cryptogamie
Algologie
2021 • 42 • 15

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art. 42 (15) — Published on 22 November 2021
www.cryptogamie.com/algologie

PUBLICATIONS SCIENTIFIQUES
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Cryptogamie, Algologie est une revue en flux continu publiée par les Publications scientifiques du Muséum, Paris
Cryptogamie, Algologie *is a fast track journal published by the Museum Science Press, Paris*

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Diffusion – Publications scientifiques Muséum national d'Histoire naturelle
CP 41 – 57 rue Cuvier F-75231 Paris cedex 05 (France)
Tél. : 33 (0)1 40 79 48 05 / Fax : 33 (0)1 40 79 38 40
diff.pub@mnhn.fr / http://sciencepress.mnhn.fr

ISSN (imprimé / *print*) : 0181-1568 / ISSN (électronique / *electronic*) : 1776-0984

First report of diversity of Cyanobacteria of Broknes Peninsula of Larsemann Hills, East Antarctica

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Submitted on 28 December 2018 | Accepted on 27 July 2021 | Published on 22 November 2021

Gupta P. 2021. — First report of diversity of Cyanobacteria of Broknes Peninsula of Larsemann Hills, East Antarctica. *Cryptogamie, Algologie* 42 (15): 241-251. https://doi.org/10.5252/cryptogamie-algologie2021v42a15. http://cryptogamie.com/algologie/42/15

ABSTRACT
Antarctica is an extreme environment and contains many unique geological, glaciological and biological features. However, due to changes in climatic conditions Antarctica is affected by Global warming. The Larsemann Hills area is located in East Antarctica approximately halfway between Vest fold Hills and Amery Ice Shelf on South-eastern coast of Prydz Bay which includes two main peninsulas, the western named Stornes and the eastern named Broknes. The Antarctic environment is highly sensitive and susceptible to the impacts of human activities and has much less natural ability to recover from disturbance than the environment of other continents. Due to coastal location and ice free landscape, Larsemann Hills is an attractive area for human activities which consit on scientific expeditions as well as touristic activities which are currently increasing. It is hypothesized that due to increase in land use pressure, the growth and diversity of Cyanobacteria in this area may be affected. The aim of this study was to record Cyanobacteria from freshwater bodies, rocks and terrestrial habitats. Considering the two main peninsulas, Stornes peninsula comes under the Antarctic Specially Protected Area (ACPA) so the samples were collected from diverse habitats of Broknes Peninsula. Altogether, 16 species of Cyanobacteria belonging to nine genera were recorded from diverse habitat of Broknes Peninsula of Larsemann Hills. This is the first Indian study report of Cyanobacteria of Broknes peninsula of Larsemann Hills. All species are reported for the first time and therefore constitutes new record from this area.

KEY WORDS
Survey, collection, identification, systematic enumeration, Antarctica.

RÉSUMÉ
Premier rapport sur la diversité des cyanobactéries de la péninsule Broknes des collines Larsemann, Antarctique oriental.
L'Antarctique est un environnement extrême qui présente de nombreuses caractéristiques géologiques, glaciologiques et biologiques uniques. Cependant, en raison des changements des conditions climatiques, l'Antarctique est affecté par le réchauffement de la planète. La région des collines Larsemann est située dans l'Antarctique oriental, à-peu-près à mi-chemin entre les collines de Vest fold et la plate-forme glaciaire d'Amery, sur la côte sud-est de la baie de Prydz, qui comprend deux péninsules principales, l'occidentale nommée Stornes et l'orientale nommée Broknes. L'environnement de l'Antarctique est très sensible et susceptible d'être affecté par les activités humaines et sa capacité naturelle à se remettre des perturbations est bien moindre que celle des autres continents. En raison de la situation côtière et du paysage sans glace, les activités humaines dans la région des collines Larsemann sont dues aux expéditions scientifiques ainsi qu'à l'augmentation du nombre de touristes dans cette région. On suppose qu'en raison de l'augmentation de la pression qui pèse sur l'utilisation des terres, la croissance et la diversité des cyanobactéries peut être affectée dans cette zone.

MOTS CLÉS
Inventaire,
collection,
identification,
recensement systématique,
Antarctique.

L'objectif de cette étude était d'inventorier les cyanobactéries provenant de masses d'eau douce, de rochers et d'habitats terrestres. Parmi les deux péninsules principales, le champ de cette étude s'est concentré sur la péninsule de Stornes qui fait partie de la zone spécialement protégée de l'Antarctique (ACPA). Ainsi les échantillons ont été collectés dans divers habitats de la péninsule de Broknes. Au total, 16 espèces de cyanobactéries appartenant à neuf genres ont été enregistrées dans divers habitats de la péninsule de Broknes des collines de Larsemann. Il s'agit du premier rapport d'étude indien sur les cyanobactéries de la péninsule de Broknes des collines de Larsemann. Toutes les espèces sont inventoriées pour la première fois et constituent donc de nouveaux enregistrements dans cette région.

INTRODUCTION

Larsemann Hills (69°23'S, 76°53'E), in the Prydz Bay, is an ice-free oasis on the Ingrid Christensen Coast, Princess Elizabeth Land, located approximately midway between the eastern extremity of the Amery Ice Shelf and the southern boundary of the Vestfold Hills. This ice-free coastal oasis was named after Mr. Larsemann Christensen. It is the second largest (area of 50 square km) of only four major ice-free oases found along East Antarctica. The highest elevations are around 180 m above sea level (ANARE 2000). Larsemann Hills region includes two main peninsulas, the western named Stornes and the eastern named Broknes. In between these two peninsulas, there are number of islands of varying dimensions and some unnamed promontories. The satellite imagery of the area indicates open sea on the eastern edge of the Broknes Peninsula. Westwards, the Clemence Fjord separates Broknes Peninsula from Stinear Peninsula and Fisher Island.

There are several lakes in the Larsemann Hills (Gillieson *et al.* 1990), ranging from small ephemeral ponds to large water bodies. Some of these water bodies are ice free for the very short period of time or partially ice free in the summer months when the water temperature increase rapidly, reaching about + 8°C in some of the shallower ones. For the remainder of the year (8-10 months), they are covered with about 2.0 m of ice (Hodgson *et al.* 2001).

Cyanobacteria occurs in a wide range of habitats and are distributed all over land and water system often. They can also occur in rather extreme environments where there is no other vegetation possibly due to their adaptive capability to adverse environmental conditions with respect to different climatic/environmental factors, availability of nutrients. Their occurrence even in wide range of ecologically stress conditions and extreme habitats proves that they are very tolerant. In Antarctica it occurs in fresh-water ecosystem like lakes, ponds, and marine water system and ocean. Besides, it also occurs on stones, rocks, snow and in cold lakes (Zakhia *et al.* 2008) and presents interesting qualitative and quantitative variance in time and space.

In Antarctic oasis Cyanobacteria species composition was investigated in Schirmacher oasis in various environment including streams lakes, moss, soil and rock (Pandey *et al.* 2004). Antarctic environment supports the growth of diazotrophic Cyanobacteria which play a key role in nitrogen cycling (Coyne *et al.* 2020). Pandey *et al.* 1992 have studied nitrogen fixation by Cyanobacteria associated with moss communities in Schirmacher oasis, Antarctica. Pandey *et al.* 1995 described nutrient status, algal and Cyanobacteria flora diversity of freshwater streams of Schirmacher oasis, Antarctica (Gupta 2015).

Cyanobacteria studies, were carried out under the Indian Scientific Expedition and other Programmes in and around the Schirmacher oasis; however, hitherto on Cyanobacteria diversity study has been undertaken from Broknes Peninsula of Larsemann Hills, Antarctica.

Sampling of the coastal areas from the Vestfold Hills to the Larsemann Hills conducted by Dhargalkar (1990) indicates that the flora of the Ingrid Christensen Coast is relatively uniform and restricted to bryophytes, lichens and algae. Sabbe *et al.* (2003) have reported Diatom flora in the fresh and saline water Lakes of Larsemann Hills and Rauer Island. Ellis-Evans *et al.* 1998 reported phytoplankton comprises autotrophic nanoflagellates, dinoflagellates and *Cosmarium* from different water bodies and benthic communities of the deep water lakes are dominated by thick Cyanobacteria mats. However, as far as work on algal diversity of Larsemann Hills, Antarctica is concerned, Bharati & Niyogi (2015) have studied phytoplankton only up to class level. Therefore, taxonomic studies of Cyanobacteria is very much required. Studies on Cyanobacteria diversity from diverse habitats of Brokenes Peninsula of Larsemann Hills, East Antarctica are still in a very nascent stage. Attempt has been made to study the diversity and factual Cyanobacterial profile from Brokenes Peninsula of Larsemann Hills, East Antarctica.

MATERIAL AND METHODS

The author participated in the 33rd Indian Scientific Expedition to Antarctica (11.XII.2013-14.IV.2014) to carry out cyanobacterial studies in Broknes Peninsula of Larsemann Hills, East Antarctica during the austral summer and surveyed Broknes Peninsula of Larsemann Hills, Antarctica.

Site description

Larsemann Hills, (Figs 1, 2) form a large area free of snow and ice during the austral summer period. During the survey Cyanobacteria samples were collected. All the samples were processed, fixed and maintained properly for study

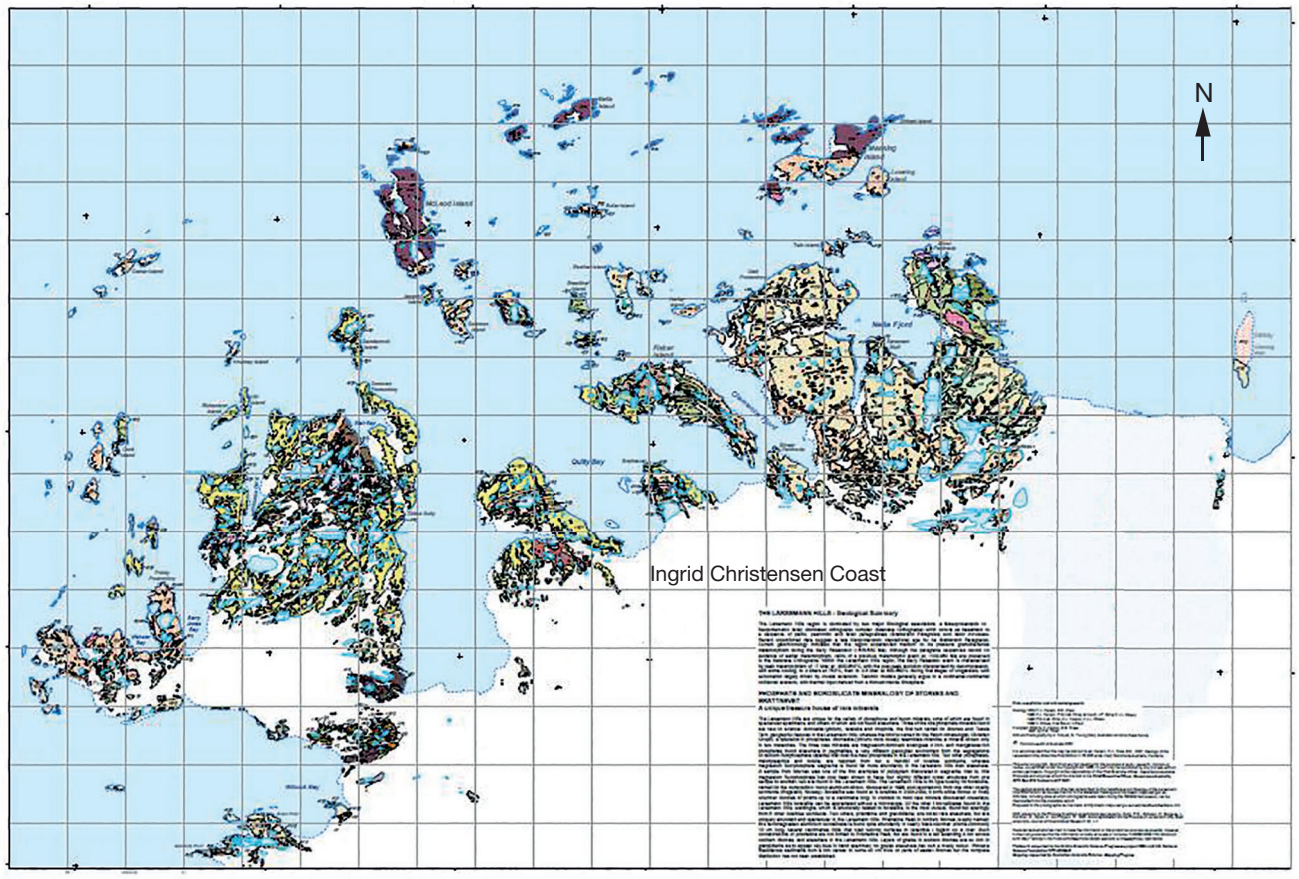

Fig. 1. — Base map of Larsemann Hills, Antarctica.

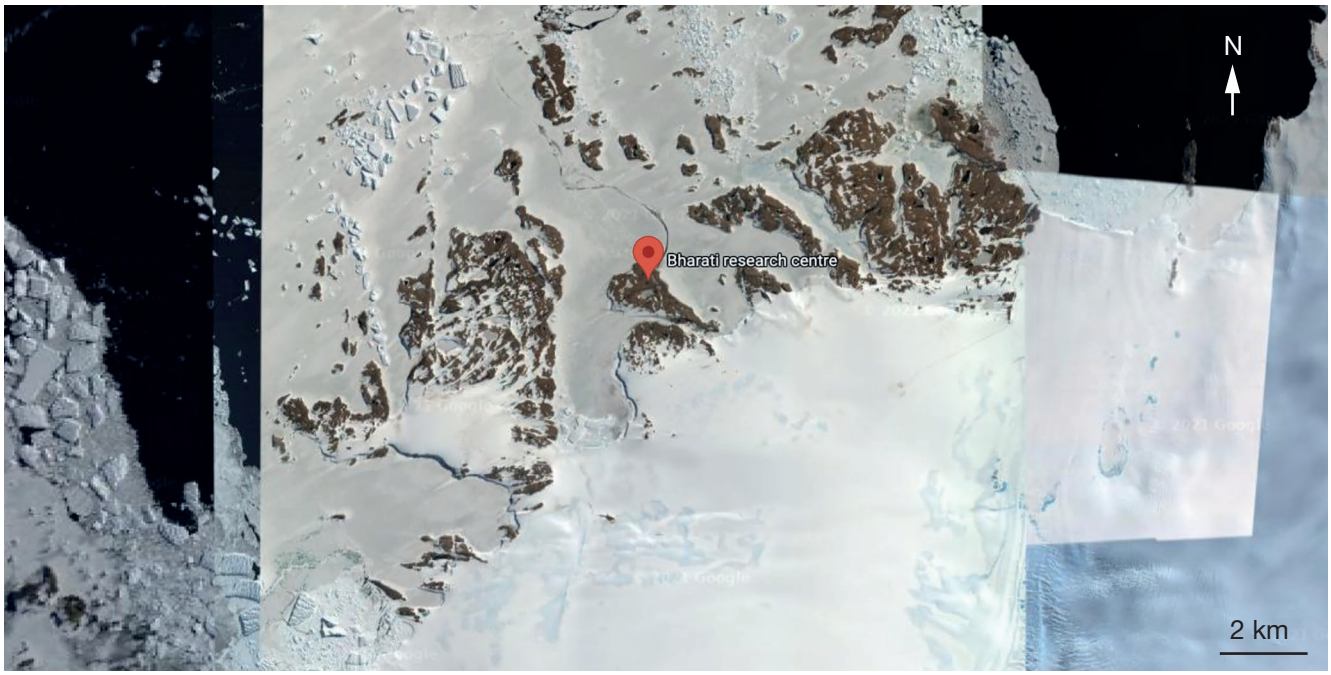

Fig. 2. — Satellite imagery map of Larsemann Hills, Antarctica. Google Earth 2021.

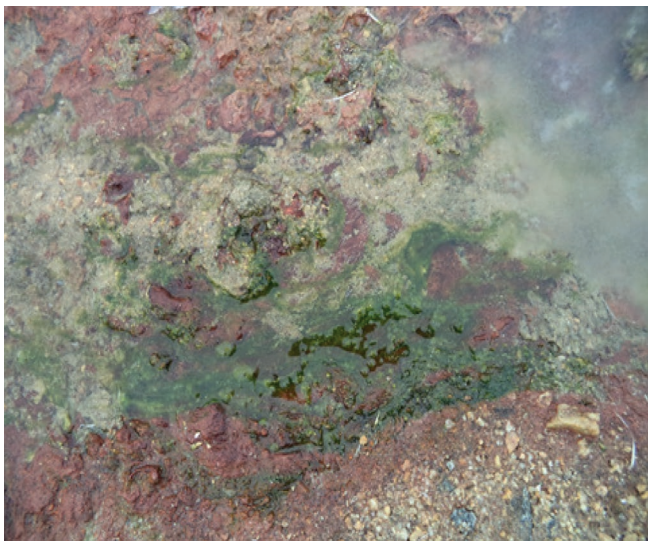

Fig. 3. — Cyanobacteria samples in water logged area on Rock.

and deposited in CBL, Howrah, W.B., India (BSI/Algae/Ant./2013-14/103-113).

Collection and Preservation of Samples

Cyanoprokaryotes samples were collected from diverse habitats like water bodies, lakes, Ponds (Fig. 5) and from terrestrial habitats like moist stones, rocks, water logged area on rocks (Figs 3, 4, 6, 7) of Broknes Peninsula of Larsemann Hills, East Antarctica.

Samples were sampled by towing Phytoplankton net (mesh size 20×) to a distance of 1-5 meter depending up on the depth of water bodies. The samples were preserved in screw cap sampling vials of Tarsons (size 25 × 50mm & 25 × 75mm) by adding 2-4 drops of 4% Formalin solution and labelled with sample number, location, type of water bodies and date of collection. Prior sampling another water body, phytoplankton net was thoroughly washed with water after collection of each sample. Samples were also collected by using forceps, needle, scalper, dropper and brush depending upon the type of the samples and habitat of water bodies.

Identification and taxonomic identification

Specimens were observed under Leica DM 2500 microscope and photomicrographs of each specimen were taken using DFC 500 digital camera and annotated using Leica QWin V 3.2 Image Processing and Analysis Software and Leica Application Suit V4.

Specimens were identified by consulting the following bibliography:

Geitler1932; Tiffany & Britton 1952; Desikachary 1959; Prescott 1982; Anand 1998; Kant & Gupta 1998; Komárek & Anagnostidis 1998, 2005; Komárek 2013; Guiry 2021. The taxonomic classification of Komárek *et al.* 2014 was followed. The author name of each species were cited in the text as described in 'Authors of Plant Names' (Brummitt & Powell 1992), title of books in citation was cited in accordance with Stafleu & Cowan (1976, 1979, 1981, 1983, 1985, 1986, 1988) and supplements as described by Stafleu & Mennege (1992, 1993, 1995, 1997, 1998, 2000), whereas journals, periodicals with botanical content as described by Bridson (2004a, b).

RESULTS

Systematic identification

The list of identified Cyanobacteria from diverse habitats of Broknes Peninsula of Larsemann Hills, East Antarctica is provided along with details including nomenclature and distribution.

Order CHROOCOCCALES Wettst.
Family Chroococcaceae Nägeli
Genus *Chroococcus* Nägeli

Chroococcus minutus (Kütz.) Nägeli

Gattungen einzelliger Algen 46 (Nägeli 1849). Desikachary, *Cyanophyta* 103, t. 24, f. 4. (Desikachary 1959). Komárek & Anagn., *Cyanoprokaryota* Part 1: Chroococcales 19 (1): 296, f. 391 (Komárek & Anagnostidis 1998).

Protococcus minutus Kütz., *Phycologia generalis* 168 (1843).

Description. — Cells spherical or oblong, solitary or in group of 2-4 or sometimes 8 cells; pale green or homogeneous or granular; sheath lamellate, delimited rarely a little diffluent (Fig. 8A).

Dimension. — Cells 4.0-10.0 µm in diameter.

Environment & habitat. — Freshwater species; planktonic; temperature 1°C.

Genus *Gloeocapsa* Kütz.

Gloeocapsa biformis Ercegovic

Acta Botanica Instituti Botanici Universitatis Zabrabensis 10: 80 (Ercegovic 1925). Komárek & Anagn., *Cyanoprokaryota Part 1: Chroococcales* 19 (1): 256, f. 336 (Komárek & Anagnostidis 1998).

Description. — Colony irregular, composed of groups of small sub-colonies; mucilage envelop colourless, yellow or yellow brown, not or slightly lamellate; cells more or less spherical, pale blue-green (Fig. 8B).

Dimension. — Cells 1.8-3.5 µm in diameter.

Environment & habitat. — Marine and terrestrial species, wet rocks; temperature 1°C.

Genus *Cyanosarcina* L.Kovácik

Cyanosarcina burmensis (Skuja) Kovácik

Archiv für Hydrobiologie 80: 177 (Kovácik 1988). — Basionym: *Myxosarcina burmensis* Skuja, Zur *Süsswasseralgenflora Burmas* 21, t. 1, f. 12 (Skuja1949).

Fig. 4. — Cyanobacteria sample after collection in sampling vial.

Description. — Cells more or less angular with rounded corners, almost arranged in transverse and vertical series, pale blue-green or olive-green, homogenous or finely granular; sheath very thin, mucilaginous, hyaline; colonies when young 4 cells (Fig. 8C).

Dimension. — Cells 2.0-3.5 µm in diameter.

Environment & habitat. — Freshwater species; free-floating in water bodies; temperature 2.5°C.

Order OSCILLATORIALES Schaffner
Family Oscillatoriaceae Engler
Genus *Oscillatoria* Vaucher ex Gomont

Oscillatoria anguina Bory ex Gomont

Annales des Sciences Naturelles, Botanique, Série 7, 16: 234, t.4, f. 16. (Gomont 1892). Desikachary, *Cyanophyta* 210, t. 41, f. 5-6

Fig. 5. — Sampling from a lake.

(Desikachary 1959). Komárek & Anagn., *Cyanoprokaryota Part 2*: *Oscillatoriales* 19 (2): 592, f. 885 (Komárek & Anagnostidis 2005).

Description. — Trichome almost straight, sometimes slightly bent, tapering at the end, not constricted or very slightly constricted, cross-walls granulated; screw like more or less twisted and gradually attenuated at the end; cells sometimes distinctly granulated,; end-cells capitate to sickle shape or obtusely button like flattened or rounded with slightly thickened outer wall, rarely with calyptra (Fig. 8D).

Dimension. — Trichome 4.6-6.5 µm broad and cells 1.6-3.4 µm long.

Environment & habitat. — Freshwater species; water logged area; temperature 5°C .

Oscillatoria curviceps C.Agardh ex Gomont

Annales des Sciences Naturelles, Botanique, Série 6, 6: 213, f. 14. (Gomont 1892). Desikachary, *Cyanophyta* 209, t. 38, f. 2 & t. 39, f. 9-10 (Desikachary 1959).

Description. — Trichome more or less straight, slightly bent from upper side, not attenuated or very slightly attenuated, not constricted at the cross-walls, sometimes cross-walls granulated; end-cell flat rounded, not capitate (Fig. 8E).

Dimension. — Trichome 6.6-12.5 µm broad and cells 1.8-2.3 µm long.

Environment & habitat. — Freshwater species; planktonic in lake temperature 2°C.

Oscillatoria jenensis G.Schmid

Jahrbücher für wissenschaftliche Botanik 60: 572, f. 1-2 (1921). — Komárek & Anagn., *Cyanoprokaryota Part 2: Oscillatoriales* 19 (2): 590 (2005).

Description. — Trichome straight, not constricted or somewhat constricted, indistinctly granulated at cross-walls, shortly attenuated at the end and slightly bent, one or more terminal cells usually pale, yellowish or yellow green; apical cell convex, widely rounded or somewhat slightly conical rounded, usually indistinctly curved, not capitate, calyptra absent or slightly thickened cell wall (Fig. 8K).

Dimension. — Trichome 6.2-11.0 µm broad and 1.0-4.5 µm long.

Environment & habitat. — Terrestrial species; wet rocks; temperature 3°C .

Oscillatoria limosa C.Agardh ex Gomont

Annales des Sciences Naturelles, Botanique, Série 210, t.6/6, f. 13 (Gomont 1892). Desikachary, *Cyanophyta* 206, t. 42, f. 11 (Desikachary 1959). Komárek & Anagn., *Cyanoprokaryota Part 2: Oscillatoriales* 19 (2): 593, f. 886 (Komárek & Anagnostidis 2005).

Description. — Trichome dull blue-green to brownish, more or less straight, sometimes slightly curved, not constricted at the cross-walls or slightly constricted; cross-walls usually frequently granulated; end cell flatly rounded or obtuse-rounded with slightly thickened outer membrane (Fig. 8F).

Dimension. — Trichome 5.1-9.6 µm broad and cells 1.5-5.0 µm long.

Environment & habitat. — Freshwater species; stagnant/free/slow-floating in the form of mats; temperature 1°C.

Oscillatoria tenuis C.Agardh ex Gomont

Annales des Sciences Naturelles, Botanique, Série 7 (16): 220 (1892). Desikachary, *Cyanophyta* 222, t. 42, f. 15 (Desikachary 1959). Komárek & Anagn., *Cyanoprokaryota Part 2: Oscillatoriales* 19 (2): 587, 878 (Komárek & Anagnostidis 2005).

Description. — Trichome more or less straight or very slightly curved, very slightly constricted or not constricted at the cross-walls; not attenuated at the apices but very slightly rarely curved at the end, not capitate; septa mostly granulated; apical cell more or less hemispherical or rounded; outer membrane sometimes slightly thickened (Fig. 8M).

DIMENSION. — Trichome 5.8-11.5 µm broad and cells 2.13-3.5 µm long.

ENVIRONMENT & HABITAT. — Freshwater species; free-floating, wet rocks & moist stones; temperature 2°C.

Genus *Phormidium* Kütz. ex Gomont

Phormidium ambiguum Gomont

Annales des Sciences Naturelles, Botanique, Série 7 (16): 178 (Gomont 1892). Desikachary, *Cyanophyta* 266, t. 44, f. 16 (Desikachary 1959). Komárek & Anagn., *Cyanoprokaryota Part 2: Oscillatoriales* 19 (2): 479 (Komárek & Anagnostidis 2005).

DESCRIPTION. — Filament elongate; sheath thin, firm, mucilaginous, colourless, sometime thicker diffluent, sometimes more or less lamellated; trichome slightly constricted or sometimes not constricted at the cross-walls; end not attenuated, not capitate, blue-green; cells not granulated at the cross-walls or sometimes granulated; end cell rounded, calyptra absent (Fig. 8I).

DIMENSION. — Trichome 3.5-7. 8 µm broad and cells 1.2-3.4 µm long.

ENVIRONMENT & HABITAT. — Freshwater and marine species; wet rocks, free-floating & benthic in stagnant water; temperature 3.5°C.

Phormidium bekesiense (I.Kiss) K.Kiss

Preslia 73: 374 (Anagnostidis 2001). Komárek & Anagn., *Cyanoprokaryota Part 2: Oscillatoriales* 19 (2): 465, f. 686 (Komárek & Anagnostidis 2005). — Basionym: *Oscillatoria bekesiensis* I.Kiss, *Szegedi Pedagógiai Föiskola évkönyve* 19, t. 1, f. 3-5 (Desikachary 1959).

DESCRIPTION. — Trichome more or less straight or cylindrical, not constricted at the cross-walls, not attenuated towards end, capitate at the end; cells distinctly granular at the cross-walls; apical cell capitate, spherical, usually narrower than other vegetative cells (Fig. 8J).

DIMENSION. — Trichome 4.6-8.5 µm broad and cells 1.6-3.5 µm long.

ENVIRONMENT & HABITAT. — Freshwater species; wet rocks & in lake water; temperature 3°C.

Phormidium subfuscum Kütz. ex Gomont

Phycologia generalis: 195 (Kützing 1843). Tiffany & Britton, *The Algae of Illinois* 332, t. 90, f. 1044 (Tiffany & Britton 1952). Desikachary, *Cyanophyta* 273, t. 44, f. 22-23 (Desikachary 1959).

DESCRIPTION. — Trichome straight, blue-green or sometimes olive-green, not constricted at the cross-walls, generally cross-walls granulated, slightly narrow apically, sometimes sub-quadrate; end more or less briefly attenuated, capitate; end cells straight, acute-conical (Fig. 8L).

DIMENSION. — Trichome 5.4-11.0 µm broad and cells 2.1-3.9 µm long.

ENVIRONMENT & HABITAT. — Freshwater species; stagnant water; temperature 1°C.

FIG. 6. — Cyanobacteria sample in water logged area.

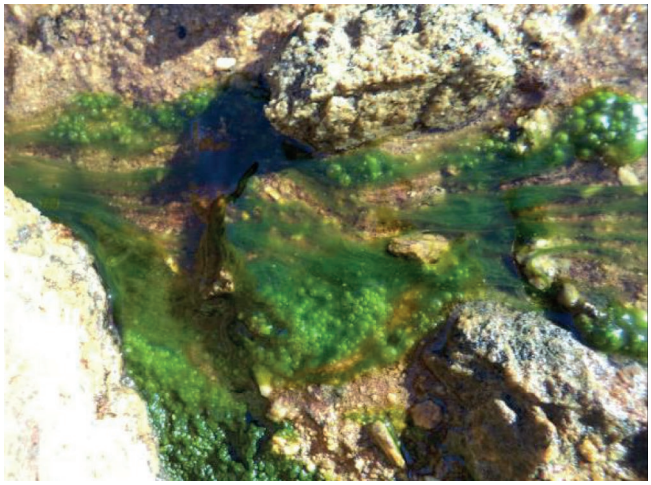

FIG. 7. — Cyanobacteria samples in water logged area on rock.

Genus *Lyngbya* C.Agardh ex Gomont

Lyngbya confervoides C.Agardh ex Gomont

Annales des Sciences Naturelles, Botanique, Série 7, 15: 136 (Gomont 1892). Desikachary, *Cyanophyta* 314, t. 49, f. 9 & t. 52, f. 13 (Desikachary 1959). Komárek & Anagn., *Cyanoprokaryota Part 2: Oscillatoriales* 19 (2): 623, f. 945 (Komárek & Anagnostidis 2005).

DESCRIPTION. — Filament almost straight; sheath colourless, homogenous, later becoming slightly thicker, lamellated; trichome olive-green or blue-green, usually not constricted at the cross-walls, cross-walls granulated, not attenuated at the end; apical cell rounded, calyptra absent (Fig. 8H).

DIMENSION. — Trichome 7.6-12.0 µm broad and cells 2.0-3.8 µm long.

ENVIRONMENT & HABITAT. — Marine species; wet rocks; temperature 3.5°C.

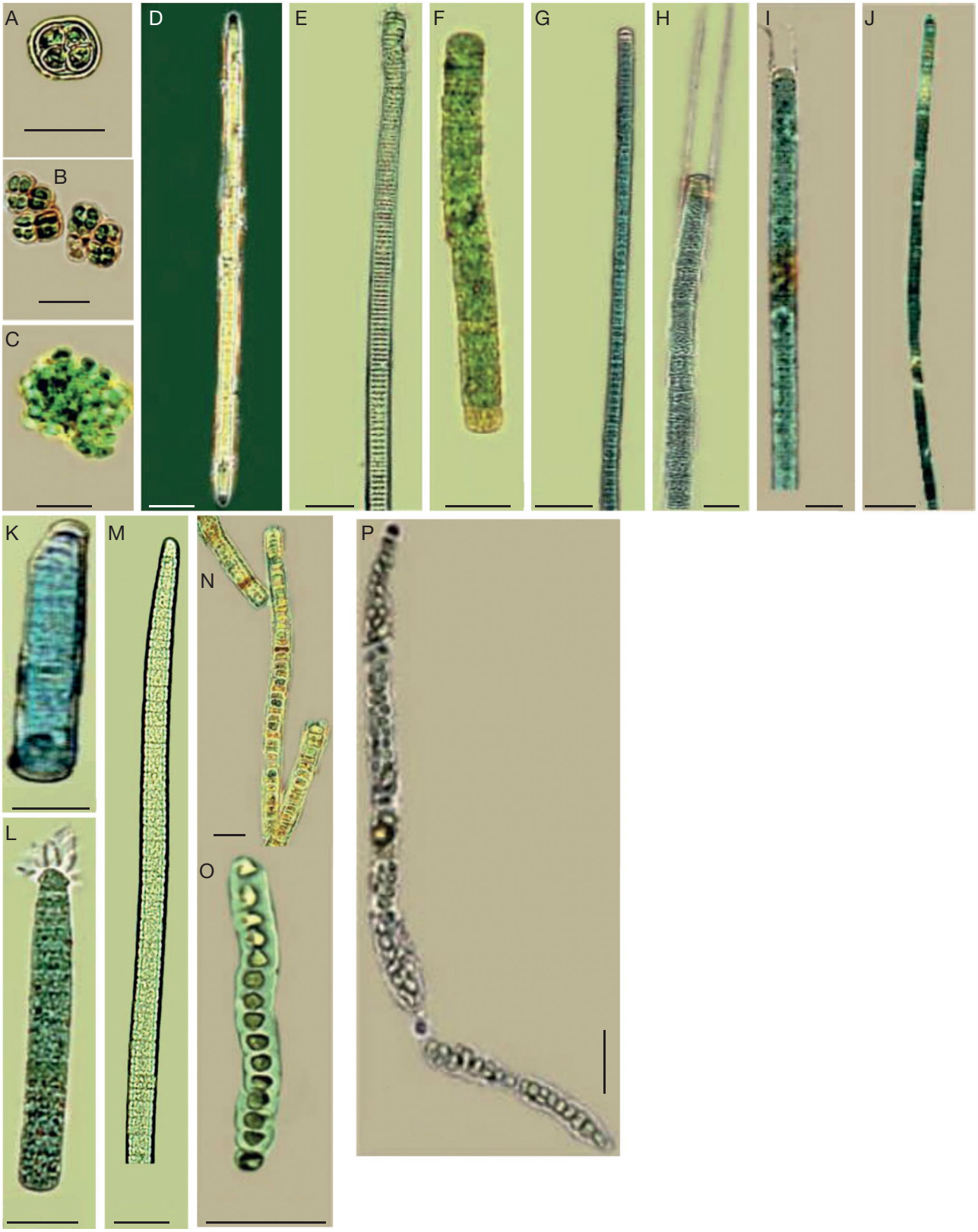

Fig. 8. — Cyanoprokaryotes of Broknes Peninsula. **A**, *Chroococcus minutus* (Kütz.) Nägeli; **B**, *Gloeocapsa biformis* Ercegovic; **C**, *Cyanosarcina burmensis* Skuja, **D**, *Oscillatoria anguina* (Bory) Gomont; **E**, *Oscillatoria curviceps* C.Agardh ex Gomont; **F**, *Oscillatoria limosa* C.Agardh ex Gomont; **G**, *Planktothrix rubescens* (DC. ex Gomont) Anagn. & Komárek; **H**, *Lyngbya confervoides* C.Agardh ex Gomont; **I**, *Phormidium ambiguum* Gomont; **J**, *Phormidium bekesiense* (I.Kiss) K.Kiss,; **K**, *Oscillatoria jenensis* G.Schmid; **L**, *Phormidium subfuscum* Kütz. ex Gomont; **M**, *Oscillatoria tenuis* C.Agardh ex Gomont; **N**, *Aulosira fritschii* Bharadwaja; **O**, *Coleospermum goeppertianum* (goppertianum) Kirch. ex Frank; **P**, *Stigonema mesentericum* Geitler. Scale bars: A, N, O, 30 µm; B, C, F, I, L, 10 µm; D, E, G, H, J, K, M, P, 20 µm.

Family Microcoleaceae
O.Strunecky, J.R.Johansen & J.Komárek
Genus *Planktothrix* Anagn. & Komárek

Planktothrix rubescens (De Candolle. ex Gomont) Anagnostidis & Komárek

Archiv für Hydrobiologie 80: 416 (1988). — Basionym: *Oscillatoria rubescens* DC. ex Gomont, *Annales des Sciences Naturelles, Botanique, Série* 7, 16: 204 (Gomont 1892).

Description. — Trichome solitary, straight, gradually attenuated at the end, not constricted at the cross-walls; cells granulated, mostly granulated at the septa; apical cell capitate with convex calyptra (Fig. 8G).

Dimension. — Trichome 6.2-8.0 µm broad and cells 2.1-4.1 µm long.

Environment & habitat. — Freshwater species; lake; temperature 4°C.

Order NOSTOCALES Geitler
Family Nostocaceae Eichler
Genus *Aulosira* Kirch. ex Bornet & Flahault

Aulosira fritschii Bharadwaja

Annals of Botany 47: 123, f. 3-4 (Bharadwaja 1933). Desikachary, *Cyanophyta* 432, t. 80, f. 7-12 (Desikachary 1959).

Description. — Filament long, more or less straight or slightly bent; sheath hyaline, outer portion diffluent; trichome constricted at the cross-walls; cells contents finely granular; heterocysts single and intercalary, cylindrical, rarely elongate cylindrical (Fig. 8N).

Dimension. — Filament 12.0-21.0 µm broad; trichome 7.0-14.0 µm broad; heterocysts 8.2-14.0 µm broad.

Environment & habitat. — Freshwater species; pond & lake; temperature 0.5°C.

Family Microchaetaceae Lemmerm.
Genus *Coleospermum* Kirch. ex Bornet et Flahault

Coleospermum goeppertianum (***goppertianum***) Kirch. ex Frank

Dr. Johannes Leunis Synopsis der Pflanzenkunde 3: 222 (Frank 1886).

Description. — Filament mostly solitary, more or less straight or slightly curved; cells more or less short cylindrical, sometimes slightly lenticular, mostly separated from one another; heterocysts only basal, ovate, or globose or compressed globose; sheath thin, without lamellation (Fig. 8O).

Dimension. — Cells 3.6-5.8 µm broad; heterocysts 5.0-6.5 µm broad.

Environment & habitat. — Freshwater species; planktonic; temperature 0.5°C.

Family Stigonemataceae Kirchn.
Genus *Stigonema* C.Agardh ex Bornet & Flahault

Stigonema mesentericum Geitler

Die Süsswasser-Flora Deutschlands, Österreichs und der Schweiz 184, f. 223 (Geitler 1925). Desikachary, *Cyanophyta* 607, t. 134, f. 5-7 (Desikachary 1959).

Description. — Filament prostrate, dense with sometimes very short protuberant branches, coralloid like; sheath firm, transparent or yellow brown; trichome mostly with 2 - 4 or sometimes with many rows of cells, in older part of the filament cells with a special envelop; heterocysts intercalary (Fig. 8P).

Dimension. — Cells 3.6-11.3 µm broad; heterocysts 5.0-6.0 µm broad.

Environment & habitat. — Terrestrial species; moist rocks; temperature 4°C.

DISCUSSION

Specimens collected during botanical survey are the sources for taxonomic studies. Altogether sixteen species of cyanobacteria were identified from Broknes peninsula of Larsemann Hills, East Antarctica. The most speciose genus was *Oscillatoria* with five species recorded namely *Oscillatoria anguina*, *O. curviceps*, *O. jenensis*, *O. limosa* and *O. tenuis* followed by *Phormidium* with three species namely *Phormidium ambiguum*, *P. bekesiense* and *P. subfuscum* recorded from Broknes peninsula. The following taxa only recorded one species per genus. *Chroococcus minutus*, *Cyanosarcina burmensis*, *Gloeocapsa biformis*, *Lyngbya confervoides*, *Aulosira fritschii*, *Coleospermum goeppertianum* (*goppertianum*), *Planktothrix rubescens* and *Stigonema mesentericum*. Gupta (2019) reported cyanobacteria and algae from ice of frozen lake of Stenear Peninsula of Larsemann Hills, Antarctica and recorded maximum species of cyanobacteria in comparison to other group of algae but from Broknes Peninsula recorded more cyanobacteria species in comparison to Stenear Peninsula. This clearly indicates that this area accommodate a rich diversity of cyanobacteria. *Lyngbya confervoides*, *Oscillatoria rubescens* (now known as *Planktothrix rubescens*) and *O. tenuis* observed from Broknes Peninsula having medicinal and chymotrypsin activity inhibitory properties. (Matthew *et al.* 2007). Kreitlow *et al.* 1999 reported that *Planktothrix rubescens* and *O. tenuis* having antibacterial properties against Gram-positive Bacteria like *Staphylococcus aureus*, *Bacillus subtilis* and *Micrococcus flavus*. Species found in this area can be used for preparation of safe medicines.

CONCLUSION

Cyanobacterial biogeography in Antarctica offers many challenges and opportunities to study *in situ* the nature and rates of adaptation of these organisms in harsh climatic conditions and geographically isolated conditions. This study constitutes a first steps towards the assessment of cyanobacterial diversity

that should be pursue by conducting phylogenetic inferences to understand in an evolutionary context the adaptive strategies developed by these organisms to thrive in this extreme harsh climatic conditions.

Acknowledgements
The author is thankful to Director, Botanical Survey of India, Kolkata for providing facilities. Author is also grateful to the Secretary, Ministry of Earth Sciences and Director, NCAOR, Dr. Rahul Mohan, Programme Director Science, Dr. Javed Beg, Programme Director Logistics, NCAOR, Goa and Leader Indian Scientific Expedition to Antarctica at Indian Research Station : Bharati for Logistic support and help during expedition. Author is also thankful to the reviewers for the careful and insightful review of this manuscript.

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Submitted on 28 December 2018;
accepted on 27 July 2021;
published on 22 November 2021.