

First Report of Lichens from Burachapori Wildlife Sanctuary with New Records for Assam and India

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ABSTRACT

Although lichens significantly contribute to biodiversity and are crucial bioindicators of ecosystem health, their broad diversity is still inadequately studied in several regions. To provide fundamental data for ecological monitoring and planning for conservation, this study assessed lichen diversity, composition, and distribution across the study area. This work was performed in Burachapori Wildlife Sanctuary under the Nagaon Wildlife Division of

Assam to document the lichen diversity for the first time. Systematic sampling was used in field surveys at specific locations, and lichen specimens were identified using morphological, anatomical, and chemical characteristics. The study revealed the occurrence of 61 lichen species belonging to 28 genera and 18 families, with crustose types of growth forms being the most dominant, followed by foliose, fruticose and squamulose. Among them, *Gyalecta effervescens* and *Pyrenula expectata* are new to India, whereas *Herpothallon minutum*, *Diorygma albocinerascens*, *Anisomeridium glaucescens*, *Bactrospora myriadea*, *Parmotrema stuppeum*, *Pyxine asiatica*, *Ramalina capensis*, and *Ramalina nervulosa* are new records to the state of Assam. Microclimatic factors, habitat disturbance, and substrate type were all closely associated with variations in species composition. The findings emphasise the ecological importance of less disturbed habitats in supporting diverse lichen populations and highlight how environmental conditions affect lichen variety. This study illustrates the importance of lichens as indicators for biodiversity assessment and environmental change and contributes to regional lichen surveys with new additions.

Keywords Bio indicators, Lichen diversity, Biodiversity assessment, New additions.

INTRODUCTION

The lichens are dual organisms with a symbiotic association of a fungal and an algal partner. Globally, about 20,000 species of lichens are known, and from

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India, a total of 3, 200 species are reported (Sinha *et al.* 2024). A wide variety of lichens in protected areas shows that these places have potential ecological quality and stable habitats, since lichens are sensitive to changes in the environment. Joshi and Upreti (2016) described lichens from the Western Ghats, which is considered one of the biodiversity hotspots in India. Being a part of the Northeastern Indian biogeographic zone on the foothills of the Eastern Himalayas, Assam possess a rich flora and fauna, including the lichens. The varied climate and topography influence the occurrence of rich lichen diversity in Assam (Singh *et al.* 2015). Various researchers from Assam conducted lichen exploration, making significant new contributions (Hazarika *et al.* 2011, Daimari *et al.* 2017, Gogoi *et al.* 2019). However, exploration and reports of lichens are still inadequate for the state. Gupta and Sinha (2018) enumerated a total of 300 species of lichens belonging to 83 genera and 26 families from Assam in their book on 'Lichen flora of Assam'. However, more species have been added to the list in recent years, and currently state has 749 species (Sinha *et al.* 2024). Several ecologically interesting sites are still remain unexplored for lichens in the state and Burachapori Wildlife Sanctuary is one such area.

Burachapori Wildlife Sanctuary, a scenic protected area, is situated in Sonitpur district under Nagaon Wildlife Division at geo-coordinates 26°30'32"N to 26°33'40"N latitude and 92°35'54"E to 92°46'07"E longitude. The sanctuary covers an area of 44.06 km² with a thick vegetation of various plant species. The sanctuary lies on the southern flood plain of the river Brahmaputra and get submerged during the monsoon. The sanctuary is popular for the One-horned rhinoceros and the endangered Bengal Florican. Bhaumik and Phukan (2012) reported a total of 254 species of angiosperms and 12 species of pteridophytes from this sanctuary. Although the lichens are a common floristic element of the sanctuary, found luxuriantly growing on the tree trunk, branches and leaves, there have been no attempts to document their diversity. Therefore, this is the first attempt to document lichens from the sanctuary.

MATERIALS AND METHODS

A total of 330 lichen samples were collected from

various locations of Burachapori Wildlife Sanctuary during October 2021 to May 2023 as shown in Fig. 1. The lichens are collected along with the substratum such as bark and whereas the foliose are collected by detaching them from the substratum. The samples were air-dried and preserved in herbarium packets. The specimens were examined for their morphology, anatomy and chemical constituents. Leica EZ24 stereozoom microscope was used to observe the external morphology and the anatomical structures were studied under Leica DM500 light microscope with a camera attachment. Thin, hand-cut sections of thallus and ascomata were mounted in plain water, observed under light microscope and the measurements are recorded. Lactophenol cotton blue was used for staining the sections. The reagents such as 10% aqueous solution of potassium hydroxide (K), Steiner's stable paraphenylenediamine solution (PD) and calcium hypochlorite solution (C) were used during spot tests. To identify the lichen substances Thin Layer Chromatography was performed in solvent system A (Toluene: Dioxan: Acetic Acid, 180:60:8) following Walker and James (1980) and Orange *et al.* (2001). For identifying the lichen specimens up to species level the keys of Awasthi (1991 2007), Nayaka (2004), and Bajpai and Upreti (2014) were consulted. Wijayawardene *et al.* (2020) was consulted for arranging species under various families.

RESULTS

The present study reveals a total of 61 lichen species belonging to 28 genera and 18 families (Table 1). The list of lichens has been enlisted and presented in Table- 1 and Figs. 2-3.

Enumeration of the newly recorded species

New records to India

Family: Gyalectaceae

1. *Gyalecta effervescens* Nyl.

Thallus corticolous and crustose. The thallus is thin, effuse, whitish, disc plane, yellowish, apothecia 0.25 mm diameter. Apothecia are coloured, exciple cartilaginous, paraphyses unbranched, confluent, and first

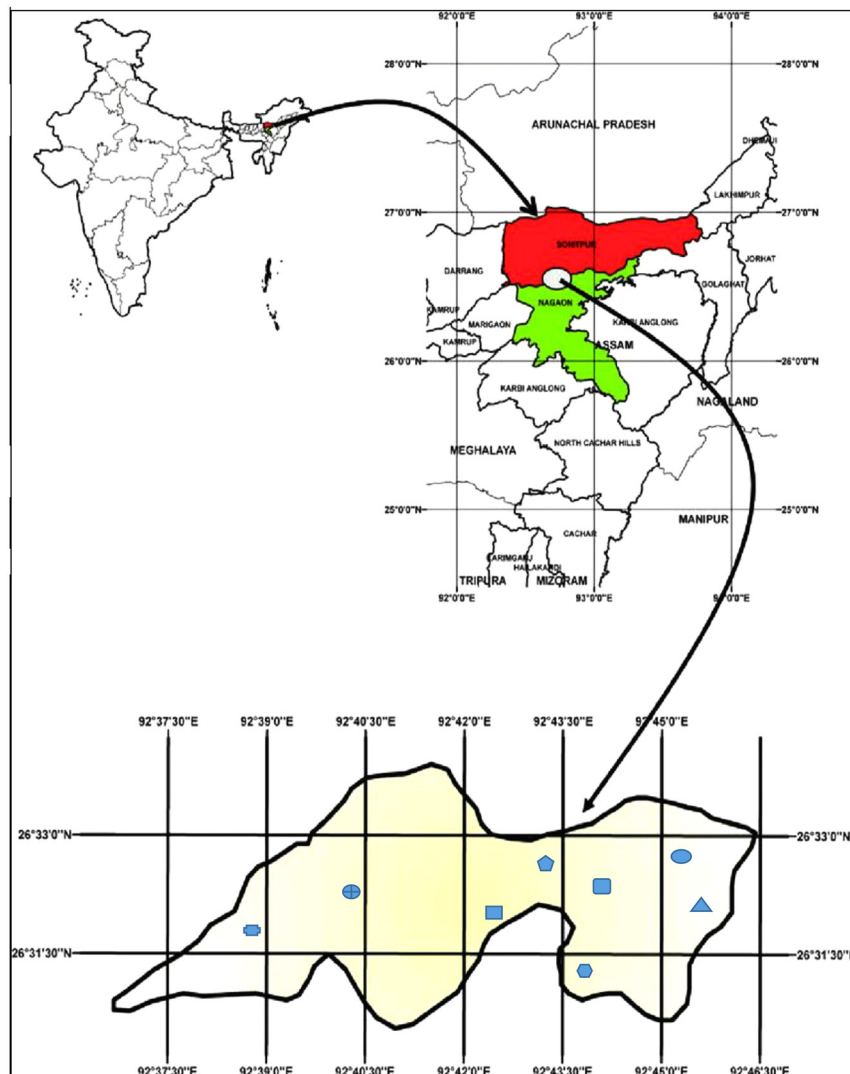


Fig. 1. Map showing the location of Bura Chapori Wildlife Sanctuary (map modified from Balasubramanian *et al.* 2016).

Major locations of Lichen collections:

- - Shiali
- - Lathimari
- - Bogoriati
- - Jawni
- - Karaitali
- - Thulomukoli
- ▲ - Burachapori Dhania Range Office
- - Kachodhora

sunken before becoming elevated and adnate. Asci 8-spored; ascospores colorless, transversely 3-many septate or muriform, fusiform to oval. 16-20 x 4 μ m spores are characteristics of the taxon.

Ecology and distribution: On bark of the tree. G.

effervescens is known to exist in Sri Lanka only. For the first time recorded for India.

Specimen examined: Specimen observed in Dhania range of Burachapori Wildlife sanctuary, Assam, India, 26°32'1.79"N, 92°45'26.71"E., Elev.60m, 8 May,

Table 1. List of lichens of Burachapori Wildlife Sanctuary, Assam, India.

Serial No.	Species	Family	Growth form
1.	** <i>Anisomeridium glaucescens</i> (Müll. Arg) R.C. Harris	Monoblastaceae	Crustose
2.	** <i>Bactrospora myriadea</i> (Fée) Egea & Torrente	Arthoniales - Gen. Incertae sedis	Crustose
3.	<i>Cryptothecia candida</i> (Kremp.) R.Sant.	Arthoniaceae	Crustose
4.	** <i>Diorygma albocinerascens</i> Makhija, Chitale & B.O. Sharma	Graphidaceae	Crustose
5.	** <i>Herpothallon minutum</i> Jagadeesh Ram	Arthoniaceae	Crustose
6.	** <i>Parmotrema stuppeum</i> (Taylor) Hale	Parmeliaceae	Foliose
7.	** <i>Pyxine asiatica</i> Vain.	Caliciaceae	Foliose
8.	** <i>Ramalina capensis</i> Th. Fr.	Ramalinaceae	Fruticose
9.	** <i>Ramalina nervulosa</i> (Müll.Arg.) Abbayes	Ramalinaceae	Fruticose
10.	<i>Gyalecta effervescens</i> Nyl.	Gyalectaceae	Crustose
11.	<i>Pyrenula expectata</i> R.C. Harris	Pyrenulaceae	Crustose
12.	<i>Anisomeridium tamarindi</i> (Fée) R.C. Harris.	Monoblastaceae	Crustose
13.	<i>Bacidia spadicea</i> (Ach.) Zahlbr	Ramalinaceae	Crustose
14.	<i>Bacidia medialis</i> (Tuck ex Nyl.) Zahlbr.	Ramalinaceae	Crustose
15.	<i>Bactrospora paludicola</i> Kantvilas	Arthoniales - Gen. Incertae sedis	Crustose
16.	<i>Bulbothrix setschwanensis</i> (Zahlbr.) Hale	Parmeliaceae	Foliose
17.	<i>Caloplaca kashmirensis</i> Y. Joshi & Upreti	Teloschistaceae	Crustose
18.	<i>Chrysotrix chlorina</i> (Ach.) J.R.Laundon	Chrysotrichaceae	Crustose
19.	<i>Coniocarpon cinnabarinum</i> DC	Arthoniaceae	Crustose
20.	<i>Cresponea flava</i> (Vain.) Egea & Torrente.	Opegraphaceae	Crustose
21.	<i>Diorygma junghuhnii</i> (Mont. & Bosch) Kalb, Staiger & Elix.	Graphidaceae	Crustose
22.	<i>Diorygma pruinosum</i> (Eschw.) Kalb, Staiger & Elix.	Graphidaceae	Crustose
23.	<i>Dirinaria aegialita</i> (Afzel. Ex. Ach) B.J. Moore	Caliciaceae	Foliose
24.	<i>Dirinaria applanata</i> (Fée) D.D.Awasthi	Caliciaceae	Foliose
25.	<i>Dirinaria confluens</i> (Fr.) D.D. Awasthi	Caliciaceae	Foliose
26.	<i>Dirinaria consimilis</i> (Stirt) D.D. Awasthi	Caliciaceae	Foliose
27.	<i>Dirinaria papillulifera</i> (Nyl.) D.D. Awasthi	Caliciaceae	Foliose
28.	<i>Glyphis cicatricosa</i> Ach.	Graphidaceae	Crustose
29.	<i>Graphis caesiella</i> Vain.	Graphidaceae	Crustose
30.	<i>Graphis cincta</i> (Pers.) Aptroot	Graphidaceae	Crustose
31.	<i>Graphis dendrogramma</i> Nyl.	Graphidaceae	Crustose
32.	<i>Graphis distincta</i> Mahija & Adaw.	Graphidaceae	Crustose
33.	<i>Graphis glaucescens</i> Fée	Graphidaceae	Crustose
34.	<i>Graphis lineola</i> Ach.	Graphidaceae	Crustose
35.	<i>Graphis pertriosa</i> (Kremp.) A.W Archer	Graphidaceae	Crustose
36.	<i>Graphis submarginata</i> Lücking	Graphidaceae	Crustose
37.	<i>Graphis vittata</i> Müll. Arg.	Graphidaceae	Crustose
38.	<i>Lecanora helva</i> Stizenb	Lecanoraceae	Crustose
39.	<i>Letrouitia transgressa</i> (Malme) Hafellner & Bellem.	Letrouitiaceae	Crustose

Table 1. Continued.

Serial No.	Species	Family	Growth form
40.	<i>Malmidea subaurigera</i> (Vain) Kalb, Rivas Plata & Lumbsch	Malmideaceae	Crustose
41.	<i>Opegrapha vulgata</i> (Ach.) Ach.	Graphidaceae	Crustose
42.	<i>Parmotrema praesorediosum</i> (Nyl.) Hale	Parmeliaceae	Foliose
43.	<i>Parmotrema tinctorum</i> (Despr. ex Nyl.) Hale	Parmeliaceae	Foliose
44.	<i>Parmotrema saccatilobum</i> (Taylor) Hale	Parmeliaceae	Foliose
45.	<i>Phyllocharis orbicularis</i> (Fr.) S.H. Jiang, Lücking & Sérus	Strigulaceae	Crustose
46.	<i>Phyllopsora furfuracea</i> (Pers.) Zahlbr.	Ramalinaceae	Squamulose
47.	<i>Physcia tribacioides</i> Nyl.	Physciaceae	Foliose
48.	<i>Porina interstes</i> (Nyl.) Harm	Pertusariaceae	Crustose
49.	<i>Porina subhibernica</i> Upreti.	Pertusariaceae	Crustose
50.	<i>Pyrenula complanata</i> (Mont.) Trevis	Pyrenulaceae	Crustose
51.	<i>Pyrenula microcarpa</i> Müll. Arg.	Pyrenulaceae	Crustose
52.	<i>Pyrenula nanospora</i> (Ajay Singh) Upreti	Pyrenulaceae	Crustose
53.	<i>Pyrenula quassitcola</i> (Fée) Fée	Pyrenulaceae	Crustose
54.	<i>Pyrenula welwitschii</i> (Upreti & Ajay Singh) Aptroot	Pyrenulaceae	Crustose
55.	<i>Pyxine cocoes</i> (Sw.) Nyl.	Caliciaceae	Foliose
56.	<i>Pyxine farinosa</i> Kashiw	Caliciaceae	Foliose
57.	<i>Pyxine reticulata</i> (Vain.) Vain.	Caliciaceae	Foliose
58.	<i>Pyxine sorediata</i> (Ach.) Mont.	Caliciaceae	Foliose
59.	<i>Pyxine subcinerea</i> Stirt.	Caliciaceae	Foliose
60.	<i>Ramalina hossei</i> Vain.	Ramalinaceae	Fruticose
61.	<i>Strigula elegans</i> (Fée) Müll. Arg.	Strigulaceae	Crustose

Note: *New records to India, ** New records to the state of Assam.

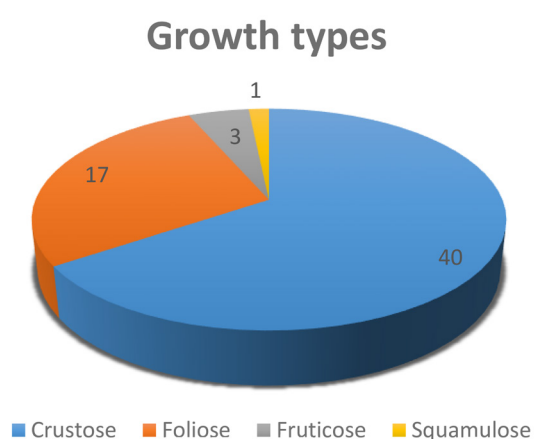


Fig. 2. Growth forms representation with number of species.

2022 .D. Tamang & Mandira Sarma 65434 (LWG).

2. *Pyrenula expectata* R.C. Harris

Family: Pyrenulaceae

Description: Not pseudocyphellate, but thallus corticate, UV-. Immersed ascomata, hemispherical, 0.4-0.5 mm in diameter, 0.3 mm high, with an ostiole at the apex and no crystals; hymenium not interspersed. Biserial, fusiform, four-celled ascospores with smaller, longer end cells that measure 24-29 x 10-12 µm.

Ecology and distribution: Specimen observed on the bark of the tree. Earlier not recorded in India.

Species examined: Specimen observed in Kachodho-

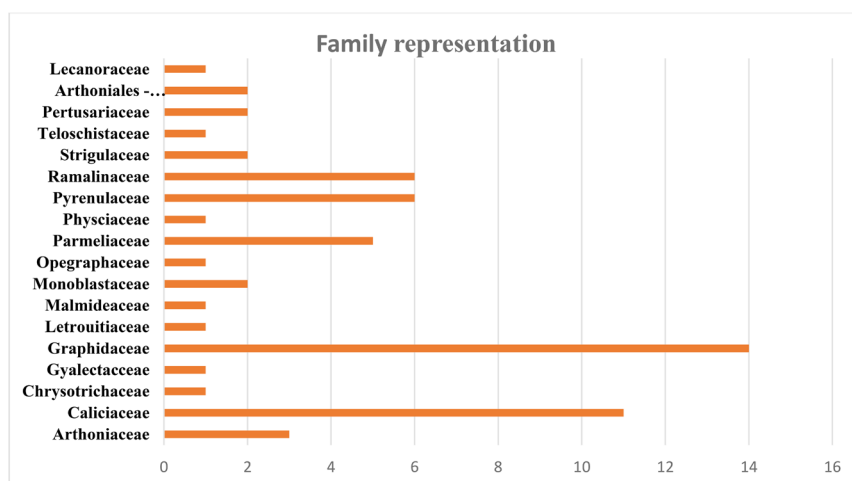


Fig. 3. Family representation by species.

ra region of Burachapori Wildlife Sanctuary, Assam, India. 26°32'35.52"N, 92°44'28.60"E, 8 May 2022. D. Tamang & Mandira Sarma 65463(LWG).

New records to Assam

1. *Herpothallon minutum* Jagadeesh Ram

Family : Arthoniaceae

Description: Greenish grey to greyish yellow herpothallon with a thallus that is firmly to loosely attached, a white prothallus and hypothallus, granular globular to short cylindrical pseudoisidia. Many, compact, tiny, granular, globular to short cylindrical, aggregated, crowded, primarily simple, felty, with protruding hyphae, are Pseudoisidia.

Ecology and distribution: Corticolous and hence observed on the bark. Earlier record in India, Andaman Islands, Middle Andaman, Rampur Beach. For the first time recorded in Assam.

Species examined: Karaitali region of the Burachapori Wildlife Sanctuary, Assam, India. 26°32'46.93"N, 92°43'49.51"E, Elev. 58m, 7 May 2022. D. Tamang & Mandira Sarma 65419(LWG).

2. *Pyxine asiatica* Vain

Family: Caliciaceae

Description: Thallus corticolous, to 3 cm across;

lobes 0.8-1.5 mm wide at periphery; upper side grey to greenish grey, white-maculate, maculae later fissured into pseudocypheae; soralia laminal, orbicular; soredia farinose; medulla white. Apothecia not known.

Ecology and Distribution: Observed on barks hence corticolous, earlier reported from Kerala.

Specimen examined: Karaitali region of the Burachapori Wildlife Sanctuary, Assam, India. 26°32'32.94"N, 92°43'48.59"E, Elev. 58 m, 18 February 2022. D. Tamang & Mandira Sarma 65432 (LWG)

3. *Diorygma albocinerascens* Makhija, Chitale & B.O. Sharma

Family: Graphidaceae

Description: Thallus crustose, corticolous, pale grey, continuous, smooth to rough, coarsely fractured, with a black hypothallus and no discernible pseudocortex. Libelline ascocarps, 0.5–6 mm length and 0.2–1 mm wide. Hyaline, muriform, ellipsoid ascospores with equal-sized peripheral and central spore locules measuring 135–150 × 18–27 µm.

Ecology and Distribution: Observed as ramicolous, on branches of tree. Earlier reported in India, Maharashtra, Sindhudurg District, on the way to Phonda. Newly reported in Assam.

Species examined: Kachodhora region of the Burachapori Wildlife Sanctuary, Assam, India.



(A) *Gyalecta effervescens*



(B) *Pyxine asiatica*



(C) *Parmotrema stuppeum*



(D) *Ramalina nervulosa*



(E) *Ramalina capensis*

Fig. 4. Some of the lichen thallus.

26°32'39.08"N, 92°43'49.7"E, Elev. 56m, 18 March 2022. D. Tamang & Mandira Sarma 65446 (LWG).

4. *Anisomeridium glaucescens* (Müll. Arg) R.C. Harris

Family: Monoblastaceae

Description: apothecia perithecioid, 0.2–0.4 mm in diam., black, solitary, ostiole lateral; hymenium

hyaline, clear, 150–200 μm ; ascus 8-spored, 165–175 $\times$ 13–17 μm ; ascospores fusiform, smooth walled, transversely 1–3-septate, 28–32 $\times$ 8–9 μm .

Ecology and distribution: Observed on the bark of the tree hence corticolous lichen. Earlier collected from southernmost part of Western Ghats also collected from Kerala, India. First reported from Assam.

Species examined: Kachodhora region of the

Burachapori Wildlife Sanctuary, Assam, India. 26°31'51.67" N, 92°44'28.42" E, Elev. 56m, 7 May 2022. D. Tamang & Mandira Sarma 65452 (LWG).

5. *Parmotrema stuppeum* (Taylor) Hale

Family: Parmeliaceae

Description: Thallus is corticolous, 12.5 cm across; lobes 13 mm wide, crenate-dentate, ciliate; upper side grey, emaculate, cracked in older parts, soralia marginal, on apices of dents in central part, often confluent and submarginal; soraliolate lobes involute; soredia farinose; lower side centrally black, wide marginal zone brown, nude or papillate; medulla white.

Ecology and distribution: Observed as ramicolous and distributed in Africa, Central and Western Europe, North and Central America.

Species examined: Bogoriati region of the Burachapori Wildlife Sanctuary, Assam, India. 26°32'5" N, 92°42'21" E, Elev. 58m, 26 February 2022. D. Tamang & Mandira Sarma 65458 (LWG).

6. *Ramalina nervulosa* (Müll.Arg.) Abbayes

Family: Ramalinaceae

Description: Thallus corticolous, 5-15(-20) cm long, erect or pendulous, yellowish grey, branched; branches flattened to 1-2(-4) mm wide, angular or terete towards apices, pseudocyphellae in longitudinal striae causing nervosa appearance, soralia marginal; thallus margins often splitting; chondroid tissue cracked into bundles; medulla solid. Apothecia to 2.5 mm in diameter, ascospores fusiform 12X4-5µm.

Ecology and distribution: Observed on branches and hence are ramicolous species. Distributed in China, Japan, Indonesia, Fuji, Philippines, East Africa, Australia. Reported in India in Karnataka, Kerala, Tamilnadu- Nilgiri Hills.

Species examined: Jawni region of the Burachapori Wildlife Sanctuary, Assam, India. 26°31'25.03" N, 92°38'22.66" E, Elev. 58m., 19 March 2022. D. Tamang & Mandira Sarma 65471 (LWG).

7. *Ramalina capensis* Th. Fr.

Family: Ramalinaceae

Description: Thallus yellowish brown, laxly branched, branches 1mm wide, younger branches angular, older flat to subcanaliculate, striae longitudinal, pseudocyphellae round to linear elongate; soredia absent; medulla solid. Apothecia laminal to 2mm in diameter, Ascospores 10-16X4-6µm.

Ecology and distribution: Observed on branches and hence ramicolous species. Distributed in Tropical Asia and Africa. In India, Reported from West Bengal-Kolkata. Newly reported from Assam for the first time.

Species examined: Lathimari APC (Anti-Poaching Camp) of the Burachapori Wildlife Sanctuary, Assam, India. 26°32'2.5"N, 92°39'56.7" E, Elev. 59m., 19 March 2022. D. Tamang & Mandira Sarma 65469 (LWG).

8. *Bactrospora myriadea* (Fée) Egea & Torrente

Family: Arthoniales - Gen. Incertae sedis

Description: Thallus crustose, not corticate, slightly glossy, greyish green, closely resembling the bark surface, with many scattered, sessile, spherical to typically irregular apothecia that are occasionally elongated and have a diameter of 0.2 to 0.5 mm. Hymenium not interspersed, Pycnidia absent, Excipulum thick, more than 25mm wide, Smooth ascomata margin; ascospores 47-85(-90) X 2.0-3.0(-3.5)µm, 12-20 septate; asci 70-95(-110) X 9-12µm.

Ecology and distribution: Recorded on bark of the tree. Pantropical in distribution, Central America, Caribbean Islands, Brazil, India, Seychelles, Thailand, Hong Kong, Taiwan.

Species examined: Kachodhora APC (Anti-Poaching Camp) of the Burachapori Wildlife Sanctuary, Assam, India. 26°31'52.57"N, 92°43'55.74"E, Elev. 59m, 7 May 2022. D. Tamang & Mandira Sarma 65478 (LWG).

DISCUSSION

Among them majority (40 species) are crustose followed by foliose (17 species). Graphidaceae with 14 species is the dominant family followed by Caliciaceae with 11 species. One each species are represented the families Opegraphaceae, Lecanoraceae, Telschistaceae, Physciaceae, Malmideaceae, Letrouitiaceae, Gyalectaceae and Chrysotrichaceae. Two species of lichens were recorded for the first time from India, while eight species were new records for the state of Assam. Some of the lichen species from the study have been shown in the Fig. 4.

CONCLUSION

Assam being one of the important zones for unexplored biological resources till date, more new additional lichen biota awaits for their discovery. This work definitely opens a new path for the upcoming taxonomists and lichenologists to work on the protected areas of the North Eastern states of India.

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