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Diversity of Cyanobacteria from freshwater bodies of Chowberia, North 24 Parganas, West Bengal, India

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Abstract

It's fascinating that we searched occurrence and types of cyanobacteria presented at my village Chowberia, Bongaon Block in North 24 Parganas in West Bengal. Population density is low; more or less 26000 people lived in Chowberia. Cyanobacteria indeed have diverse applications and play important roles in various ecosystems, including paddy fields, surfaces on rocks, damp soil, and decaying house walls. This diversity of habitats suggests that cyanobacteria are adapted to a wide range of environmental conditions. The aim of this study was to investigate the prevalence and diversity of cyanobacterial species in the Chowberia area. 32 samples were selected of total randomly collected samples from various environments such as paddy fields, drains, damp walls, rock surfaces, etc. The collected samples were then identified, and the relative abundance of different cyanobacterial genera was quantified. The results revealed the presence of various cyanobacterial organisms, with the following distribution:

Oscillatoria sp.: 11 organisms, *Phormidium* sp.: 8 organisms, *Cylindrospermum* sp.: 5 organisms *Anabaena* sp.: 2 organisms, *Lyngbya* sp.: 2 organisms, *Calothrix* sp.: 1 organism, *Nostoc* sp.: 1 organism, *Microcystis* sp.: 1 organism, *Gloeothece* sp.: 1 organism

Based on the data obtained, it was deduced that *Oscillatoria* was the dominant cyanobacterial genus in the Chowberia area, with the highest percentage of occurrence among the identified species. This investigation sheds light on the cyanobacterial community composition in Chowberia and highlights the prevalence of *Oscillatoria* in the studied ecosystem. The relative abundance and diversity of cyanobacterial species have been characterized, contributing to our understanding of the microbial ecology in this region.

Key words: Diversity, Cyanobacteria, Freshwater, Chowberia

1. Introduction

Cyanobacteria are originated 3.5 billion egos in the earth that are Gram negative prokaryotes and occurrences in various habits such as marine waters, brackish waters, soda lakes, fresh water, paddy fields, soils, hot springs etc. While some cyanobacteria are indeed known to grow at temperatures around 65°C to 68°C [19]. Cyanobacteria have chlorophyll a (many have chlorophyll b & d), phycobiliprotein, glycogen etc. Cyanobacteria are known for their ability to perform oxygenic photosynthesis. This process is crucial for maintaining the oxygen levels in the Earth's atmosphere and supporting many other organisms. In addition to their ecological significance, cyanobacteria have several practical applications; some cyanobacteria can fix atmospheric nitrogen and convert it into a form that plants can use as a nutrient. This can enhance soil fertility and reduce the need for chemical fertilizers. Certain cyanobacteria are rich in proteins, vitamins, and other nutrients, making them a potential source of nutritional supplements and functional foods. Cyanobacteria produce a variety of bioactive compounds that have potential pharmaceutical and medicinal application. Researchers are exploring the use of cyanobacteria for the production of biofuels, such as biodiesel and bioethanol. Cyanobacteria can serve as indicators of water quality. Their presence and abundance can provide insights into the health of aquatic ecosystems. Some cyanobacteria produce secondary metabolites that have ecological roles and potential applications. However, certain cyanobacterial species can also produce toxins that pose a risk to aquatic life and human health. Cyanobacteria are a source of various phytochemicals, which are chemical compounds produced by plants that may have health benefits.

Literature reveals that a handful of scientists or researchers of West Bengal have worked on cyanobacteria such as Biswas (1925) [2] toiled on road slimes of Calcutta. Banerji (1938) [1] worked few cyanoprokaryotes of adjoining area from Calcutta. Jana and Sarkar (1971) [8] worked cyanoprokaryotes in Bakreshwar. Mukhopadhyay and Chatterjee (1981) [11] reported on cyanoprokaryota in the rice field of 24 Pargana district. Pal and Santra (1982) [13] toiled on

Murshidabad district. Sen et al. (1987, 1998) [16][17] reported on Gangetic planes of West Bengal. Santra et al (1988) [15] provided information on cyanoprokaryotes of sa-line habitats. Sen and Naskar(2003)[18] reported on the flo-ra unusual habitats of Sundarban . Sinha and Mukerjee (1975a, 1975b) [20] investigated the cyanoprokar-yota of Bankura district. Some scientists are Gupta (1975) [7], Brühl and Biswas (1922a, 1922b)[3], Naskar et al., 2008[12], Chakraborty et al. (2010)[4] and Keshri & Chatterjee (2010)[10], Dey et al.(2020)[6] ,There is no extensive work has been occurred at North 24 Parganas.

The studies were conducted from different Freshwater bodies Of chowberia, a small village under the subdivision, of North 24 Parganas West Bengal, which is 65 km from state capital Kolkata. Chowberia covers a vast area of 25.4 km^2. Lies in the eastern side of the state lies in between latitude 22.9165 and longitude 88.82165 with average elevation 14 meters . Chowberia bounded by Bhagirathi River on the west side and Ichamati River on West side and the Nadia district on the North side and South 24 Parganas district on South side of the State (fig-1). A portion of the east forms the boundary with Bangladesh. Due to the presence Yamuna River (local name) was surrounded by chowberia, this river the soil type is alluvial and agricultural is main source of income.

2. Methodology

Study area

Chowberia is a Gram Panchayet area of North 24 Parganas district in India state of West Bengal. It consists of chowberia 1 Gram Panchayet. Coordinates :- latitude 22.9165 and longitude 88.82165 , Country :- India , State :- West Bengal , District :- North 24 Parganas , Area :-25.4 km2 , Population :- 26000.

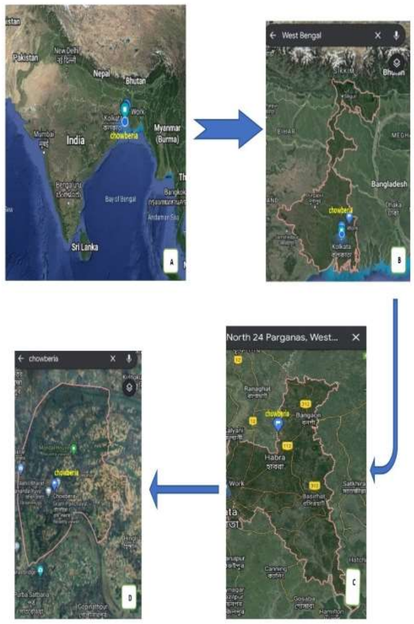


Figure:-1 (A-D) showing the position of chowberia within north 24 Parganas district of Indian state of West Bengal

Figure: - 2: -Mode of occurrence of samples (A-G); Collection various places in Chowberia (H-I).

Collection and identification of samples

Samples were collected from different types of freshwater bodies, including rivers, drains, ponds, and rice fields, located in Chowberia, North 24 Parganas (fig-2). This suggests a diverse range of habitats were sampled to capture a comprehensive view of the microbial life in the area. Fine forceps, a scalpel, sampling bottles, and clean polythene bags were used for collecting the samples. These tools would ensure aseptic and contamination-free collection of specimens. Upon collection, each sample was immediately assigned a unique number and the collection date was recorded in a field notebook. This documentation helps in keeping track of the collected samples and their associated information. At the sampling sites, water pH was measured using universal pH paper. Monitoring pH can provide insights into the water's acidity or alkalinity, which could impact the types of organisms present. Temporary slides were prepared for each collected sample(fig-3). This likely involved placing a small portion of the sample on a microscope slide and covering it with a cover slip. These slides were then observed under a bright-field microscope, which is a standard type of light microscope used for viewing samples that allow light to pass through them. The samples were identified based on their morphological features. This could involve observing characteristics like the color of thallus (a plant body in algae), cell shape, cell size, shape of heterocysts (specialized cells in some cyanobacteria), and akinetes (dormant, thick-walled cells) helped by Desikachary (1959) [5]. The identification process seems to have been guided by established monographs, which are detailed written works providing descriptions and classifications of organisms.

Purification, Maintenance and Preservation of the Samples

Pure culture was obtained by serial dilution and agar plate methods (Kaushik., 1987)[9]. The samples were managed by culturing in freshly groomed BG-11±N medium both in solid and liquid culture (Rippka et al., 1979)[14]. A part of each collected cyanobacterial samples were conserved in 4% form aldehyde solutionand was also deposited in the Phycology laboratory, P.G. Department of Botany, Ramakrishna Mission Vivekananda Centenary College for future references.

Figure: -3 Slide preparations

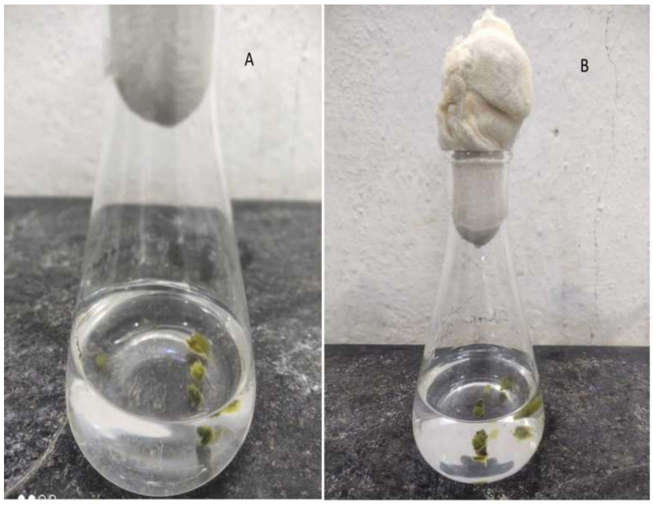


Figure: - 4(A-B) Culture media BG-11±N with cyanobacteria

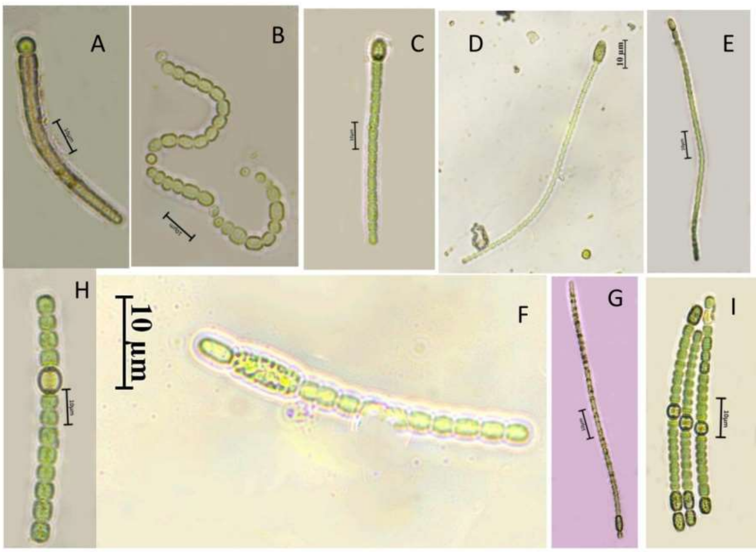
3. Results

Cyanobacteria are a type of photosynthetic bacteria that can be found in various aquatic environments. The results of the study indicated the presence of several cyanobacterial species, with different levels of abundance. Here's a breakdown of the findings:

Oscillatoria sp. - 11 organisms, *Phormidium* sp. - 8 organisms, *Cylindrospermum* sp. - 5 organisms, Anabaena sp. - 2 organisms, *Lyngbya* sp. - 2 organisms, *Calothrix* sp. - 1 organism, *Nostoc* sp. - 1 organism , *Microcystis* sp. - 1 organism, *Gloeothece* sp. - 1 organism.

From these results, it was determined that *Oscillatoria* was the dominant genus among the identified cyanobacterial species in the Chowberia area. It had the highest number of occurrences compared to other genera. This dominance suggests that *Oscillatoria* is well-suited to the environmental conditions of Chowberia and plays a significant role in the local ecosystem.

The study provides valuable insights into the composition of the cyanobacterial community in Chowberia. By characterizing the relative abundance and diversity of different cyanobacterial species, the research contributes to our understanding of microbial ecology in this specific region. This type of information is crucial for assessing the health of aquatic ecosystems, understanding nutrient cycles and potentially predicting any ecological changes or imbalances that might occur due to cyanobacterial dominance.



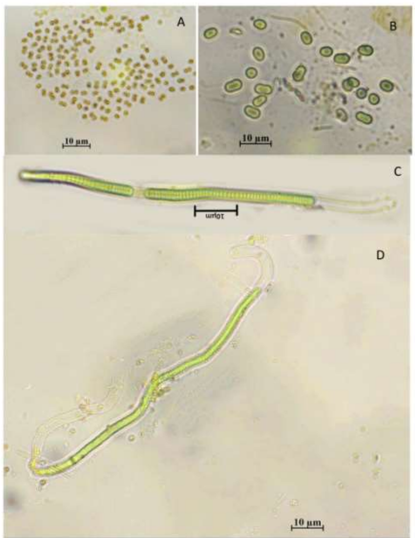
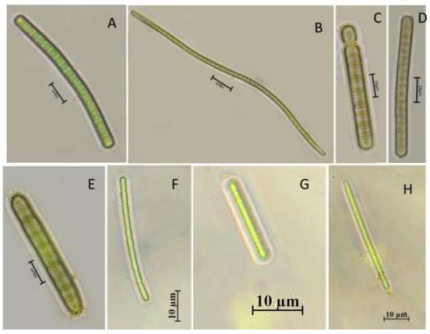


Figure: - 5(A-I):- Microphotographs of heterocystous cyanobacteria.

A. *Calothrix stellaris* Bornet & Flahault , **B.** *Nostoc commune* vaucher ex Bornet & Flahault , **C.** *Cylindrospermum* sp. , **D.** *Cylindrospermum* sp. , **E.** *Cylindrospermum michailovskoense* Elenkin , **F.** *Cylindrospermum muscicola* Kützing ex Bornet & Flahault , **G**. *Cylindrospermum stagnale* Bornet & Flahault , **H.** *Anabaena oryzae* F.E.Fritsch , **I.** *Anabaena anomala* F.E.Fritsch

Gomont Figure: - 8(A-D):- Microphotographs of non heterocystous cyanobacteria.

A. *Microcystis aeruginosa* (Kützing) Kützing , **B.** *Gloeothece samoensis* Wille , **C.** *Lyngbya ceylanica* Will e , **D**. *Lyngbya lagerheimii*



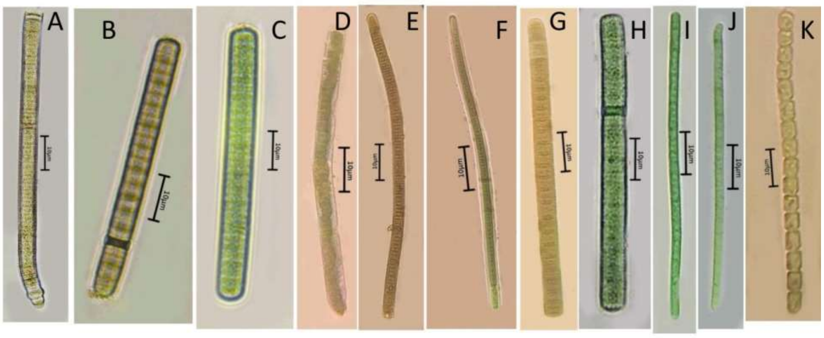


Figure: -7 (A-H):- Microphotographs of non heterocystous cyanobacteria.

A. *Phormidium anomalum* C.B.Rao, **B**. *Phormidium tenue* Gomont , **C.** *Phormidium stagninum* C.B.Rao , **D.** *Phormidium lucidum* Kützing ex Gomont , **E.** *Phormidium* sp. , **F.** *Phormidium mucosum* N.L.Gardner , **G**. *Phormidium* sp**.**, **H.** *Phormidium foveolarum* Gomont

Figure: - 8(A-K):- Microphotographs of non heterocystous cyanobacteria.

A. *Oscillatoria anguina* Bory ex Gomont , **B.** *Oscillatoria curviceps* C.Agardh ex Gomont , **C.** *Oscillatoria subbrevis* Schmidle , **D**. *Oscillatoria limosa* C.Agardh ex Gomont , **E.** *Oscillatoria princeps* Vaucher ex Gomont , **F.** *Oscillatoria splendida* Greville ex Gomont , **G.** *Oscillatoria raoi* G.De Toni, nom. illeg. , **H**. *Oscillatoria amoena* Gomont **, I.** *Oscillatoria obscura* Brühl & Biswas , **J.** *Oscillatoria acula* Brühl & Biswas , **K.** *Oscillatoria limnetica* Lemmermann

TABLE:-1
ENUMERATION AND MODE OF OCCURRENCE OF FRESHWATER FILAMENTOUS CYANOBACTERIA

SL NO	FIGURE	CYANOBACTERIA TYPE	MODE OF OCCURRENCE
1	FIGURE 5-A	*Calothrix stellaris* Bornet & Flahault	paddy field, soil attached
2	FIGURE 5-B	*Nostoc commune* vaucher ex Bornet & Flahault	paddy field, soil attached
3	FIGURE 5-C	*Cylindrospermum* sp.	paddy field, soil attached
4	FIGURE 5-D	*Cylindrospermum* sp.	paddy field, soil attached
5	FIGURE 5-E	*Cylindrospermum michailovskoense* Elenkin	paddy field, soil attached
6	FIGURE 5-F	*Cylindrospermum muscicola* Kützing ex Bornet & Flahault	paddy field, soil attached
7	FIGURE 5-G	*Cylindrospermum stagnale* Bornet & Flahault	paddy field, soil attached
8	FIGURE 5-H	*Anabaena oryzae* F.E.Fritsch	paddy field, soil attached
9	FIGURE 5-I	*Anabaena anomala* F.E.Fritsch	paddy field, soil attached
10	FIGURE 6-A	*Phormidium anomalum* C.B.Rao	submerged
11	FIGURE 6-B	*Phormidium tenue* Gomont	free floating
12	FIGURE 6-C	*Phormidium stagninum* C.B.Rao	submerged
13	FIGURE 6-D	*Phormidium lucidum* Kützing ex Gomont	soil attached
14	FIGURE 6-E	*Phormidium* sp.	submerged
15	FIGURE 6-F	*Phormidium mucosum* N.L.Gardner	soil attached
16	FIGURE 6-G	*Phormidium* sp.	submerged
17	FIGURE 6-H	*Phormidium foveolarum* Gomont	free floating
18	FIGURE 7-A	*Oscillatoria anguina* Bory ex Gomont	rock attached
19	FIGURE 7-B	*Oscillatoria curviceps* C.Agardh ex Gomont	wall attached
20	FIGURE 7-C	*Oscillatoria subbrevis* Schmidle	submerged
21	FIGURE 7-D	*Oscillatoria limosa* C.Agardh ex Gomont	paddy field, soil attached
22	FIGURE 7-E	*Oscillatoria princeps* Vaucher ex Gomont	wall attached
23	FIGURE 7-F	*Oscillatoria splendida* Greville ex Gomont	free floating
24	FIGURE 7-G	*Oscillatoria raoi* G.De Toni, nom. illeg.	soil attached
25	FIGURE 7-H	*Oscillatoria amoena* Gomont	submerged
26	FIGURE 7-I	*Oscillatoria obscura* Brühl & Biswas	soil attached
27	FIGURE 7-J	*Oscillatoria acula* Brühl & Biswas	rock attached
28	FIGURE 7-K	*Oscillatoria limnetica* Lemmermann	soil attached
29	FIGURE 8-A	*Microcystis aeruginosa* (Kützing) Kützing	free floating
30	FIGURE 8-B	*Gloeothece samoensis* Wille	rock attached
31	FIGURE 8-C	*Lyngbya ceylanica* Wille	soil attached
32	FIGURE 8-D	*Lyngbya lagerheimii* Gomont	rock attached

4. Discussion

The widespread distribution and potential applications of cyanobacteria, as well as their role in nutrient balance and their prevalence in the Chowberia area of the North 24 Parganas district. Cyanobacteria indeed have significant ecological and biotechnological importance. Cyanobacteria are found in various environments worldwide, including freshwater bodies like ponds, pools, rivers, gutters, drains, sewage water, as well as in marine waters. They can also be present in terrestrial habitats such as damp soil, paddy fields, decaying houses' walls, and even attached to calcareous rocks. Cyanobacteria are known to produce a variety of bioactive compounds. Due to their rapid growth rate, they are utilized in various biotechnological applications such as bioenergy production, natural product synthesis, medicine, agriculture, and environmental management. Cyanobacteria have the potential to produce lipids, which can be used as a source of biofuel. This can contribute to addressing the increasing demand for alternative and sustainable energy sources. Cyanobacteria play a crucial role in global nutrient cycling. They have the ability to fix carbon dioxide (CO_2) and nitrogen gas (N_2) from the atmosphere, using enzymes like ribulose-1,5-bisphosphate carboxylase/oxygenase (rubisco) and nitrogenase, respectively. This helps in maintaining nutrient balance in ecosystems. In your specific study area, Chowberia in the North 24 Parganas district, there seems to be an issue with nitrogen (N) imbalance. This could be due to various factors, including excess nutrient runoff, pollution, or other environmental changes. This imbalance might be contributing to the high growth rate of both heterocystous and non-heterocystous cyanobacteria in the area.

5. Conclusion

The studies conducted in Chowberia, North 24 Parganas have revealed a significant diversity of cyanobacteria. This is particularly noteworthy because no previous research had been conducted in this area regarding cyanobacteria diversity. The findings from these studies are expected to be of great value to researchers around the world, opening up new avenues for exploration and investigation in the field of cyanobacteria diversity. This previously unexplored area has the potential to contribute to our understanding of cyanobacteria and its ecological significance, as well as to inform various applications and studies related to this group of microorganisms. The research conducted in Chowberia could potentially lead to important discoveries, insights, and collaborations that could advance scientific knowledge and contribute to various fields of study.

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