Building evidence for conservation globally

Journal of Threatened Taxa

Open Access

10.11609/jott.2022.14.3.20703-20810
www.threatenedtaxa.org

26 March 2022 (Online & Print)
14(3): 20703–20810
ISSN 0974-7907 (Online)
ISSN 0974-7893 (Print)

ISSN 0974-7907 (Online); ISSN 0974-7893 (Print)

Publisher
Wildlife Information Liaison Development Society
www.wild.zooreach.org

Host
Zoo Outreach Organization
www.zooreach.org

No. 12, Thiruvannamalai Nagar, Saravanampatti - Kalapatti Road, Saravanampatti,
Coimbatore, Tamil Nadu 641035, India
Ph: +91 9385339863 | www.threatenedtaxa.org
Email: sanjay@threatenedtaxa.org

For Focus, Scope, Aims, and Policies, visit https://threatenedtaxa.org/index.php/JoTT/aims_scope
For Article Submission Guidelines, visit https://threatenedtaxa.org/index.php/JoTT/about/submissions
For Policies against Scientific Misconduct, visit https://threatenedtaxa.org/index.php/JoTT/policies_various

continued on the back inside cover

Cover: Rufous-headed Hornbill *Rhabdotorrhinus waldeni* © Philip Godfrey C. Jakosalem.

Journal of Threatened Taxa | www.threatenedtaxa.org | 26 March 2022 | 14(3): 20758–20772

ISSN 0974-7907 (Online) | ISSN 0974-7893 (Print)

https://doi.org/10.11609/jott.6754.14.3.20758-20772

#6754 | Received 30 September 2020 | Final received 09 December 2021 | Finally accepted 02 March 2022

OPEN ACCESS

COMMUNICATION

A checklist of blue-green algae (Cyanobacteria) from Punjab, India

Yadvinder Singh [1*], Gurdarshan Singh [2], D.P. Singh [3] & J.I.S. Khattar [4*]

[1,2] Department of Botany and Environmental Science, Sri Guru Granth Sahib World University, Fatehgarh Sahib, Punjab 140406, India.
[3,4] Department of Botany, Punjabi University, Patiala, Punjab 147002, India.
[1] yadbotany@gmail.com, [2] gurdarshanrangra@gmail.com, [3] dp.khokhar@rediffmail.com, [4] jisk_pbi@rediffmail.com
* (corresponding authors)

Abstract: A checklist of Cyanobacteria (Blue-green algae) has been made by reviewing available literature in order to contribute to the knowledge of biodiversity of algae in the Punjab state of India. The list records 317 taxa of the phylum Cyanobacteria distributed among 74 genera, 32 families, and six orders. The order Oscillatoriales has 115 taxa, followed by Nostocales (84), Synechococcales (60), Chroococcales (49), Spirulinales (8), and Pleurocapsales (1). The family Nostocaceae has the maximum number of genera followed by Microcoleaceae, Chroococcaceae, Oscillatoriaceae and other reported families. The genera with the highest number of species were *Phormidium* (39 species), *Lyngbya* (15 species), *Oscillatoria* (14 species), and *Leptolyngbya* & *Scytonema* (13 species each). The checklist revealed a high degree of species richness within phylum Cyanobacteria found in Punjab. This checklist can provide a baseline for future floristic studies with taxonomically updated/accepted name of genera/species of cyanobacteria.

Keywords: Algae, biogeography, cyanophyceae, diversity, documentation, inventory, taxonomy.

Punjabi: ਭਾਰਤ ਦੇ ਪੰਜਾਬ ਰਾਜ ਵਿੱਚ ਕਾਈ ਦੀ ਜੈਵ-ਵਿਭਿੰਨਤਾ ਦੇ ਗਿਆਨ ਵਿੱਚ ਯੋਗਦਾਨ ਪਾਉਣ ਲਈ ਉਪਲਬੱਧ ਲਿਟਰੇਚਰ ਦੀ ਸਮੀਖਿਆ ਕਰਕੇ ਸਾਇਨੋਬੈਕਟੀਰੀਆ (ਨੀਲੀ-ਹਰੀ ਕਾਈ) ਦੀ ਇੱਕ ਸੂਚੀ ਬਣਾਈ ਗਈ ਹੈ। ਸੂਚੀ ਵਿੱਚ ਸਾਇਨੋਬੈਕਟੀਰੀਆ ਦੇ 06 ਕੁਲਾਂ ਦੇ 32 ਪ੍ਰੀਵਾਰਾਂ ਦੀਆਂ 74 ਪ੍ਰਜਾਤੀਆਂ ਦੀਆਂ 317 ਕਿਸਮਾਂ (ਟੈਕਸਾ) ਨੂੰ ਸੂਚੀ ਬੰਦ ਕੀਤਾ ਗਿਆ ਹੈ। ਸੂਚੀ ਅਨੁਸਾਰ ਪੰਜਾਬ ਰਾਜ ਵਿੱਚ ਓਸੀਲੇਟੋਰੀਏਲਸ ਕੁਲ ਦੀਆਂ ਸਭ ਤੋਂ ਵੱਧ 115 ਕਿਸਮਾਂ ਹਨ, ਇਸ ਤੋਂ ਬਾਅਦ ਨੋਸਟੋਕੇਲਸ (84), ਸਿਨੇਕੋਕੋਕੇਲਸ (60), ਕਰੂਕੋਕੇਲਸ (49), ਸਪੀਰੂਲਿਨੇਲਜ਼ (8), ਅਤੇ ਪਲੀਰੋਕੈਪਸੇਲਸ (1) ਕੁਲ ਆਉਂਦੇ ਹਨ। ਨੋਸਟੋਕੇਸੀ ਪਰਿਵਾਰ ਦੀਆਂ ਸਭ ਤੋਂ ਵੱਧ ਪ੍ਰਜਾਤੀਆਂ ਸੂਚੀ ਵਿੱਚ ਸ਼ਾਮਿਲ ਹਨ। ਇਸ ਤੋਂ ਬਾਅਦ ਮਾਈਕ੍ਰੋਕੋਲੀਏਸੀ, ਕਰੂਕੋਕੇਸੀ, ਓਸੀਲੇਟੋਰੀਏਸੀ ਅਤੇ ਬਾਕੀ ਰਿਪੋਰਟ ਕੀਤੇ ਗਏ ਪਰਿਵਾਰਾਂ ਦੀ ਵਾਰੀ ਆਉਂਦੀ ਹੈ। ਸਭ ਤੋਂ ਵੱਧ ਜਾਤੀ ਵਾਲੀਆਂ ਪ੍ਰਜਾਤੀਆਂ ਫੋਰਮਿਡੀਅਮ (39 ਜਾਤੀਆਂ), ਲਿੰਗਬਿਆ (15 ਜਾਤੀਆਂ), ਓਸੀਲੇਟੋਰੀਆ (14 ਜਾਤੀਆਂ), ਅਤੇ ਲੈਪਟੋਲਿੰਗਬਿਆ ਅਤੇ ਸਾਇਟੋਨੇਮਾ (ਹਰੇਕ 13 ਜਾਤੀਆਂ) ਹਨ। ਇਸ ਸੂਚੀ ਅਨੁਸਾਰ ਪੰਜਾਬ ਵਿੱਚ ਪਾਏ ਜਾਣ ਵਾਲੇ ਸਾਇਨੋਬੈਕਟੀਰੀਆ ਦੀਆਂ ਜਾਤੀਆਂ ਵਿਚ ਉੱਚ ਪੱਧਰੀ ਵਿਭਿੰਨਤਾ ਹੈ। ਇਹ ਸੂਚੀ ਸਾਇਨੋਬੈਕਟੀਰੀਆ ਦੀਆਂ ਪ੍ਰਜਾਤੀਆਂ / ਜਾਤੀਆਂ ਦੇ ਟੈਕਸੋਨੋਮਿਕ ਤੌਰ 'ਤੇ ਅੱਪਡੇਟ ਕੀਤੇ/ਸਵੀਕਾਰ ਕੀਤੇ ਗਏ ਨਾਮਾਂ ਦੇ ਨਾਲ-ਨਾਲ ਭਵਿੱਖੀ ਫਲੋਰਿਸਟਿਕ ਅਧਿਐਨਾਂ ਲਈ ਅਧਾਰ ਪ੍ਰਦਾਨ ਕਰਦੀ ਹੈ।

Editor: K. Priyadarshani, Y.C. Institute of Science, Satara, India. **Date of publication:** 26 March 2022 (online & print)

Citation: Singh, Y., G. Singh, D.P. Singh & J.I.S. Khattar (2022). A checklist of blue-green algae (Cyanobacteria) from Punjab, India. *Journal of Threatened Taxa* 14(3): 20758–20772. https://doi.org/10.11609/jott.6754.14.3.20758-20772

Funding: Early career research grant (No. ECR/2017/001103) from SERB-DST, New Delhi to Yadvinder Singh (YS).

Competing interests: The authors declare no competing interests.

Author details: Dr. Yadvinder Singh is working as Assistant Professor (Botany) in Department of Botany and Environmental Science of Sri Guru Granth Sahib World University. He has published extensively on various aspects of extremophilic cyanobacteria, fresh water limnology and ecology, bioremediation potential of cyanobacteria, cyanobacterial systematics and phylogenetics. Mr. Gurdarshan Singh currently doing his PhD at Department of Botany and Environmental Science, Sri Guru Granth Sahib World University. He is doing his research work on the water quality and diversity of blue green algae (cyanobacteria) from the wetlands of Punjab, India. Prof. D.P. Singh is working as Professor (Botany) and Head in Department of Botany, Punjabi University, Patiala. He is the member of various professional bodies and organizations. He has published a number of research papers in journals of international repute and several book chapters, having more than 674 citations with 15 h-index and 22 i10-index. Prof. J.I.S. Khattar is working as Professor (Botany), Department of Botany, Punjabi University. He has published 65 research papers in reputed International Journals on various aspects of algae including the physiology & biochemistry of cyanobacteria, environmental microbiology, and cyanobacterial biotechnology. He was completed 07 research projects sponsored by various funding agencies. He has guided 27 Ph.D. and M.Phil. students in their research projects.

Author contributions: Conceptualization (YS, JISK & DPS), investigation (GS & YS), writing (GS), original draft (YS & GS), writing - review & editing (GS, YS, JISK & DPS).

Acknowledgements: The authors are thankful to the vice-chancellor, Sri Guru Granth Sahib World University, Fatehgarh Sahib, Punjab, India for providing laboratory facilities and SERB-DST, New Delhi for financial assistance in the form research project (ECR/2017/001103).

INTRODUCTION

Cyanobacteria, also known as Blue-green algae, are oxygenic photosynthetic prokaryotes belonging to the class Cyanophyceae. It has been estimated that these organisms originated nearly 3.5–3.8 billion years ago at the beginning of Archean era (Schopf 2002; Blank & Sanchez-Baracaldo 2010; Sleep 2010). Cyanobacteria occur in diverse range of aquatic and terrestrial habitats including extreme environments (Whitton & Potts 2000; Singh et al. 2014, 2018; Kimambo et al. 2019). They show high degree of phenotypic variation when compared to other prokaryotic organisms (Dvořák et al. 2017). Traditionally these organisms have been identified and categorized mainly using morphological features such as dimension, shape of vegetative and perennation stage, colour & characteristics of sheath, branching pattern, and cell contents (Komárek & Anagnostidis 1998, 2005; Komárek 2013). Presently, the advancement and use of modern taxonomic tools including ultrastructural studies, 16S rRNA gene, 16S-23S rRNA ITS region and cpcB-cpcA IGS region of phycocyanin locus has lead to the changes in taxonomic position of various cyanobacterial genera/ species (Komárek 2014). The ability of cyanobacteria to release exopolysaccharides and fix atmospheric nitrogen is pertinent in maintaining a healthy condition of the soil; addidtionally, this ability can further assist with the reclamation of barren land (Singh et al. 2016). In recent years, cyanobacterial research has gained greater academic interest as many species in this phylum have been identified to be a potential source of various value-added products such as biofertilizers, biofuels, and bioactive compounds. Cyanobacteria is also an attractive laboratory model that is used for genetic studies to understand their adaptation to extreme conditions and climatic changes. (Abed et al. 2008; Al-Haj 2016; Singh et al. 2017; Kumar et al. 2019).

Cyanobacteria have been reported from various habitats in Punjab including wetlands, paddy fields and polluted water etc. (Vasishta 1960a, 1961, 1962a,b, 1963; Pandhol 1974; Grover & Pandhol 1975; Mehta 1975; Sarma et al. 1979; Dhingra 2006; Singh et al. 2009; Khattar et al. 2015). Despite an increase in research effort, knowledge regarding the diversity and distribution of cyanobacteria in Punjab is still inconsistent. Thus there is need for an updated species checklist in order to contribute to the current knowledge of cyanobacterial diversity of the state. Although, in Gupta (2012) published a checklist of cyanobacteria from India in which 218 cyanobacterial taxa were reported from Punjab, the present study adds 99 taxa to this list, hence increasing the total to 317 taxa. Since cyanobacteria are an important component of the aquatic ecosystem, cyanobacterial wealth of the state should be known so that these can be collected and cultured for future studies.

The objective of this work was to revise and organize all available existing taxonomic data for cyanobacteria of recent taxonomic revisions in the state of Punjab. The checklist could serve as a baseline for future diversity, limnological, environmental impact assessment, bio-geographic distribution and speciation studies. Creation of a checklist is the most basic taxonomic work on a group of organisms arranged in systematic or alphabetical order. The checklist prepared during present work is done in a systematic order by reviewing the available literature up to September 2020. This is the first complete checklist of cyanobacteria from Punjab covering all currently accepted species names and their synonyms.

MATERIALS AND METHODS

This checklist has been prepared by consulting available literature including research papers and dissertations (PhD/ M.Phil/ MSc.). Data were compiled by reviewing diversity, taxonomy and ecological studies containing lists of cyanobacteria identified up to species level. Geographically, Punjab is situated in the north of the country between 29.30–32.32 °N and 73.55–76.50 °E (Figure 1). The climate of Punjab is continental, semiarid to sub-humid, it experiences both extreme summer and winter with annual rainfall of 58–96 cm (Gosal 2004; Krishan et al. 2015). The texture of soil in Punjab varies from coarse to fine sand, silt, and loam (Dhingra 2006). Cyanobacterial species recorded in this checklist were identified by various workers from the year 1936 to 2020. In this checklist species were arranged taxonomically by following the classification system recommended by Komárek (2014). Additionally, the taxonomic position, authorities and the currently accepted name was verified from AlgaeBase website (Guiry & Guiry 2020).

RESULTS AND DISCUSSION

This compiled checklist revealed that cyanobacterial diversity within Punjab is represented by 317 taxa (297 species, 13 varieties, and 7 forms) belonging to 74 genera and five orders (i.e., Chroococcales,

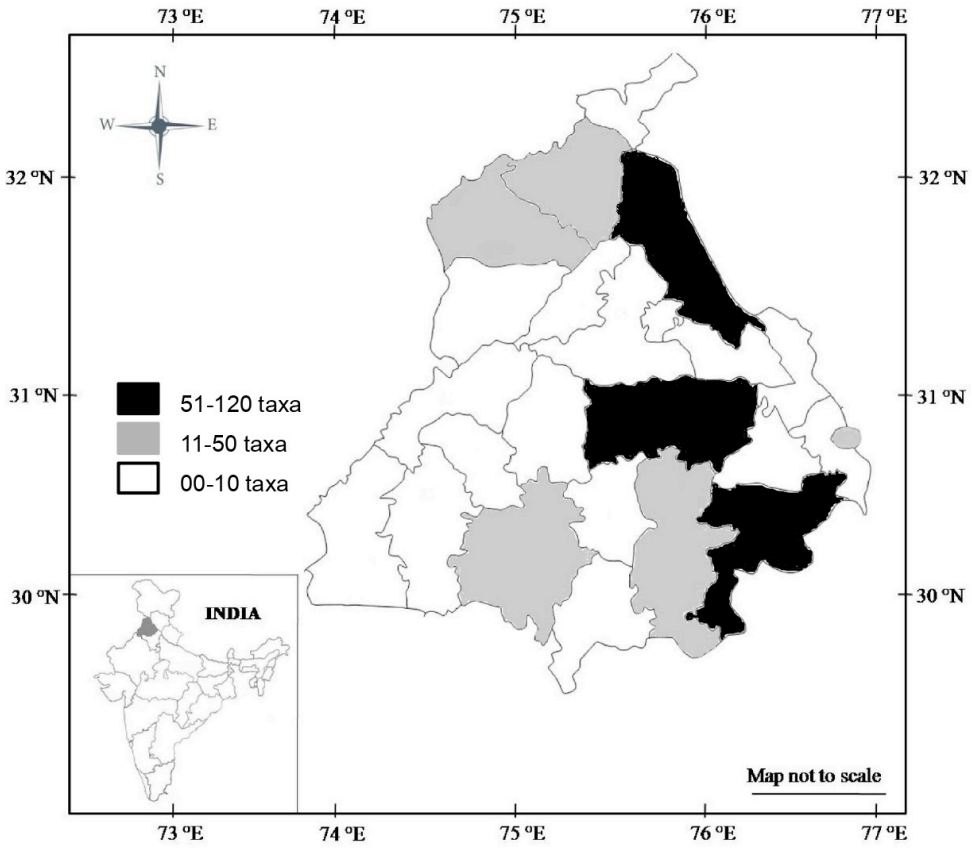

Figure 1. Distribution of cyanobacterial taxa in different regions of Punjab state of India (Source: www.google.com)

Synechococcales, Spirulinales, Oscillatoriales, and Nostocales) of Class Cyanophyceae (Table 1). On the basis of number of species, order Oscillatoriales (36%) is found to be the most diverse followed by Nostocales (27%), Synechococcales (19%), Chroococcales (15%), and Spirulinales (3%) (Figure 2). Among the genera, genus *Phormidium* had the maximum number of species, i.e., 39 followed by *Lyngbya* with 15 species, *Oscillatoria* with 14 species, *Leptolyngbya* and *Scytonema* with 13 species each. The families with the highest number of taxa were Oscillatoriaceae (72), Nostocaceae (51), Microcoleaceae (30), Microcystaceae (22) and Merismopediaceae (16). Vasishta (1960d, 1961, 1963b) reported 117 cyanobacterial taxa from Hoshiarpur district of Punjab. Grover and Pandhol (1974) reported 62 cyanobacterial species from paddy fields of Punjab. Sarma et al. (1979) identified 67 cyanobacterial species from varied localities in Patiala district of Punjab. Extensive floristic work performed by Dhingra (2006) on blue-green algae reported 158 species from moist soils, wetlands, ponds, roadside puddles, bricked and cemented surfaces from various localities of Punjab. Singh et al. (2009) studied cyanobacterial diversity from the rice fields of Patiala district and reported 25 cyanobacterial species from the study area.

The taxonomic identity of 87 cyanobacterial taxa previously reported from Punjab on their morphology has been revised with the help of modern taxonomic tools (marked with '*' in Table 1). Current accepted names of such taxa were updated following Algaebase. Taxonomic revision is continuous leading to the revision of taxonomic status as well as the nomenclature of the organism. Application of modern ecological, ultra-structural and molecular methods, aided by the cultivation of numerous cyanobacterial morphotypes, has substantially changed our knowledge of these organisms (Komárek 2006). Modern taxonomic tools have also enabled major advances in cyanobacterial taxonomy and aided with the criteria used for their phylogenetic classification (Komárek 2006, 2014).

Cyanobacteria recorded from Punjab inhabit varied habitats from planktonic to terrestrial and epilithic to epiphytic. Observations made from the present checklist note that the number of cyanobacterial species growing on terrestrial habitats (110) were greater than planktonic (84), epilithic (26), and epiphytic (15) (Table 1). However,

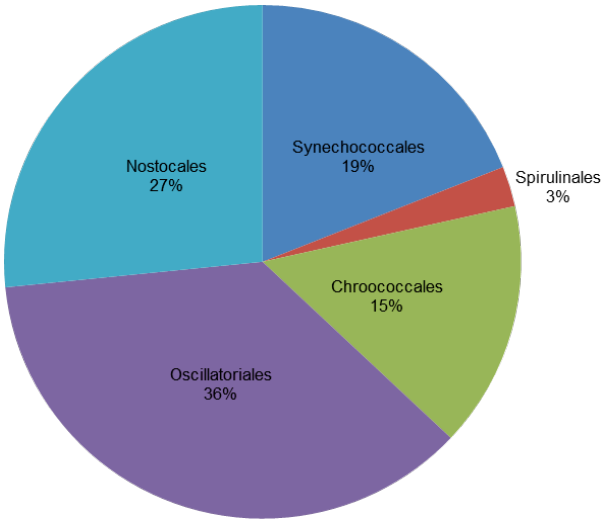

Figure 2. Prevalence of taxa belonging to different cyanobacterial orders in Punjab.

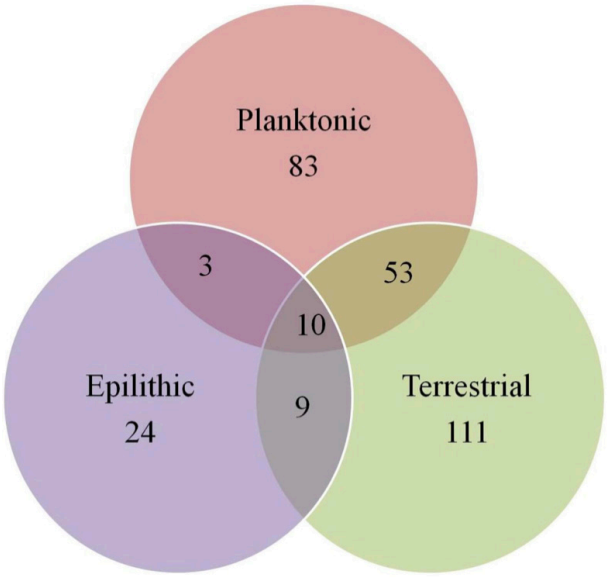

Figure 3. Habitat-wise distribution of cyanobacteria in Punjab.

78 cyanobacterial species were reported from more than one habitat (Table 1, Figure 3). They colonize large portions of the available terrestrial habitats due to its ability of 'anhydrobiosis' (Billi & Potts 2002; Alpert 2005). Moreover, they have a wide distribution range due to their unimaginable adaptive capacities (Gaysina 2019).

In conclusion, as a first complete and updated checklist of cyanobacteria from Punjab this will provide a baseline data for future floristic study. The explored and poorly explored regions of Punjab in terms of number of cyanobacterial taxa are highlighted in Figure 1. We can also assume that future studies of cyanobacterial diversity from poorly explored regions will increase the number of species by exploring more unexplored habitats of Punjab.

REFERENCES

Abed, R.M.M., S. Dobretsov & S. Kumar (2008). Applications of cyanobacteria in biotechnology. *Journal of Applied Microbiology* 106: 1–12.

Al-Haj, L., Y.T. Lui, R. M. M. Abed, M. A. Gomaa & S. Purton (2016). Cyanobacteria as chassis for industrial biotechnology: Progress and Prospects. *Life* 6: 1–17.

Alpert, P. (2005). The limits and frontiers of desiccation-tolerant life. *Integrative and Comparative Biology*. 45: 685–695.

Billi, D. & M. Potts (2002). Life and death of dry prokaryotes. *Research in Microbiology* 153(1): 7–12.

Blank, C.E. & P. Sanchez-Baracaldo (2010). Timing of morphological and ecological innovations in the cyanobacteria -a key to understanding the rise in atmospheric oxygen. *Geobiology* 8 (1): 1–23.

Dhingra, R. (2006). Biodiversity assessment and conservation of blue green algae from Punjab. PhD thesis. Department of Botany, Panjab University, Chandigarh, 241 pp.

Dvořák, P., D.A. Casamatta, P. Hašler, E. Jahodářová, A.R. Norwich & A. Poulíčková (2017) Diversity of the Cyanobacteria. pp. 3–46. In: P.C. Hallenbeck (eds.) *Modern topics in the Phototrophic Prokaryotes*. Springer. International Publshing Switzerland, 480pp.

Gaysina, L. A., A. Saraf & P. Singh (2019). Cyanobacteria in Diverse Habitats, pp. 1-28. In: Rai, A.N., D.N. Tewari and A.K. Mishra (eds.) *Cyanobacteria: From Basic Science to Applications*. Elsevier: Amsterdam, The Netherlands, 541 pp.

Gosal, G. (2004). Physical geography of the Punjab. *Journal of Punjab Studies*. 11: 19–37.

Grover, I.S. & R.K. Pandhol (1975) Algal flora of paddy fields of Ludhiana and its adjacent areas. *Phykos* 14(1–2): 89–97.

Guiry, M.D. & G.M. Guiry (2020). AlgaeBase. World-wide electronic publication, National University of Ireland, Galway. https://www.algaebase.org. Searched on 26 February 2020.

Gupta, R.K. (2012). *Algae of India* Vol-1: *A checklist of Cyanoprokaryota (Cyanophyceae)*. Botanical Survey of India, Ministry of Environment & Forests, Kolkata, 160 pp.

Jindal, N., D.P. Singh & J.I.S. Khattar (2013). Optimization, characterization, and flow properties of exopolysaccharides produced by the cyanobacterium *Lyngbya stagnina*. *Journal of Basic Microbiology* 53(11): 902–912.

Kaur, S., A.S. Ahluwalia & S. Kumar (2017). Seasonal variation of phytoplankton assemblages and relation to environmental variables in a freshwater lake situated in the zoological park, Chattbir, Punjab, India. *Panjab University Research Journal (Science)* 67: 35–48.

Kimambo, O.N., R.G. Jabulani & C. Hector (2019). The occurrence of cyanobacteria blooms in freshwater ecosystems and their link with hydro-meteorological and environmental variations in Tanzania. *Heliyon* 5(3): 1–23.

Khattar, J.I.S. & N. Jindal (2008). Isolation and characterization of exopolysaccharides produced by the cyanobacterium *Phormidium valderianum*. *Journal of Biotechnology* 136: 423–424.

Khattar, J.I.S. & Shailza (2009). Optimization of Cd^{2+} removal by the cyanobacterium *Synechocystis pevalekii* using the response surface methodology. *Process Biochemistry* 44(1): 118–121.

Khattar, J.I.S., S. Kaur, S. Kaushal, Y. Singh, D.P. Singh, S. Rana & A. Gulati (2015). Hyperproduction of phycobiliproteins by the cyanobacterium *Anabaena fertilissima* PUPCCC 410.5 under

Table 1. Checklist of cyanobacteria recorded for the state of Punjab, India.

	Taxonomic Assignment	Planktonic	Terrestrial	Epilithic	Epiphytic/ Endophytic	References
	Class: Cyanophyceae					
	Subclass: Synechococcophycidae					
	Order: Synechococcales					
	Family: Synechococcaceae					
1	*Anathece clathrata* (West & G.S.West) Komárek, Kastovsky & Jezberová **Aphanothece clathrata* West & G.S.West	+	-	-	-	16
2	*Rhabdogloea minuta* B. Hickel	+	-	-	-	16
3	*Synechococcus elongatus* (Nägeli) Nägeli	+	+	-	-	16, 20
	Family Merismopediaceae					
4	*Aphanocapsa biformis* A.Braun	+	-	-	-	7
5	*Aphanocapsa delicatissima* West & G.S.West	-	+	-	-	12
6	*Aphanocapsa elachista* West & G.S.West	-	+	-	-	12
7	*Aphanocapsa grevillei* (Berkeley) Rabenhorst	+	-	-	-	16
8	*Aphanocapsa koordersi* K.M.Strøm	+	-	-	-	16
9	*Aphanocapsa muscicola* (Meneghini) Wille **Aphanocapsa montana* Cramer	+	+	+	-	1, 7, 12
10	*Aphanocapsa roseana* De Bary	-	+	-	-	12
11	*Aphanocapsa stagnalis* (Lemmermann) R.N.Beljakova **Microcystis stagnalis* (Lemmermann) Lemmermann	+	-	-	-	12, 16
12	*Limnococcus limneticus* (Lemmermann) Komárková, Jezberová, O.Komárek & Zapomelová **Chroococcus limneticus* Lemmermann	+	-	-	-	10
13	*Merismopedia elegans* A. Braun ex Kützing	+	-	-	-	16, 25
14	*Merismopedia glauca* (Ehrenberg) Kützing **Merismopedia aeruginea* Brébisson	+	+	-	-	7, 10, 16
15	*Merismopedia sparsa* Komárek & G.Cronberg	+	-	-	-	30
16	*Merismopedia tranquilla* (Ehrenberg) Trevisan **Merismopedia punctata* Meyen	+	+	-	-	2, 12, 16
17	*Merismopedia warmingiana* (Lagerheim) Forti	+	+	+	-	16
18	*Synechocystis aquatilis* Sauvageau	+	+	-	-	10, 11, 16
19	*Synechocystis pevalekii* Ercegovic	+	+	+	-	11, 19, 21
	Family Coelosphaeriaceae					
20	*Coelosphaerium aerugineum* Lemmermann	+	-	-	-	16
21	*Coelosphaerium dubium* Grunow	+	-	-	-	16
22	*Snowella lacustris* (Chodat) Komárek & Hindák	+	-	-	-	16
	Family Pseudanabaenaceae					
23	*Limnothrix redekei* (Goor) Meffert	-	+	-	-	21
24	*Pseudanabaena amphigranulata* (Goor) Anagnostidis **Oscillatoria amphigranulata* Goor	+	-	-	-	10
25	*Pseudanabaena catenata* Lauterborn	+	+	-	-	16
26	*Pseudanabaena galeata* Böcher	+	-	-	-	16
27	*Pseudanabaena limnetica* (Lemmermann) Komárek	+	-	-	-	16
28	*Pseudanabaena minima* (G.S.An) Anagnostidis	+	+	-	-	16
29	*Pseudanabaena mucicola* (Naumann & Huber-Pestalozzi) Schwabe **Phormidium mucicola* Nauman & Huber-Pestalozzi	-	+	+	-	16, 20
	Family Leptolyngbyaceae					
30	*Leibleinia gracilis* (Rabenhorst ex Gomont) Anagnostidis & Komárek **Lyngbya gracilis* (Menegh) Rabenhorst ex Gomont	+	+	-	-	11
31	*Leptolyngbya africana* (Lemmermann) Anagnostidis & Komárek **Phormidium africanum* Lemmermann	-	+	-	-	12, 20

	Taxonomic Assignment	Planktonic	Terrestrial	Epilithic	Epiphytic/ Endophytic	References
32	*Leptolyngbya amplivaginata* (Goor) Anagnostidis & Komárek	+	-	-	-	16
33	*Leptolyngbya boryana* (Gomont) Anagnostidis & Komárek **Plectonema boryanum* Gomont	-	+	-	-	31
34	*Leptolyngbya foveolarum* (Gomont) Anagnostidis & Komárek **Phormidium foveolarum* Gomont	-	+	-	-	12, 20, 27
35	*Leptolyngbya fragilis* (Gomont) Anagnostidis & Komárek **Phormidium fragile* Gomont	-	+	+	-	10, 12
36	*Leptolyngbya mucosa* (N.L.Gardner) Anagnostidis & Komárek **Phormidium mucosum* N.L.Gardner	-	+	+	-	10, 20
37	*Leptolyngbya nostocorum* (Bornet ex Gomont) Anagnostidis & Komárek **Plectonema nostocorum* Bornet ex Gomont	-	+	-	-	20
38	*Leptolyngbya perelegans* (Lemmermann) Anagnostidis & Komárek **Lyngbya perelegans* Lemmermann	+	+	-	-	6
39	*Leptolyngbya polysiphoniae* (Frémy) Anagnostidis **Lyngbya polysiphoniae* Frémy	-	-	+	-	2
40	*Leptolyngbya purpurascens* (Gomont ex Gomont) Anagnostidis & Komárek **Phormidium purpurascens* Gomont ex Gomont	-	-	+	-	7
41	*Leptolyngbya scottii* (F.E.Fritsch) Anagnostidis & Komárek **Lyngbya scottii* Fritsch	-	+	-	-	20
42	*Leptolyngbya truncata* (Lemmermann) Anagnostidis & Komarek	+	-	-	-	16
43	*Leptolyngbya valderiana* (Gomont) Anagnostidis & Komárek **Phormidium valderianum* Gomont	-	+	-	-	7, 18, 20
44	*Phormidesmis molle* (Gomont) Turicchia, Ventura, Komárková & Komárek **Phormidium molle* Gomont	+	+	-	-	12, 20, 22
	Family Trichocoleusaceae					
45	*Trichocoleus delicatulus* (West & G.S.West) Anagnostidis	+	+	-	-	16
46	*Trichocoleus hospitus* Hansgirg	-	-	+	-	16
47	*Trichocoleus sociatus* (West & G.S.West) Anagnostidis **Microcoleus sociatus* West & G.S.West	+	+	-	-	10, 11
	Family *Oculatellaceae*					
48	*Drouetiella lurida* (Gomont) Mai, J.R.Johansen & Pietrasiak **Phormidium luridum* Gomont	-	-	+	-	7
	Family Synechococcales familia incertae sedis					
49	*Dasygloea amorpha* Berkeley ex Gomont	+	-	-	-	16
50	*Heteroleibleinia gardneri* (Geitler) Anagnostidis & Komárek **Lyngbya gardneri* Geitler	+	+	-	-	6
51	*Heteroleibleinia kuetzingii* (Schmidle) Compère **Lyngbya kuetzingii* Schmidle	+	-	-	-	10
52	*Heteroleibleinia lachneri* (W.Zimmermann) Anagnostidis & Komárek **Lyngbya lachneri* (W.Zimmermann) Geitler	-	-	+	+	10, 12
53	*Heteroleibleinia mesotricha* (Skuja) Anagnostidis & Komárek **Lyngbya mesotricha* Skuja	-	+	-	-	20
54	*Jaaginema angustissimum* (West & G.S.West) Anagnostidis & Komárek	-	+	-	-	16
55	*Jaaginema borodinii* (Woronichin) Anagnostidis & Komárek	-	+	-	-	16
56	*Jaaginema subtilissimum* (Kützing ex Forti) Anagnostidis & Komárek **Oscillatoria subtilissima* Kützing ex Forti	+	+	-	-	11, 16
57	*Schizothrix arenaria* Gomont	-	+	-	-	16
58	*Schizothrix heufleri* Grunow ex Gomont	-	+	-	-	16
59	*Schizothrix lateritia* Gomont	-	-	+	-	7
60	*Schizothrix mexicana* Gomont	+	-	-	-	1
	Subclass Oscillatoriophycidae					
	Order Spirulinales					
	Family Spirulinaceae					
61	*Spirulina labyrinthiformis* Gomont	-	+	-	-	12, 16
62	*Spirulina major* Kützing ex Gomont	+	-	-	-	16

	Taxonomic Assignment	Planktonic	Terrestrial	Epilithic	Epiphytic/ Endophytic	References
63	*Spirulina meneghiniana* Zanardini ex Gomont	+	-	-	-	16
64	*Spirulina platensis* var. *tenuis* C.B.Rao **Arthrospira platensis tenuis* (C.B.Rao) Desikachary	+	-	-	-	11
65	*Spirulina princeps* West & G.S.West	+	+	-	-	7, 12, 20
66	*Spirulina subsalsa* Oersted ex Gomont	+	+	-	-	11, 16
67	*Spirulina subtilissima* Kützing ex Gomont	-	+	-	-	11
68	*Spirulina tenerrima* Kützing ex Gomont	-	+	-	-	16
	Order Chroococcales					
	Family Microcystaceae					
69	*Gloeocapsa aeruginosa* Kützing	-	+	+	-	7, 12
70	*Gloeocapsa calcarea* Tilden	-	-	+	-	16
71	*Gloeocapsa cordae Guiry* **Gloeocapsa violacea* (Corda) Rabenhorst	-	-	+	-	11
72	*Gloeocapsa decorticans* (A.Braun) P.Richter	-	+	-	-	16
73	*Gloeocapsa kuetzingiana* Nägeli ex Kützing	-	-	+	-	10
74	*Gloeocapsa livida* (Carmichael) Kützing	+	+	-	-	16
75	*Gloeocapsa nigrescens* Nägeli	+	-	-	-	11
76	*Gloeocapsa pleurocapsoides* Novácek	-	-	+	-	7
77	*Gloeocapsa punctata* Nägeli	-	+	-	-	16
78	*Gloeocapsa quaternata* Kützing	-	-	-	+	10
79	*Gloeocapsa sanguinea* (C.Agardh) Kützing	-	-	-	+	10
80	*Microcystis aeruginosa* (Kützing) Kützing	+	+	-	-	6, 11, 12, 16, 30
81	*Microcystis elongata* Desikachary	+	-	-	-	12
82	*Microcystis flosaquae* (Wittrock) Kirchner	+	-	-	-	7, 11, 16
83	*Microcystis marginata* (Meneghini) Kützing	+	-	-	-	12
84	*Microcystis protocystis* W.B. Crow	+	-	-	-	12
85	*Microcystis pulvera* (H.C.Wood) Forti	+	-	-	-	12, 16
86	*Microcystis pulverea* f. *irregularis* (J.B.Petersen) Elenkin **Aphanocapsa lachista* var. *irregularis* J.B.Petersen	+	-	-	-	16
87	*Microcystis scripta* (P.Richter) Lemmermann	+	-	-	-	16
88	*Microcystis smithii* Komárek & Anagnostidis **Aphanocapsa pulchra* (Kützing) Rabenhorst	+	+	-	-	11, 12
89	*Microcystis viridis* (A.Braun) Lemmermann	+	-	-	-	16
90	*Microcystis wesenbergii* (Komárek) Komárek ex Komárek	+	-	-	-	16
	Family Aphanothecaceae					
91	*Aphanothece microscopica* Nägeli	+	+	-	-	6, 12, 16
92	*Aphanothece naegelii* Wartmann	-	+	-	-	11, 16
93	*Aphanothece nidulans* P.Richter	+	-	-	-	16
94	*Aphanothece pallida* (Kützing) Rabenhorst	+	+	-	-	11
95	*Aphanothece saxicola* Nägeli	+	+	-	-	16
96	*Aphanothece stagnina* (Sprengel) A.Braun	-	+	-	+	7, 11
97	*Gloeothece membranacea* (Rabenhorst) Bornet	-	+	-	-	12
98	*Gloeothece rupestris* (Lyngbye) Bornet	-	+	-	-	6, 12
99	*Gloeothece samoensis* Wille	-	+	-	-	7
	Family Cyanobacteriaceae					
100	*Cyanobacterium cedrorum* (Sauvageau) Komárek, J. Kopecký & Cepák **Synechococcus cedrorum* Sauvageau	+	+	-	-	10, 12

	Taxonomic Assignment	Planktonic	Terrestrial	Epilithic	Epiphytic/ Endophytic	References
	Family Cyanothrichaceae					
101	*Johannesbaptistia pellucida* (Dickie) W.R.Taylor & Drouet	+	-	-	-	16
	Family Gomphosphaeriaceae					
102	*Gomphosphaeria natans* Komárek & Hindák	+	-	-	-	16
	Family Chroococcaceae					
103	*Asterocapsa nidulans* (N.L.Gardner) Komárek & Komárková-Legnerová **Anacystis nidulans* N.L.Gardner	+	-	-	-	15
104	*Chroococcus indicus* Zeller	-	+	-	-	20
105	*Chroococcus minimus* (Keissler) Lemmermann	+	-	-	-	7
106	*Chroococcus minor* (Kützing) Nägeli	+	+	+	-	10, 11, 12, 16
107	*Chroococcus minutus* (Kützing) Nägeli	+	+	+	-	7, 11, 16
108	*Chroococcus pallidus* Nägeli	-	+	-	-	11
109	*Chroococcus subnudus* (Hansgirg) G.Cronberg & J.Komárek	+	-	-	-	16
110	*Chroococcus turgidus* (Kützing) Nägeli	-	+	-	-	12
111	*Chroococcus varius* A.Braun	+	-	-	-	16
112	*Cyanosarcina burmensis* (Skuja) Kovácik	-	-	+	-	16
113	*Cyanosarcina spectabilis* (Geitler) Kovácik **Myxosarcina spectabilis* Geitler	-	-	-	+	10
114	*Gloeocapsopsis cyanea* (Krieger) Komárek & Anagnostidis	-	+	-	-	16
115	*Pseudocapsa dubia* Ercegovic	+	+	-	-	16
116	*Dactylococcopsis rhaphidioides* Hansgirg	+	-	-	-	7
	Family Entophysalidaceae					
117	*Chlorogloea microcystoides* Geitler	-	-	+	-	16
	Order *Pleurocapsales*					
	Family *Dermocarpellaceae*					
118	*Stanieria sphaerica* (Setchell & N.L.Gardner) Anagnostidis & Pantazidou **Dermocarpa sphaerica* Setchell & N.L.Gardner	+	-	-	-	7
	Order Oscillatoriales					
	Family Coleofasciculaceae					
119	*Anagnostidinema acutissimum* (Kufferath) Strunecký, Bohunická, J.R.Johansen & J.Komárek **Geitlerinema acutissimum* (Kufferath) Anagnostidis	-	+	-	-	31
120	*Anagnostidinema exile* (Skuja) Strunecky **Geitlerinema exile* (Skuja) Anagnostidis	-	+	-	-	16
121	*Anagnostidinema ionicum* (Skuja) Strunecky **Geitlerinema ionicum* (Skuja) Anagnostidis	+	-	-	-	16
122	*Anagnostidinema lemmermannii* (Woloszynska) Strunecky **Geitlerinema lemmermanni* (Woloszynska) Anagnostidis	+	-	-	-	16
123	*Coleofasciculus chthonoplastes* (Thuret ex Gomont) M.Siegesmund, J.R.Johansen & T.Friedl in Siegesmund **Microcoleus chthonoplastes* Thuret ex Gomont	-	+	-	-	2, 7, 16
124	*Geitlerinema bigranulatum* (C.B.Rao) Anagnostidis **Oscillatoria claricentrosa* f. *bigranulata* C.B.Rao	-	-	+	-	6
125	*Geitlerinema crassum* (Woronichin) Anagnostidis **Oscillatoria deflexa crassa* (Woronichin) Elenkin & Poljansky	+	+	-	-	2, 11
	Family Microcoleaceae					
126	*Arthrospira gigantea* (Schmidle) Anagnostidis **Spirulina gigantean* Schmidle	+	+	-	-	10, 11
127	*Arthrospira jenneri* Stizenberger ex Gomont	+	+	-	-	11
128	*Arthrospira khannae* Drouet & Strickland	+	-	-	-	7
129	*Arthrospira massartii* var. *indica* Desikachary	+	-	-	-	16
130	*Arthrospira platensis* Gomont	+	-	-	-	12

	Taxonomic Assignment	Planktonic	Terrestrial	Epilithic	Epiphytic/ Endophytic	References
131	*Arthrospira platensis non-constricta* (Banerji) Desikachary	+	-	-	-	12, 16
132	*Kamptonema animale* (C.Agardh ex Gomont) Strunecký, Komárek & J.Smarda **Oscillatoria animalis* C.Agardh ex Gomont **Phormidium animale* (C.Agardh ex Gomont) Anagnostidis & Komárek	+	+	+	-	10, 16
133	*Kamptonema chlorinum* (Kützing ex Gomont) Strunecký, Komárek & J.Smarda **Oscillatoria chlorina* Kützing ex Gomont **Phormidium chlorinum* (Kützing ex Gomont)	+	+	-	-	6, 11, 12, 16, 22
134	*Kamptonema cortianum* (Meneghini ex Gomont) Strunecký, Komárek & J.Smarda **Phormidium cortianum* (Meneghini ex Gomont) Anagnostidis & Komárek	-	+	-	-	16
135	*Kamptonema formosum* (Bory ex Gomont) Strunecký, Komárek & J.Smarda **Phormidium formosum* (Bory ex Gomont) Anagnostidis & Komárek **Oscillatoria formosa* Bory ex Gomont	+	+	+	-	10, 16, 20
136	*Kamptonema gebhardtianum* (Claus) Strunecký, Komárek & J.Smarda **Phormidium gebhardtianum* (Claus) Anagnostidis & Komárek	-	+	-	-	16
137	*Kamptonema jasorvense* (Vouk) Strunecký, Komárek & J.Smarda **Oscillatoria jasorvensis* Vouk	-	+	-	-	11
138	*Kamptonema laetevirens* (H.M.Crouan & P.L.Crouan ex Gomont) Strunecký, Komárek & J. Smarda **Phormidium laetevirens* (P.Crouan & H.Crouan ex Gomont) Anagnostidis & Komárek **Oscillatoria latevirens* P.Crouan & H.Crouan ex Gomont	-	+	-	-	16, 20
139	*Kamptonema okenii* (C.Agardh ex Gomont) Strunecký, Komárek & J.Smarda **Oscillatoria okenii* C.Agardh ex Gomont **Phormidium okenii* (C.Agardh ex Gomont) Anagnostidis & Komárek	+	+	+	-	11, 12, 16
140	*Kamptonema proteus* (Skuja) Strunecký, Komárek & J.Smarda **Oscillatoria proteus* Skuja	+	+	-	-	7, 12
141	*Microcoleus amoenus* (Gomont) Strunecky, Komárek & J.R.Johansen Strunecky **Phormidium amoenum* Kützing ex Anagnostidis & Komárek	-	+	-	-	16
142	*Microcoleus autumnalis* (Gomont) Strunecky, Komárek & J.R. Johansen **Phormidium autumnale* Gomont	-	+	+	-	16
143	*Microcoleus lacustris* Desikachary	-	+	-	-	16
144	*Microcoleus lacustris* f. *intermedius* Vasishta	-	+	-	-	7
145	*Microcoleus paludosus* Gomont	+	+	-	-	7, 11, 16
146	*Microcoleus subtorulosus* Gomont ex Gomont	+	-	-	-	11
147	*Microcoleus vaginatus* Gomont ex Gomont	-	+	-	-	11
148	*Oxynema acuminatum* (Gomont) Chatchawan, Komárek, Strunecky, Smarda & Peerapornpisal **Oscillatoria acuminata* Gomont	-	+	-	-	20
149	*Planktothrix agardhii* (Gomont) Anagnostidis & Komárek **Oscillatoria agardhii* Gomont	+	+	-	-	2, 7, 17
150	*Planktothrix compressa* (Utermöhl) Anagnostidis & Komárek	+	-	-	-	16
151	*Planktothrix isothrix* (Skuja) Komárek & Komárková	+	-	-	-	16
152	*Planktothrix rubescens* (De Candolle ex Gomont) Anagnostidis & Komárek **Oscillatoria mougeotii* Kützing ex Forti	+	-	-	-	10, 16
153	*Porphyrosiphon kashyapii* (Ghose) Anagnostidis & Komárek **Lyngbya kashaypii* Ghose	-	+	-	-	11
154	*Porphyrosiphon notarisii* Kützing ex Gomont	-	-	+	-	16
155	*Porphyrosiphon shackletonii* (West & G.S.West) Anagnostidis & Komárek **Lyngbya shackletoni* W.& G.S. West	-	+	-	-	12
	Family *Homoeotrichaceae*					
156	*Homoeothrix desikacharyensis* Vasishta	-	+	-	-	9
157	*Homoeothrix juliana* (Bornet & Flahault ex Gomont) Kirchner	-	-	+	-	7
158	*Homoeothrix moniliformis* Vasishta	-	+	-	-	9

	Taxonomic Assignment	Planktonic	Terrestrial	Epilithic	Epiphytic/ Endophytic	References
	Family Oscillatoriaceae					
159	*Limnoraphis birgei* (G.M.Smith) J.Komárek, E. Zapomelová, J.Smarda, J.Kopecký, E.Rejmánková, J.Woodhouse, B.A.Neilan & J.Komárková **Lyngbya birgei* G.M.Smith	-	+	-	-	11
160	*Limnoraphis cryptovaginata* (Schkorbatov) J.Komárek, E.Zapomelová, J.Smarda, J.Kopecký, E.Rejmámková, J.Woodhouse, B.A.Neilan & J.Komárková **Lyngbya cryptovaginata* Schkorbatov	+	+	-	-	10, 11, 12, 20
161	*Limnoraphis hieronymusii* (Lemmermann) J.Komárek, E.Zapomelová, J.Smarda, J.Kopecký, E.Rejmánková, J.Woodhouse, B.A.Neilan & J.Komárková **Lyngbya hieronymusii* Lemmermann	+	+	-	-	7, 11, 12
162	*Limnospira fusiformis* (Voronichin) Nowicka-Krawczyk, Mühlsteinová & Hauer **Arthrospira fusiformis* (Voronichin) Komárek & J.W.G.Lund	+	-	-	-	16
163	*Lyngbya aerugineocoerulea* Gomont	-	+	-	-	11, 12
164	*Lyngbya aestuarii* Liebman ex Gomont	+	-	-	-	7
165	*Lyngbya aestuarii* var. *arbustiva* Brühl & Biswas	-	+	-	-	7
166	*Lyngbya anomala* (C.B.Rao) Umezaki & Watanabe **Phormidium anomalum* C.B.Rao	-	+	-	+	12, 16
167	*Lyngbya laxespiralis* Skuja	-	+	-	-	12
168	*Lyngbya laxespiralis* var. *major* Vasishta	-	+	-	-	10
169	*Lyngbya martensiana* Meneghini ex Gomont	+	+	+	-	2, 6, 12, 16
170	*Lyngbya major* Meneghini ex Gomont	+	-	-	-	7
171	*Lyngbya palmarum* Brühl & Biswas	-	-	-	+	6
172	*Lyngbya putalis* Montagne ex Gomont	+	-	-	-	7
173	*Lyngbya semiplena* J.Agardh ex Gomont	-	-	+	-	16
174	*Lyngbya spiralis* Geitler	+	+	-	-	6, 20, 22
175	*Lyngbya spirulioides* Gomont	-	+	-	-	12
176	*Lyngbya spirulinoides* var. *minor* Vasishta	+	-	-	-	10
177	*Lyngbya trunicola* Ghose	-	-	-	+	16
178	*Oscillatoria anguina* Bory ex Gomont	+	+	-	-	16
179	*Oscillatoria annae* Goor	+	+	-	-	12, 16
180	*Oscillatoria curviceps* C.Agardh ex Gomont	+	+	-	-	11, 12, 16
181	*Oscillatoria indica* P.C.Silva **Oscillatoria salina* Biswas	+	-	-	-	7
182	*Oscillatoria limosa* C.Agardh ex Gomont	+	+	-	-	7, 12, 16
183	*Oscillatoria mehrai* Vasishta	-	+	-	-	9
184	*Oscillatoria obscura* Brühl & Biswas	-	+	-	-	11
185	*Oscillatoria perornata* Skuja	+	-	-	-	16
186	*Oscillatoria princeps* Vaucher ex Gomont	+	+	-	-	1, 11
187	*Oscillatoria sancta* Kützing ex Gomont	+	+	+	-	7, 11, 12, 16
188	*Oscillatoria simplicissima* Gomont	+	+	-	-	12
189	*Oscillatoria subbrevis* Schmidle	+	+	+	-	2, 6, 11, 12, 25
190	*Oscillatoria tenuis* C.Agardh ex Gomont	+	-	-	-	16
191	*Oscillatoria variabilis* C.B.Rao **Oscillatoria raoi* G. De Toni	+	-	-	-	11, 12
192	*Phormidium abronema* Skuja	-	+	-	-	12
193	*Phormidium allorgei* (Frémy) Anagnostidis & Komárek	-	+	-	-	6
194	*Phormidium ambiguum* Gomont	-	+	-	-	10, 16
195	*Phormidium articulatum* (N.L.Gardner) Anagnostidis & Komárek	+	-	-	-	16

	Taxonomic Assignment	Planktonic	Terrestrial	Epilithic	Epiphytic/ Endophytic	References
196	*Phormidium boryanum* (Bory ex Gomont) Anagnostidis & Komárek **Oscillatoria boryana* Bory de Saint-Vincent ex Gomont	+	+	-	-	11, 12
197	*Phormidium breve* (Kützing ex Gomont) Anagnostidis & Komárek	-	+	-	-	16
198	*Phormidium bulgaricum* (Komárek) Anagnostidis & Komárek	+	-	-	-	16
199	*Phormidium calcareum* Kützing ex Gomont	-	-	+	-	16
200	*Phormidium corbierei* (Frémy) Anagnostidis	-	-	+	-	16
201	*Phormidium corium* Gomont ex Gomont	-	-	+	-	10
202	*Phormidium dimorphum* Lemmermann	-	+	-	-	12
203	*Phormidium favosum* Gomont	+	-	+	-	16
204	*Phormidium foreaui* (Frémy) Umezaki & Watanabe **Oscillatoria foreaui* Frémy	+	+	-	-	10, 11, 12
205	*Phormidium granulatum* (N.L.Gardner) Anagnostidis	-	+	-	-	16
206	*Phormidium hieronymusii Lemmermann*	-	+	-	-	10
207	*Phormidium interruptum* Kützing ex Forti	-	-	+	-	16
208	*Phormidium inundatum* Kützing ex Gomont	-	+	-	-	20
209	*Phormidium jadinianum* Gomont	-	+	-	-	12
210	*Phormidium janthiphorum* (Gomont) Elenkin	-	+	-	-	16
211	*Phormidium jenkelianum* G.Schmid	+	+	-	-	12, 16, 20
212	*Phormidium karakalpakense* (Muzafarov) Anagnostidis & Komárek	-	+	-	-	16
213	*Phormidium kuetzingianum* (Kirchner ex Hansgirg) Anagnostidis & Komárek	-	+	-	-	16
214	*Phormidium molle* var. *tenuior* West & G.S.West ex Geitler **Phormidium molle* f. *tenuior* West & G.S.West	-	-	+	-	10
215	*Phormidium nigrum* (Vaucher ex Gomont) Anagnostidis & Komárek	+	-	-	-	16
216	*Phormidium papyraceum* Gomont ex Gomont	-	+	-	-	12
217	*Phormidium rubriterricola* N.L.Gardner	-	+	-	-	10
218	*Phormidium schultzii* (Lemmermann) Anagnostidis & Komárek **Oscillatoria schultzii* Lemmermann	-	+	-	-	11
219	*Phormidium stagninum* Anagnostidis **Lyngbya stagnina* Kützing	+	-	+	-	16, 24
220	*Phormidium stagninum* var. *minus* Vasishta	-	-	+	-	10
221	*Phormidium subfuscum* Kützing ex Gomont	-	+	-	-	16
222	*Phormidium subincrustatum* Fritsch & M.F.Rich	-	+	-	-	12
223	*Phormidium takyricum* (Novichkova) O.N.Vinogradova **Phormidium paulsenianum* f. *takyricum* Novickova	-	+	-	-	16
224	*Phormidium terebriforme* (C.Agardh ex Gomont) Anagnostidis & Komárek **Oscillatoria terebriformis* C.Agardh ex Gomont	+	+	-	-	2, 11
225	*Phormidium tergestinum* (Rabenhorst ex Gomont) Anagnostidis & Komárek	-	+	-	-	16
226	*Phormidium thwaitesii* I.Umezaki & M.Watanabe **Oscillatoria subuliformis* Kützing ex Gomont	-	-	-	+	10
227	*Phormidium tortuosum* (N.L.Gardner) Anagnostidis & Komárek	-	+	-	-	16
228	*Phormidium uncinatum* Gomont ex Gomont	-	-	+	-	16
229	*Phormidium usteri* Schmidle	-	+	-	-	12
230	*Phormidium willei* (N.L.Gardner) Anagnostidis & Komárek **Oscillatoria willei* N.L.Gardner	-	+	-	-	11
	Family Phormidiaceae					
	Sub Family Phormidioideae					
231	*Potamolinea aerugineocaerulea* (Gomont) M.D.Martins & L.H.Z.Branco **Lyngbya aerugineocaerulea* Gomont **Phormidium aerugineo-caeruleum* (Gomont) Anagnostidis & Komárek	+	+	+	-	7, 16

	Taxonomic Assignment	Planktonic	Terrestrial	Epilithic	Epiphytic/ Endophytic	References
	Family Gomontiellaceae					
232	*Komvophoron breve* (N.Carter) Anagnostidis	-	+	-	-	16
233	*Komvophoron groenlandicum* Anagnostidis et Komarek	+	-	-	-	16
	Subclass Nostocophycidae					
	Order Nostocales					
	Family Scytonemataceae					
234	*Scytonema burmanicum* Skuja	-	-	+	-	16
235	*Scytonema hofmanii* C.Agardh ex Bornet & Flahault	-	+	-	-	10, 16
236	*Scytonema iyengarii* Bharadwaja	-	-	+	-	2
237	*Scytonema julianum* Meneghini ex B.A.Whitton	-	-	+	-	16
238	*Scytonema leptobasis* S.L.Ghose	-	-	+	-	16
239	*Scytonema millei Bornet ex Bornet & Flahault*	-	+	-	-	10
240	*Scytonema ocellatum* Lyngbye ex Bornet & Flahaul	-	+	+	-	10, 16
241	*Scytonema pseudohofmanni* Bharadwaja	-	+	+	-	16
242	*Scytonema saleyeriense* Weber-van Bosse	+	-	+	-	16
243	*Scytonema simplex* Bharadwaja	+	-	-	-	16
244	*Scytonema simplex* f. *majus* Vasishta	+	-	-	-	7
245	*Scytonema tolypothrichoides* Kützing ex Bornet & Flahault	-	+	-	-	16
246	*Scytonema varium* Kützing ex Bornet & Flahault	-	+	-	-	17
	Family Rivulariaceae					
247	*Microchaete tenera* var. *major* Möbius	-	-	-	+	10
248	*Rivularia joshii* Vasishta	+	-	-	-	8, 11
249	Rivularia mehrai Vasishta	-	+	-	-	5
	Family Tolypothrichaceae					
250	*Tolypothrix crassa* West & G.S.West	-	-	-	+	7
251	*Tolypothrix campylonemoides S.L.Ghose*	-	-	-	+	7
	Family Chlorogloeopsidaceae					
252	*Chlorogleopsis fritschii* (A.K.Mitra) A.K.Mitra & D.C.Pandey	-	+	-	-	16
	Family Hapalosiphonaceae					
253	*Hapalosiphon welwitschii* West & G.S.West	-	+	-	-	16
254	*Mastigocladus laminosus* Cohn ex Kirchner	-	+	-	-	7, 16
255	*Westiellopsis prolifica* Janet	-	+	-	-	17
	Family Gloeotrichiaceae					
256	*Gloeotrichia ghosei* R.N.Singh	-	+	-	-	11
257	*Gloeotrichia natans* Rabenhorst ex Bornet & Flahault **Rivularia natans* (Hedwig) S.F.Gray	+	-	-	-	1
258	*Gloeotrichia raciborskii* var. *kashiensis* C.B.Rao	-	-	-	+	7
	Family Calothricaceae					
259	*Calothrix braunii* Bornet & Flahault	-	+	-	-	7, 11
260	*Calothrix castellii* var. *somastipurense* C.S.Rao	+	-	-	-	16
261	*Calothrix clavata* G.S.West	-	+	-	-	16
262	*Calothrix desikacharyensis* Vasishta	-	-	-	+	9
263	*Calothrix fusca* Bornet & Flahault	-	+	-	-	2
264	*Calothrix parietina* Thuret ex Bornet & Flahault	-	-	+	-	7
	Family Aphanizomenonaceae					
265	*Anabaenopsis arnoldii* Aptekar	+	-	-	-	16

	Taxonomic Assignment	Planktonic	Terrestrial	Epilithic	Epiphytic/ Endophytic	References
266	*Anabaenopsis circularis* (G.S.West) Woloszynska & V.V.Miller	+	-	-	-	16
267	*Dolichospermum nathii* (Vasishta) Wacklin, L.Hoffmann & Komárek **Anabaena nathii Vasishta*	+	-	-	-	3
268	*Nodularia spumigena* Mertens ex Bornet & Flahault	+	-	-	-	1, 6, 7
	Family Nostocaceae					
269	*Anabaena ambigua* C.B.Rao	-	+	-	-	11
270	*Anabaena anomala* F.E.Fritsch	-	+	-	-	11
271	*Anabaena iyengarii* Bharadwaja	+	+	-	-	10, 14, 16
272	*Anabaena iyengarii* var. *tenuis* C.B.Rao	+	+	-	-	6, 16
273	*Anabaena mehrai* Vasishta	+	-	-	-	6
274	*Anabaena oryzae* F.E.Fritsch	-	+	-	-	11
275	*Anabaena oscillarioides* Bory ex Bornet & Flahault	+	-	-	-	7
276	*Anabaena oscillarioides* var. *crassa* Vasishta	+	-	-	-	6
277	*Anabaena sphaerica* Bornet & Flahault	+	+	-	-	11, 14
278	*Anabaena sphaerica* var. *attenuata* Bharadwaja	+	-	-	-	16
279	*Anabaena sphaerica* f. *major* Kiselev	+	-	-	-	7
280	*Anabaena torulosa* Lagerheim ex Bornet & Flahault	+	+	-	-	11, 12, 20, 22, 23
281	*Aulosira aenigmatica* Frémy	-	+	-	-	12
282	*Aulosira fertilissima* S.L.Ghose	+	+	-	-	1, 7, 11
283	*Aulosira fertilissima* var. *tenuis* C.B.Rao	+	-	-	-	16
284	*Aulosira laxa* O. Kirchner ex Bornet & Flahault	-	+	-	-	12
285	*Aulosira prolifica* Bharadwaja	+	+	-	-	6, 11, 12
286	*Aulosira pseudoramosa* Bharadwaja	-	+	-	-	16
287	*Camptylonemopsis iyengarii* Desikachary	-	-	-	+	16
288	*Cylindrospermum alatosporum* F.E.Fritsch	-	+	-	-	6
289	*Cylindrospermum doryphorum* Brühl & Biswas	-	+	-	-	16
290	*Cylindrospermum licheniforme* Kützing ex Bornet & Flahault	+	-	-	-	10
291	*Cylindrospermum majus* Kützing ex Bornet & Flahault	-	+	-	-	11, 16
292	*Cylindrospermum michailovskoense* Elenkin	-	+	-	-	16
293	*Cylindrospermum muscicola* Kützing ex Bornet & Flahault	+	+	-	-	2, 6
294	*Cylindrospermum muscicola* var. *kashmiriensis* Bharadwaja	-	+	-	-	16
295	*Cylindrospermum muscicola* f. *hoshiarpurense* Vasishta	-	+	-	-	7
296	*Cylindrospermum stagnale* Bornet & Flahault	+	+	-	-	1, 16
297	*Desmonostoc muscorum* (C.Agardh ex Bornet & Flahault) Hrouzek & Ventura in Hrouzek **Nostoc muscorum* C.Agardh ex Bornet & Flahault	-	+	-	-	7, 13, 16, 29
298	*Nostoc carneum* C.Agardh ex Bornet & Flahault **Nostoc spongiaeformae* C.Agardh ex Bornet & Flahault	+	+	-	-	10, 12, 16, 20
299	*Nostoc commune* C.Agardh ex Bornet & Flahault	-	+	-	-	16
300	*Nostoc corneum* Vaucher ex Bornet & Flahault	-	+	-	-	12
301	*Nostoc ellipsosporum* Rabenhorst ex Bornet & Flahault	+	+	-	-	6, 17
302	*Nostoc hatei* S.C.Dixit	+	-	-	-	16
303	*Nostoc linckia* Bornet ex Bornet & Flahault, **Nostoc piscinale* Kützing ex Bornet & Flahault	-	+	-	-	6, 12, 16, 20
304	*Nostoc maculiforme* Bornet & Flahault	+	+	-	-	7, 11
305	*Nostoc paludosum* Kützing ex Bornet & Flahault **Nostoc entophytum* Bornet & Flahault	-	+	-	-	12, 16
306	*Nostoc parmeliodes* Kutz. ex Born.e/ Flah.	-	+	-	-	16

	Taxonomic Assignment	Planktonic	Terrestrial	Epilithic	Epiphytic/ Endophytic	References
307	*Nostoc punctiforme* Hariot	-	+	-	-	6, 12, 16
308	*Nostoc spongiiforme* var. *tenue* C.B.Rao	-	+	-	-	10
309	*Nostoc verrucosum* Vaucher ex Bornet & Flahault	-	-	+	-	2, 6
310	*Trichormus azollae* (Strasburger) Komárek & Anagnostidis	-	-	-	+	16
311	*Trichormus fertilissimus* (C.B.Rao) Komárek & Anagnostidis **Anabaena fertilissima* C.B.Rao	-	+	-	-	28
312	*Trichormus hoshiarpurensis* (Vasishta) Komárek & Anagnostidis **Anabaena hoshiarpurensis* Vasishta	+	-	-	-	4
313	*Trichormus indicus Komárek* **Anabaena vaginicola* f. *fertilissima* Prasad	+	-	-	-	10
314	*Trichormus naviculoides* (F.E.Fritsch) J.Komárek & K.Anagnostidis **Anabaena naviculoides* F.E.Fritsch	-	+	-	-	20, 26
315	*Trichormus variabilis* (Kützing ex Bornet & Flahault) Komárek & Anagnostidis **Anabaena variabilis* Kützing ex Bornet & Flahault	+	+	-	-	16, 20
316	*Wollea bharadwajae* R.N.Singh	-	-	-	+	7
317	*Wollea vaginicola* (F.E.Fritsch & Rich) R.N.Singh	-	-	-	+	6

Previously accepted name/synonym of taxa are marked with star '*'
1—Randhawa (1936) | 2—Singh (1941) | 3—Vasishta (1960a) | 4—Vasishta (1960b) | 5—Vasishta (1960c) | 6—Vasishta (1960d) | 7—Vasishta (1961) | 8—Vasishta (1962) | 9—Vasishta (1963a) | 10—Vasishta (1963b) | 11—Grover & Pandhol (1975) | 12—Sarma (1979) | 13—Surekha (1989) | 14—Reena (1992) | 15—Khattar et al. (1999) | 16—Dhingra (2006) | 17—Singh et al. (2007) | 18—Khattar & Jindal (2008) | 19—Khattar & Shailza (2009) | 20—Singh et al. (2009) | 21—Khattar et al. (2010) | 22—Shailza (2010) | 23—Singh et al. (2012) | 24—Jindal et al. (2013) | 25—Sharma et al. (2013) | 26—Singh et al. (2013) | 27—Singh et al. (2014) | 28—Khattar et al. (2015) | 29—Singh et al. (2015) | 30—Kaur et al. (2017) | 31—Manpreet (2017).

optimized culture conditions. *Algal Research* 12: 463–469.

Khattar, J.I.S., T.A. Sarma & D.P. Singh (1999). Removal of chromium ions by agar immobilized cells of the cyanobacterium *Anacystis nidulans* in a continuous flow bioreactor. *Enzyme and Microbial Technology* 25(7): 564–568.

Khattar, J.I.S., D.P. Singh, N. Jindal, N. Kaur, Y. Singh, P. Rahi & A. Gulati (2010). Isolation and characterization of exopolysaccharides produced by the cyanobacterium *Limnothrix redekei* PUPCCC 116. *Applied Biochemistry and Biotechnology* 162(5): 1327–1338.

Komárek, J. & K. Anagnostidis (1998). Cyanoprokaryota 1. Chroococcales. – In: Ettl H., Gärtner G., Heynig H. & Mollenhauer D. (eds), Süsswasserflora von Mitteleuropa 19/1. Gustav Fischer, Jena-StuttgartLübeck-Ulm, 548 pp.

Komárek, J. & K. Anagnostidis (2005). Cyanoprokaryota. 2. Oscillatoriales. – In: Büdel B., Krienitz L., Gärtner G. & Schagerl M. (eds), Süsswasserflora von Mitteleuropa 19/2. Elsevier/Spektrum, Heidelberg, 759 pp.

Komárek, J. (2006). Cyanobacterial taxonomy: current problems and prospects for the integration of traditional and molecular approaches. *Algae* 21: 349–375.

Komárek, J. (2013). Cyanoprokaryota. 3. Heterocytous genera. In: Büdel B., G. Gärtner, L. Krienitz & M. Schagerl (eds.). Süswasserflora von Mitteleuropa/Freshwater flora of Central Europe. Springer Spektrum Berlin, Heidelberg, 1130 pp.

Komárek, J., J. Kaštovský, J. Mareš & J.R. Johansen (2014). Taxonomic classification of cyanoprokaryotes (cyanobacterial genera) 2014, using a polyphasic approach. *Preslia* 86: 295–335.

Krishan, G., S.K. Chandniha & A.K. Lohani (2015). Rainfall Trend Analysis of Punjab, India Using Statistical Non-Parametric Test. *Current World Environment* 10(3): 792–800.

Kumar, J., D. Singh, M.B. Tyagi & A. Kumar (2019). Cyanobacteria: Applications in Biotechnology, pp. 327–346. In: Rai, A.N., D.N. Tewari and A.K. Mishra (eds.) *Cyanobacteria: From Basic Science to Applications*. Elsevier, Amsterdam, The Netherlands, 541 pp.

Manpreet (2017). Temperature tolerance and level of antioxidants in selected cyanobacteria in the presence of sodium sulphide. PhD Thesis. Department of Botany, Punjabi University, Patiala, 141 pp.

Randhawa, M.S. (1936) Marked periodicity in reproduction of the Panjab freshwater algae. *Proceedings of the Indian Academy of Sciences - Section* B3: 401–406.

Mehta, S.K. (1975). Blue-green algae of Patiala city and adjacent areas. M.Sc. thesis. Department of Botany, Punjabi University, Patiala, 32 pp.

Pandhol, R.K. (1974). Survey of Algal Flora of Ludhiana & its Adjoining areas with particular reference to the Paddy Fields. M.Sc. thesis. PAU, Ludhiana, 146 pp.

Reena (1992). Studies on heterocyst and akinetes differentiation in some anabaena species. PhD Thesis. Department of Botany, Panjab University, Chandigarh, 223 pp.

Sarma, T.A., S. Kanta & Sunita (1979) Algal flora of Patiala and its environs- Cyanophyceae II. *Phykos* 18: 13–14.

Schopf, J.W., A.B. Kudryavtsev, D.G. Agresti, T.J. Wdowiak & A.D. Czaja (2002). Laser–Raman imagery of Earth's earliest fossils. *Nature* 416 (6876): 73–76.

Shailza (2010). Evaluation of heavy metal bioremediation potential of algae growing in polluted water. PhD Thesis. Department of Botany, Punjabi University, Patiala, 134 pp.

Sharma, C., R. Jindal, U.B. Singh, A.S. Ahluwalia & R.K. Thakur (2013). Population dynamics and species diversity of plankton in relation to hydrobiological characteristics of river Sutlej, Punjab, India. *Ecology, Environment and Conservation* 19(3): 717–724.

Singh, D.P., J.I.S. Khattar, G. Ahuja & Y. Singh (2007). Cyanobacterial diversity in rice fields of Malwa region of Punjab and their tolerance to Chlorpyrifos. *Journal, Punjab Academy of Sciences* 4(1&2): 106–113.

Singh, V.P. (1941) On a collection of algae from the Chamba state (Punjab) I. *Procedings of the Indian Academy of Sciences B* 14(3): 250–255.

Singh, Y., A. Gulati, D.P. Singh & J.I.S. Khattar (2018). Cyanobacterial community structure in hot water springs of Indian north-western Himalayas: a morphological, molecular and ecological approach. *Algal Research* 29: 179–192.

Singh, Y., J.I.S. Khattar, D.P. Singh, P. Rahi & A. Gulati (2014). Limnology and cyanobacterial diversity of high altitude lakes of Lahaul-Spiti in

Himachal Pradesh, India. *Journal of Biosciences* 39: 643–657.

Singh, D.P., J.I.S. Khattar, M. Gupta & G. Kaur (2014). Evaluation of toxicological impact of cartap hydrochloride on some physiological activities of a non-heterocystous cyanobacterium *Leptolyngbya foveolarum*. *Pesticide Biochemistry and Physiology* 110: 63–70.

Singh, D.P., J.I.S. Khattar, G. Kaur, M. Gupta, Y. Singh & A. Gulati (2015). Effect of pretilachlor on nitrogen uptake and assimilation by the cyanobacterium *Desmonostoc muscorum* PUPCCC 405.10. *Acta Physiologiae Plantarum* 37(9): 1–14.

Singh, D.P., J.I.S. Khattar, K. Kaur, B.S. Sandhu & Y. Singh (2012). Toxicological impact of anilofos on some physiological processes of a rice field cyanobacterium *Anabaena torulosa*. *Toxicological & Environmental Chemistry* 94(7): 1304–1318.

Singh, D.P., J.I.S. Khattar & Y. Singh (2009). Effect of pesticides on the distribution pattern of cyanobacteria in a rice field ecosystem. *The Journal of the Indian Botanical Society* 88(1&2): 163–169.

Singh, H., A.S. Ahluwalia & J.I.S. Khattar (2013). Induction of sporulation by different nitrogen sources in *Anabaena naviculoides*, a diazotrophic strain capable of colonizing paddy field soil of Punjab (India). *Vegetos* 26(1): 283–292.

Singh, J.S., A. Kumar, A.N. Rai & D.P. Singh (2016). Cyanobacteria: a precious bio-resource in agriculture, ecosystem, and environmental sustainability. *Frontiers in Microbiology* 7(529): 1–19.

Singh, R., P. Parihar, M. Singh, A. Bajguz, J. Kumar, S. Singh & V.P. Singh & S.M. Prasad (2017). Uncovering potential applications of cyanobacteria and algal metabolites in biology, agriculture and medicine: current status and future prospects. *Frontiers in Microbiology* 8(515): 1–37.

Sleep, N.H. (2010). The Hadean-Archaean Environment. *Cold Spring Harbor Perspectives in Biology* 2(6): 1–14.

Surekha (1989). Studies on the effect of some pesticides on growth and differentiation in two blue-green algal species. PhD Thesis. Department of Botany, Panjab University, Chandigarh, 258 pp.

Vasishta P.C. (1960a). *Anabaena nathi* sp. nov. from Hoshiarpur. *Research bulletin of the Panjab University* 2(1–2): 63-67.

Vasishta P.C. (1960b). *Anabaena hoshiarpurensis* sp. nov. from Hoshiarpur. *Research bulletin of the Panjab University* 2(1–2): 93–97.

Vasishta P.C. (1960c). On the structure and life history of *Rivularia mehrai* sp. nov. *Research bulletin of the Panjab University* 2(3–4): 237–244.

Vasishta P.C. (1960d). A systematic and ecological account of the cyanophyceae of Hoshiarpur. *Journal of the Bombay Natural History Society* 57(3): 579–589.

Vasishta P.C. (1961). More cyanophyceae of Hoshiarpur. *Journal of the Bombay Natural History Society* 58(1): 135–146.

Vasishta P.C. (1962a). Some observations on the life history of *Rivularia joshii* sp. nov. from Hoshiarpur (Punjab, India). *Journal of the Indian Botanical Society* 41(4): 516–523.

Vasishta P.C. (1962b). Three colourless Cyanophyceae from Hoshiaipur. *Journal of the Indian Botanical Society* 41(2): 99–103.

Vasishta P.C. (1963a). Five new cyanophyceae from Hoshiarpur. *Journal of the Bombay Natural History Society* 41(1–2): 574–582.

Vasishta P.C. (1963b). More cyanophyceae of Hoshiarpur II. *Journal of the Bombay Natural History Society* 60(3): 671–678.

Whitton, B.A. & M. Potts (2000). Introduction to the Cyanobacteria, pp 1–11. In: Whitton, B.A. & M. Potts (eds.). Ecology of Cyanobacteria: Their Diversity in Space and Time, 632 pp.

Journal of Threatened Taxa is indexed/abstracted in Bibliography of Systematic Mycology, Biological Abstracts, BIOSIS Previews, CAB Abstracts, EBSCO, Google Scholar, Index Copernicus, Index Fungorum, JournalSeek, National Academy of Agricultural Sciences, NewJour, OCLC WorldCat, SCOPUS, Stanford University Libraries, Virtual Library of Biology, Zoological Records.

NAAS rating (India) 5.64

Print copies of the Journal are available at cost. Write to:
The Managing Editor, JoTT,
c/o Wildlife Information Liaison Development Society,
No. 12, Thiruvannamalai Nagar, Saravanampatti - Kalapatti Road,
Saravanampatti, Coimbatore, Tamil Nadu 641035, India
ravi@threatenedtaxa.org

Journal of Threatened Taxa

www.threatenedtaxa.org

ISSN 0974-7907 (Online) | ISSN 0974-7893 (Print)

March 2022 | Vol. 14 | No. 3 | Pages: 20703–20810
Date of Publication: 26 March 2022 (Online & Print)
DOI: 10.11609/jott.2022.14.3.20703-20810

Publisher & Host

WILD ZOOREACH
Threatened Taxa