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Notes on Foliicolous Lichens from Western Ghats Part of Goa, India

Pallavi Randive, Siljo Joseph, Sanjeeva Nayaka and M.K. Janarthanam

ABSTRACT: A total of 17 lichens growing over leaves in the forest of Goa are enumerated. Out of the total eight obligate (*Coenogonium dilucidum*, *Fellhanera bouteillei*, *Mazosia phyllosema*, *Porina karnatakensis*, *P. nitidula*, *P. rufula*, *Strigula nitidula*, *S. phyllogena*) and two facultative (*Dirinaria confluens*, *Graphis pyrrocheiloides*) foliicolous species are recorded for the first time from Goa. A sterile specimen of *Echinoplaca* identified up to genus level based on thallus morphology and anatomical characters. Brief descriptions for the species new to Goa are provided.

KEYWORDS: Lichenized Fungi, Foliicolous Habitat, New Records, Taxonomy, Western Ghats, Goa, India.

INTRODUCTION

Foliicolous lichens are those grow on the surface of leaves. In the world as many as 925 foliicolous lichens are known (Awasthi, 2010) and from India Singh and Pinokiyo (2014) reported 136 species. Subsequently, two new species (Subramanya and Krishnamurthy, 2015a) and 14 new records (Gupta and Sinha, 2015; Jagadeesh Ram, 2015; Subramanya and Krishnamurthy, 2016a) of foliicolous lichens were reported from India including many regional distributional records (Gupta and Sinha, 2015, 2016; Rashmi and Rajkumar, 2015; Subramanya and Krishnamurthy, 2015b, 2016b). From these studies a total number of foliicolous lichens in India has reached to 152.

Detailed study on lichens of Goa is recently initiated with Cotigao Wildlife Sanctuary (CWS). Randive *et al.* (2017) presented a checklist of lichens for Goa with 118 species with several new records from CWS. During the study it is noticed that forest in Goa has luxuriant growth of foliicolous lichens. Earlier, Nayaka *et al.* (2004) reported six foliicolous species from Bondla and Bhagwan Mahavir Wildlife Sanctuaries of Goa. The aim of the present communication is to exclusively study the foliicolous lichens from Goa, especially collected from CWS.

MATERIALS AND METHODS

The specimens examined in the present study were freshly collected from CWS and previous collections from Goa

housed at LWG. Morphological and anatomical characters were studied by using stereo zoom Leica S8APO and light DM2500 microscopes attached with camera and image analysis software. Hand-cut sections were mounted in distilled water and lactophenol cotton blue. The amyloid reactions were tested in Lugol's iodine solution (I) with and without pre-treatment of KOH. All measurements were made on material mounted in distilled water. The literature of Awasthi (2007), Lücking (2008), Lücking *et al.* (2009), and Singh and Pinokiyo (2014) are followed for identification of various taxa. Chemical analysis was performed on selected species with regular spot tests following Orange *et al.* (2001). Lücking *et al.* (2016) was followed for recent classification of lichenized fungi. Identified fresh collection of lichens from CWS are at present preserved at herbarium of Goa University with abbreviation GU.

RESULTS AND DISCUSSION

The study resulted in a total of 17 species of lichen growing over leaves of which 10 are recorded for the first time from Goa. A sterile specimen of *Echinoplaca* is identified up to genus level based on thallus morphological and anatomical characters. A ubiquitous, otherwise corticolous or saxicolous foliose lichen species *Dirinaria confluens* (Fr.) D.D. Awasthi was found growing on the leaf-lets of *Cycas*. The foliicolous habitat of *D. confluens* was also frequently encountered elsewhere from Assam (unpublished) and Karnataka (Rashmi and Rajkumar, 2015). Whereas scorticolous *Graphis pyrrocheiloides* Zahlbr. found on foliicolous habitat for the first time. Brief descriptions of the lichen taxa reported new to Goa are provided here. Further, *Porina kameruniensis* F. Schill. [identified as *P. chrysophora* (Stirt.) R. Sant.] from Bhagwan Mahavir Wildlife Sanctuary by Nayaka *et al.* (2004) turns out to be a non lichenized fungus species of *Asterina*. However, this species is freshly collected from CWS.

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Enumeration of the taxa (* marked are new to Goa)

Aulaxina epiphylla (Zahlbr.) R. Sant., Symb. Bot. Upsal. 12(1): 305, 1952. *Dictyographa epiphylla* Zahlbr., Ann. Crypt. Exot.: 123, 1928. (Gomphillaceae).

Distribution: Andaman Islands and Goa.

Specimen examined: Goa, Bhagwan Mahavir Wildlife Sanctuary, 20.07.2003, Upreti, Nayaka, Samuel & Pathak 03-001858 (LWG).

Aulaxina quadrangula (Stirt.) R. Sant. in Thorold, J. Ecol. 40: 129, 1952. *Platygrapha quadrangula* Stirt., Proc. Roy. Philos. Soc. Glasgow 11: 103, 1878. (Gomphillaceae).

Distribution: Andaman Islands, Arunachal Pradesh, Goa and Karnataka.

Specimen examined: Bhagwan Mahavir Wildlife Sanctuary, 20.07.2003, Upreti, Nayaka, Samuel & Pathak 03-001859 (LWG).

***Coenogonium dilucidum** (Kremp.) Kalb & Lücking, Bot. Jahrb. Syst. 122(1): 32, 2000. *Lecidea dilucida* Kremp., J. Mus. Godeffroy 1(4): 103, 1873. (Coenogoniaceae).

Thallus continuous, smooth, greenish-yellow, apothecia few, margin distinct, disc pale whitish to yellowish, excipulum colour less. Asci 8-spored, ascospores hyaline, 1-septate, $6.2-9.8 \times 2-3 \mu\text{m}$.

Distribution: Andaman Islands, Assam, Goa, Karnataka and Uttar Pradesh.

Specimen examined: Cotigao Wildlife Sanctuary, Nadkem, N14°59'01.5", E074°13'22.6", 15.12.2016, P.P. Randive, GU-206C.

***Dirinaria confluens** (Fr.) D.D. Awasthi, Biblioth. Lichenol. 2: 281, 1975. *Parmelia confluens* Fr., Syst. Orb. Veg. 1: 284, 1825. (Caliciaceae). Fig. 1 A.

Thallus foliose, up to 1-2 cm across, flabellate, closely adpressed to leaf, lobes confluent to free; upper side glaucous white to grey, isidia and soredia absent, lower side pale, lacking rhizine, medulla white, apothecia not seen.

Chemistry: Medulla K-, C-, P-; TLC: not conducted.

Distribution: Cosmopolitan. On foliicolous habitat – Goa and Karnataka.

Specimen examined: Cotigao Wildlife Sanctuary, Kuske Waterfall, N15°01'06.72", E074°12'33.30", 15.11.2016, P.P. Randive GU-189A.

Echinoplaca sp. (Gomphillaceae)

Thallus whitish grey, continuous to rounded patches, minutely verrucose, verrucae whitish, encrusted with calcium oxalate crystals, often with white to pale yellowish sterile setae, 0.2-0.5 mm long, hypothallus indistinct, photobiont *Trebouxia*, apothecia not seen.

Specimens examined: Cotigao Wildlife Sanctuary, Nadkem, N14°59'51.2", E074°11'52.1", 15.12.2016, P.P. Randive GU-205, 215.

***Fellhanera bouteillei** (Desm.) Vězda, Folia Geobot. Phytotax. 21: 214, 1986. *Parmelia bouteillei* Desm., Ann. Sci. Nat. Bot., sér. 3(8): 191, 1847. (Pilocarpaceae). Fig. 1 B.

Thallus continuous, in circular patches, whitish with bluish tinge, farinose to fine granular, sometimes appear as sorediate, apothecia rounded to irregular, margin pale to whitish, disc pale yellowish, excipulum colour less. Asci 8-spored, ascospores hyaline, 1-septate, $9-12.2 \times 2.5-5.2 \mu\text{m}$.

Distribution: Arunachal Pradesh, Assam, Goa, Manipur, Meghalaya, Nagaland, Sikkim, Tamil Nadu and West Bengal.

Specimen examined: Cotigao Wildlife Sanctuary, Nadkem, N14°58'79.0", E074°07'99.1", 15.12.2016, P.P. Randive GU-208.

***Graphis pyrrocheiloides** Zahlbr., Cat. Lich. Univ. 2: 321, 1923. (Graphidaceae). Fig. 1 C.

Thallus greenish white, with numerous calcium oxalate crystals, lirellae unbranched, *scripta*-morph, labia entire, exciple laterally carbonized, hymenium clear. Asci 8-spored. Ascospores hyaline, 6-9-septate, I+ blue, $11.7-30.2 \times 6-8 \mu\text{m}$.

Chemistry: K+ yellow, C-, P+ golden yellow (near lirellae), UV-; TLC: norstictic acid, salazinic acid and protocetraric acid (minor).

Distribution: As corticolous species in Arunachal Pradesh, Assam, Karnataka, Maharashtra, Manipur, Orissa, Uttarakhand, Uttar Pradesh and West Bengal; foliicolous habitat in Goa.

Specimens examined: Cotigao Wildlife Sanctuary, Kuske Waterfall, N15°01'06.72", E074°12'33.30", 15.11.2016, P.P. Randive GU-190; N15°01'11.58", E074°12'32.88", 15.11.2016, P.P. Randive GU-178; Nadkem, N14°59'01.5", E074°13'22.6", 15.12.2016, P.P. Randive GU-207.

***Mazosia phyllosema** (Nyl.) Zahlbr., Cat. Lich. Univ. 2: 503, 1923. *Platygrapha phyllosema* Nyl., Bull. Soc. Linn. Normandie. sér. 2 (7): 171, 1873. (Roccellaceae). Fig. 1 D.

Thallus light greenish, smooth, without any ridges, ascomata apothecioid, rounded, disc open, black, epruinose, margin sloping outwards, excipulum pale brown, covered by a

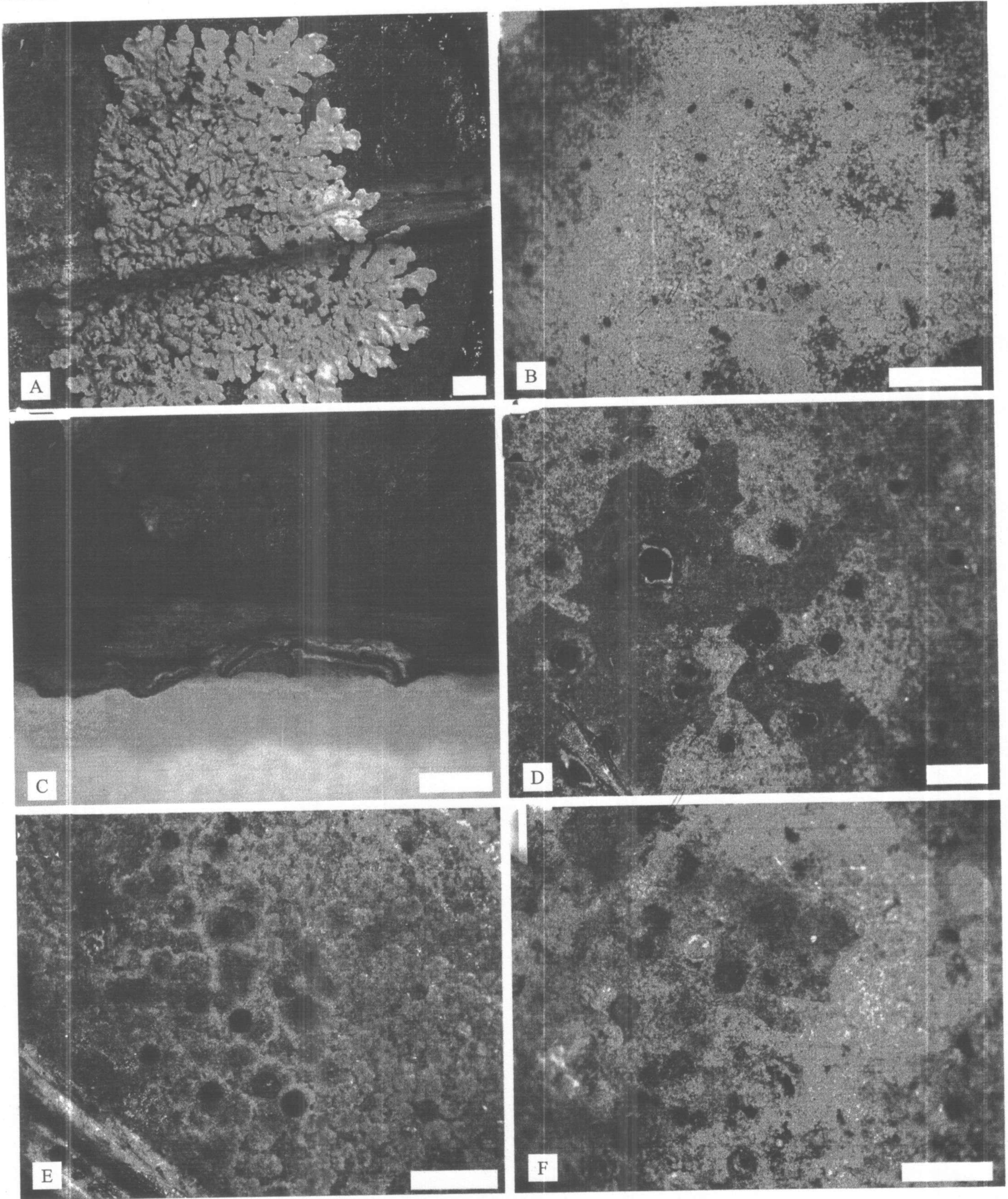


Fig. 1. (A-F) Habits (A) *Dirinaria confluens* (Fr.) D.D. Awasthi (B) *Fellhanera bouteillei* (Desm.) Vězda, (C) *Graphis pyrrhocheiloides* Zahlbr. (D) *Mazosia phyllosema* (Nyl.) Zahlbr., (E) *Porina kameruensis* F. Schill, (F) *Porina karnatakensis* Makhija, Adaw. & Patw. Scale bars: (A-F) 1 mm.

crystalline layer followed by thalline tissue. Asci 8-spored, ascospores hyaline, 3-septate, fusiform, microcephalic, 2nd cell enlarged, 16.2–24 × 3.5–5.2 µm.

Distribution: Andaman Islands, Arunachal Pradesh, Goa, Meghalaya, Mizoram, Nagaland and Tamil Nadu.

Specimen examined: Bhagwan Mahavir Wildlife Sanctuary, 20.07.2003, Upreti, Nayaka, Samuel & Pathak 03-001861C (LWG).

Porina conica R. Sant., Symb. Bot. Upsal. 12 (1): 232, 1952. (Porinaceae).

Distribution: Andaman Islands, Arunachal Pradesh, Goa, Meghalaya, Mizoram, Nagaland, Nicobar Islands, Sikkim and Tamil Nadu.

Specimen examined: Bhagwan Mahavir Wildlife Sanctuary, 20.07.2003, Upreti, Nayaka, Samuel & Pathak 03-001857 (LWG).

Porina epiphylla (Fée) Fée, Essai Crypt. Écorc.: 76. 1837. *Porina americana* var. *epiphylla* Fée, Dict. Class. Hist. Nat. [Bory] 17: 26, 1831. (Porinaceae).

Distribution: Andaman Islands, Arunachal Pradesh, Goa, Karnataka, Kerala, Meghalaya, Nagaland, Tamil Nadu and West Bengal.

Specimen examined: Bhagwan Mahavir Wildlife Sanctuary, 20.07.2003, Upreti, Nayaka, Samuel & Pathak 03-001861A (LWG).

Porina kameruniensis F. Schill., Hedwigia 67: 289. 1927. (Porinaceae). Fig. 1 E.

Distribution: Arunachal Pradesh, Goa, Sikkim and Tamil Nadu.

Specimen examined: Cotigao Wildlife Sanctuary, Nadkem, N15°00'00.36", E074°05'85.9", 22.12.2016, P.P. Randive GU-218.

***Porina karnatakensis** Makhija, Adaw. & Patw., J. Econ. Taxon. Bot. 18(3): 538. 1994. (Porinaceae). Fig. 1 F.

Thallus smooth to minutely verrucose, pale greyish-yellow, perithecia conical-wart shaped, ostiole pale brownish, involucrellum yellowish brown to black top, K+ reddish brown, externally covered by colourless crystalline layer followed by thick algal layer up to ostiolar region, excipulum pale yellowish. Asci 8-spored, ascospores 7-septate, hyaline, narrowly fusiform, 34–42.8 × 4–5.5 µm.

Distribution: Arunachal Pradesh, Assam, Goa, Karnataka, Kerala and Tamil Nadu.

Specimen examined: Cotigao Wildlife Sanctuary, Nadkem, N14°59'01.5", E074°13'22.6", 15.12.2016, P.P. Randive GU-206A.

***Porina nitidula** Müll. Arg., Flora 66: 336, 1883. (Porinaceae).

Thallus continuous to dispersed patches, pale greyish-green, perithecia aglobose, ostiole black to greyish, sometimes minutely tomentose, involucrellum black, not distinct from excipulum, K-, excipulum dark brown. Asci 8-spored, ascospores hyaline, fusiform, (3–)5-septate, 20.2–24.8 × 3.2–5.2 µm.

Distribution: Andaman Islands, Arunachal Pradesh, Goa, Meghalaya, Mizoram, Nagaland, Tamil Nadu and West Bengal.

Specimen examined: Cotigao Wildlife Sanctuary, Nadkem, N14°58'79.0", E074°07'99.1", 15.12.2016, P.P. Randive GU-209.

***Porina rufula** (Kremp.) Vain., Acta Soc. Fauna Fl. Fenn. 7: 227, 1890. *Verrucaria rufula* Kremp., Lich. Foliicol.: 20, 1874. (Porinaceae).

Thallus in dispersed patches, greenish-yellow, perithecia lens-hemispherical, orange-yellowish brown, ostiole indistinct, involucrellum orange-brown, K+ red brown, covered by algal layer, excipulum hyaline. Asci 8-spored, ascospores hyaline, oblong, 3–(4)–septate, 17–23 × 3.5–5 µm.

Distribution: Andaman Islands, Arunachal Pradesh, Goa, Manipur and Tamil Nadu.

Specimen examined: Cotigao Wildlife Sanctuary, Nadkem, N14°58'22.6", E074°09'31.9", 27.01.2016, P.P. Randive GU-81.

***Strigula nitidula** Mont. in Sagra, Hist. Phys. Cuba, Bot., Pl. Cell. 42: 139. 1838. (Strigulaceae).

Thallus subcuticular, yellowish green, rounded to irregular patches, perithecia exposed, wart shaped, involucrellum dark brownish to black, excipulum hyaline to pale brownish. Asci 8-spored, ascospores hyaline, ±ellipsoid, 1-septate, 8–10 × 2.2–3.2 µm.

Distribution: Andaman Islands, Arunachal Pradesh, Assam, Goa, Meghalaya, Sikkim, Tamil Nadu and West Bengal.

Specimen examined: Cotigao Wildlife Sanctuary, Kuske Waterfall, N15°01'06.72", E074°12'32.30", 15.11.2016, P.P. Randive GU-189B.

***Strigula phyllogena** (Müll. Arg.) R. C. Harris, More Florida Lichens: 159, 1995. (Strigulaceae).

Thallus supracuticular, grayish, continuous, perithecia exposed, conical, involucrellum dark brownish to black, excipulum

hyaline to pale brownish. Asci 8-spored, ascospores hyaline, fusiform-ellipsoid, 1-septate, $8-13 \times 2.5-3.5 \mu\text{m}$.

Distribution: Andaman Islands, Arunachal Pradesh, Assam, Goa, Meghalaya, Nagaland, Sikkim, Tamil Nadu and West Bengal.

Specimen examined: Cotigao Wildlife Sanctuary, Nadkem, N14°59'01.5", E074°13'22.6", 15.12.2016, P.P. Randive GU-206 B.

Strigula smaragdula Fr., *Linnaea* 5: 550, 1830. (Strigulaceae).

Thallus subcuticular, grey-green. Perithecia black, immersed, involucrellum dark brownish, excipulum hyaline to pale brownish. Asci 8-spored, ascospores hyaline, fusiform, 1-septate, $16-23.2 \times 4.2-6.5 \mu\text{m}$.

Distribution: Andaman Islands, Arunachal Pradesh, Assam, Goa, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, Tamil Nadu and West Bengal.

Specimen examined: Cotigao Wildlife Sanctuary, Gaodonger Village, alt. 300 m, 06.06.2003, Nayaka, Singh, Pathak & Samuel 03-001620 (LWG).

CONCLUSION

The foliicolous lichens are considered as bioindicators of health of the forest. They depend upon the atmosphere for their survival and their life cycle is restricted to life-span of the leaf. Therefore foliicolous lichens exhibit an accelerated life cycle and immediately react upon environmental changes (Lücking, 1997). The luxuriant growth of foliicolous lichens at CWS indicates the availability of the shady, moist conditions of the forest and less anthropogenic disturbances. This information would be helpful for biomonitoring studies in the area in future.

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