hydrobiol Suppl. 1990;86:1-73.
26. Komarek J, Anagnostidis K. Modern approach to the classification system of Cyanophytes, 2-Chrococales. Arch Hydrobiol Suppl. 1986;73:157-266.
27. Komarek J, Anagnostidis K. Modern approach to the classification system of Cyanophytes, 4 - Nostocales. Arch Hydrobiol Suppl. 1989;82:247-345.
28. Komarek J, Anagnostidis K. Cyanoprokaryota-2.Teil/2nd Part: Oscillatoriales. Elsevier/Spektrum. 2005;19(2):759
29. Kaushik BD. Laboratory Methods for Blue Green Algae. Associated Publishing Company. New Delhi. 1987.
30. Rippka R, Deruelles J, Waterbury JB, Herdman M, Stainer RY. Generic assignments, strains histories and properties of pure culture of cyanobacteria. J Gen Microbiol. 1979;111(1):1-61.
31. Kaushik BD. Algalization of rice in salt-affected soils. Annales of Agricultural Research. 1994;14:105-6.
32. Dominic TK, Madhusoodanan PV. Cyanobacteria from extreme acidic environments. Curr Sci. 1999;77(8):1021-2.
33. Nayak S, Prasanna R. Soil pH and its role in cyanobacterial abundance and diversity in rice field soils. Applied Ecology and Environmental Research. 2007;5(2):103-13.

Cite this article: Dey HS, Chakraborty S. Diversity of Non-Heterocystous Filamentous Cyanobacteria from Freshwater Bodies of Bidhannagar, North 24 Parganas, West Bengal. Asian J Biol Life Sci. 2020;9(3):386-90.