
New Records of Lichen Taxa from the State of Kerala, India

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ABSTRACT

The present paper deals with 11 new records of lichens under 7 genera and 6 families, for the state of Kerala in India. The species are *Bacidia personata*, *Chrysothrix chlorina*, *Cryptothecia candida*, *Cryptothecia emergens*, *Cryptothecia nilghiriensis*, *Letroitia aureola*, *Ochrolechia africana*, *Pertusaria coronata*, *P. quassiae*, *P. subdepressa*, and *Phyllopsora manipurensis*. Brief descriptions of these taxa were provided to facilitate their identification.

INTRODUCTION

Situated on the track of Western Ghats, Kerala holds rich diversity of lichens in its diverse habitats. Unfortunately, the inventory of lichens in Kerala has not received much attention compared to other plant groups. Vohra *et al.* (1982) collected 77 species of lichens from Silent Valley National Park in Kerala of which 11 were new additions to India. Kumar and Sequiera (1997) reported 20 species of macro lichens as new records to Kerala from Silent Valley National park. Compilation made by Kumar and Sequiera (1999) resulted in 206 species of lichens under 53 genera of which 153 were microlichens and 53 were macrolichens. Subsequently, more species were added to the macrolichen biota of Kerala from the diverse habitats. Kumar (2000) listed 254 macrolichen species under 43 genera belonging to 18 families, which is about 36% of the estimated macrolichen flora of India. Further, Kumar and Sequiera (2001, 2002, 2003) enumerated lichens from New Amarambalam Reserve Forest in Malappuram district, Chembra and Thirunelly in Wayanad district. Later, Sequiera (2003) added more species from Silent Valley National Park. Biju (2009) listed 242 species of lichens belonging to 62 genera and 29 families from the montane forests of Kerala part of Western Ghats. Singh and Sinha (2010) in their monumental work Indian Lichens: An Annotated Checklist, reported 391 lichens from Kerala. Biju *et al.* (2010) delineated 10 lichen species belonging to the Parmelioid lichen group new to the lichen biota of Kerala.

Biju *et al.* (2012) reported the occurrence of eight lichen species of the family Graphidaceae from Kerala, while Pandit and Sharma (2012) reported *Lobaria adscripta* (Nyl.) Hue from the state. Biju *et al.* (2014) listed 136 species of lichens belonging to 45 genera and 25 families from six major forest areas of the Idukki district. Biju *et al.* (2014) also described six graphidaceous lichens new to the Western Ghats of Kerala. In addition to this, Biju *et al.* (2015) rediscovered two endemic and little-known species of *Pyxine* from the Western Ghats of Kerala after a gap of five decades. Joshi *et al.* (2016, 2018) recorded the occurrence of *Normandina pulchella* (Borrer) Nyl. and *Crocynia gossypina* (Sw.) A. Massal. from Kerala, while Bajpai *et al.* (2018) added eight *Lepraria* and three *Leprocaulon* species as new to Kerala. Zachariah *et al.* (2018, 2019, 2020) added 38 species to the lichen biota of Kerala state, of which two were new to India. Purushothaman *et al.* (2021) enumerated five lichen species from the Goodrical Reserve Forest in the Pathanamthitta district of Kerala as new to the state, while Biju *et al.* (2021) again reported 15 graphidaceous lichens from Kerala, of which six were new to India, one was new to Peninsular India and eight were new records for Kerala. Anilkumar *et al.* (2022) added seven new records of macrolichens from Mathikettan Shola National Park in the Western Ghats of Kerala state of which two species were new to Peninsular India and five were new to the lichen flora of Kerala. Sequeira *et al.* (2022) have described *Parmotrema sahyadrica*, a new species of parmelioid lichen

from Southern Western Ghats. In our ongoing study on lichens of Kerala, we encountered 11 previously unrecorded species for the state of Kerala.

MATERIALS AND METHODS

To get a clearer picture of the status of lichen diversity in the state, extensive collection trips for lichen exploration were undertaken. The collections were made from 13 localities of seven districts representing different altitudinal gradients and different types of vegetations of the Western Ghats of Kerala. During the survey and collection, special emphasis was given to the collection of lichen from the montane forests of Kerala state covering protected areas, national parks, and wildlife sanctuaries. The lichen specimens collected from various forest localities of Kerala were dried and preserved in herbarium packets and deposited in the herbarium of Jawaharlal Nehru Tropical Botanic Garden and Research Institute, Thiruvananthapuram, Kerala under TBGT and a set of voucher specimens at the herbarium of CSIR-National Botanical Research Institute, Lucknow (LWG). The morphological characterization of lichen thallus was done under a stereo zoom Magnus MLX Plus microscope. Thin hand-cut sections of ascomata and thallus were mounted in distilled water, lactophenol cotton blue (LCB), 5% KOH, and Lugol's iodine solution and observed under a Leica DM 2000 optical microscopes attached with camera and image analysis software. The chemical spot tests on the thallus and ascomatal tissue were done following Orange *et al.* (2001) by using routine reagents K (5% aqueous solution of Potassium hydroxide), C (aqueous solution of Calcium hypochlorite), and P (0.5 g of para-phenylenediamine dissolved in 5ml of ethanol). Thin layer chromatography was performed in solvent system C (toluene: acetic acid; 85:15 ml) following Orange *et al.* (2001). Identification of taxa was done by referring to relevant literature (Patwardhan and Makhija 1981; Awasthi and Mathur 1987; Awasthi and Srivastava 1989; Lücking *et al.* 2006; Mishra *et al.* 2011; Kukwa *et al.* 2013; Jagadeesh Ram and Sinha 2016; Archer and Elix 2018; Orange *et al.* 2021). The nomenclature and classification of lichens were updated following Wijaywardhane *et al.* (2020).

RESULTS

1. *Bacidia personata* Malme.

(Ramalinaceae)

(Fig. 1)

Thallus crustose, corticolous, effuse, thin, 40–70 µm thick, smooth to verrucose, yellowish grey. Apothecia dense, sessile, 0.5–1.0 mm in diam.; disc black, concave to plane, often convex, epruinose; margin entire, distinct, brown in

young apothecia, becoming concolorous to disc in mature apothecia. Exciple colorless to pale brown, marginally brown, 70–120 µm thick, K–. Epithecium brown, 10–20 µm thick, K+ violet; hymenium 90–120 µm thick; hypothecium colorless to pale yellow, 36–60 µm. Ascospores acicular, transversely 15–25 septate, 50–100 × 4–5 µm.

Chemistry: No Chemical substance present.

Remarks: *B. personata* is very close to *B. phaeolomoides* (Müll. Arg.) Zahlbr. in the shape and size of spores, but the latter is distinguished by granular, furfuraceous thallus, brown to brown black apothecia, epithecium K–, and slightly narrower spores (Awasthi and Mathur 1987).

Distribution: In India, the species is reported from Arunachal Pradesh (Bajpai *et al.* 2018), Maharashtra (Pandit 2014), Odisha (Satapathy *et al.* 2021), Tamil Nadu (Awasthi and Mathur 1987) and Uttarakhand (Karakoti *et al.* 2013; Mishra and Saini 2016). Outside India it is reported from Brazil (Singh and Sinha 2010) and Nepal (Olley and Sharma 2013).

Specimens examined: Appapara, Wayanad, KERALA, alt. 820 m, May 18, 2006, H. Biju, TBGT 781, LWG 06-008465.

2. *Chrysothrix chlorina* (Ach.) J. R. Laundon

Lichen chlorinus Ach.

(Chrysothrichaceae)

(Fig. 2)

Thallus leprose is diffuse, thick, continuous, non-areolate, bright yellow; thallus surface is composed of a mass of pulverulent spherical granules 0.1–0.2 mm diam.; cortex absent and thallus unstratified, being yellow throughout; thallus margin absent; prothallus not apparent. Apothecia not seen.

Chemistry: Thallus K– or K+ faint orange, C–, KC– or KC + red, P–; TLC: Calycin and vulpinic acid present.

Remarks: *C. chlorina* is characterised by its thick, yellow, leprose thallus of granules. *C. candelaris* (L.) Laundon, differs from it in having thinner, orange-yellow thallus (Pant and Awasthi, 1989). Moreover, *C. chlorina* always contains vulpinic acid, absent in *C. candelaris*.

Distribution: In India, the taxon is reported from Andhra Pradesh (Reddy *et al.* 2011), Assam (Yadav *et al.* 2018), Karnataka (Rashmi and Rajkumar 2015b), Himachal Pradesh, Jammu & Kashmir, Sikkim (Singh and Sinha 2010), Madhya Pradesh (Satya *et al.* 2013) Meghalaya (Behera and Nayaka 2020), Tamil Nadu (Ingle *et al.* 2016) and Uttarakhand (Karakoti *et al.* 2013). Outside India, it is reported from Alaska (Dillman *et al.* 2010), China, Europe, North America, Great Britain, Ireland, Italy, Scotland (Pant and Awasthi 1989), Canada (Lewis and Brinker 2017) Korea

(Yakovchenko *et al.* 2018), Nepal (Baral 2015) Russia (Davydov *et al.* 2012) and Turkey (Yazici *et al.* 2008).

Specimens examined: Peppara Wildlife Sanctuary, Trivandrum, KERALA, alt. 100 m, October 16, 2006, H. Biju, TBGT 1173, LWG 06-008392.

3. *Cryptothecia candida* (Kremp.) R. Sant.

Myriostigma candidum Kremp.

Arthothelium candidum (Kremp.) Müll. Arg.

(Arthoniaceae) (Fig. 3)

Thallus foliicolous, crustose, greenish to whitish grey, thin, smooth, determined by distinct black hypothalloidal region at the periphery, 20–30 µm thick, thick ascigerous parts of the thallus, rounded to irregular in outline, slightly raised above the thallus, foveolate, white, soft and bitunicate, globose, thick-walled, 60–75 × 50–55 µm in size; ascospores 8 per ascus, hyaline, ovate, straight or curved, muriform, 40–55 × 12–17 µm.

Chemistry: Spot test and TLC not done.

Remarks: *Cryptothecia candida* differs from all the known other *Cryptothecia* species for its foliicolous habitat.

Distribution: In India, the species is reported from Eastern Himalayas (Singh *et al.* 2018), Goa (Randive *et al.* 2019), Karnataka (Rashmi and Rajkumar 2015a), Northeast states (Pinokiyo and Singh 2004), Sikkim (Sinha and Gupta 2017) and West Bengal hills (Singh and Sinha 2010). Outside India, it is reported from its type locality in Sumatra Islands (Makhija and Patwardhan 1994), China (Aptroot *et al.* 2003), tropical America, Malaysia and scarce in tropical Africa (Singh and Sinha 2010), Democratic Republic of Congo (Van Den Broeck *et al.* 2014), Thailand (Buaruang *et al.* 2017) and Uganda (Frisch *et al.* 2014).

Specimens examined: JNTBGRI Campus, Trivandrum, KERALA, alt. 140 m, March 29, 2007, Joemon Jacob, TBGT 1595, LWG s. n.

4. *Cryptothecia emergens* Makhija & Patw.

(Arthoniaceae) (Fig. 4)

Thallus corticolous, crustose, epiphloedal, greenish white, smooth to verruculose, cracked with age, black hypothalloidal region at the periphery, 180–250 µm thick, composed of loosely interwoven, thin anastomosing hyphae; with continuous algal layer; ascigerous parts of the thallus round, white; asci separated by loose interthecial tissue, globose, bitunicate, thick walled; wall 10–13 µm thick; 130–138 × 132–140 µm in size; ascospores 6 per ascus, hyaline, ovate, oblong, fusiform, curved, 30–35 × 75–130 µm.

Chemistry: Thallus K+ yellow, C–, KC+ yellow, P+ yellow; TLC: Confluent and gyrophoric acids present.

Remarks: *C. emergens* is closely related to *C. nilghiriensis* Patw. and Makhija with respect to morphology but easily distinguished by absence of psoromic acid in *C. emergens* (Makhija and Patwardhan 1985).

Distribution: The species is reported only from its type locality in Karnataka (Makhija and Patwardhan 1985).

Specimens examined: JNTBGRI Campus, Trivandrum, KERALA, alt. 140 m, March 29, 2007, Joemon Jacob, TBGT 1577, 1580, 1581, 1584, 1585, LWG s. n.

5. *Cryptothecia nilghiriensis* Patw. & Makhija

(Arthoniaceae) (Fig. 5)

Thallus corticolous, crustose, pale grey, smooth, epiphloedal, composed of interwoven hyphae, branched, anastomosing, 250–300 µm thick; algal layer 35–80 µm thick, continuous, asci scattered, globose to subglobose, bitunicate, thick-walled, ascospores 4–8 per ascus hyaline, muriform, slightly curved, often ovoid, 30–50 × 60–80 µm in size.

Chemistry: Thallus P+ yellow; TLC: Psoromic acid present.

Remarks: The species is distinguished by the emergent, black fertile areas, large ascospores and K+, P+ thallus (Patwardhan and Makhija 1981). It is close to *C. emergens* Makhija & Patw. but differs from it in the absence of psoromic acid.

Distribution: The species is endemic to India and it is reported from Karnataka, Madhya Pradesh and Tamil Nadu (Singh and Sinha 2010).

Specimens examined: Vazhachal range, Thrissur, KERALA, alt. 340 m, September 27, 2006, H. Biju, TBGT 1096, LWG 06-008296.

6. *Letrouitia aureola* (Tuck.) Hafellner & Bellem.

Lecidea aureola Tuck.

(Brigantiaeaceae) (Fig. 6)

Thallus corticolous, crustose, smooth to verrucose, pale greenish to pale orange; lacking isidia and soredia, apothecia very few, disc pale orange, margin prominent, lighter than the disc, exciple biatorine, hymenium 60–80 µm, asci 50–60 × 9–12 µm, 8-spored, ascospores narrowly ellipsoid, transversely septate, 6–8 loculed, 18–24 × 5–6 µm.

Chemistry: K + violet to purple; TLC: Anthraquinone present.

Remarks: *Letrouitia aureola* is close to *L. flavocrocea* (Nyl.) Haf. & Bellem., but differs from it in having narrowly ellipsoid spores.

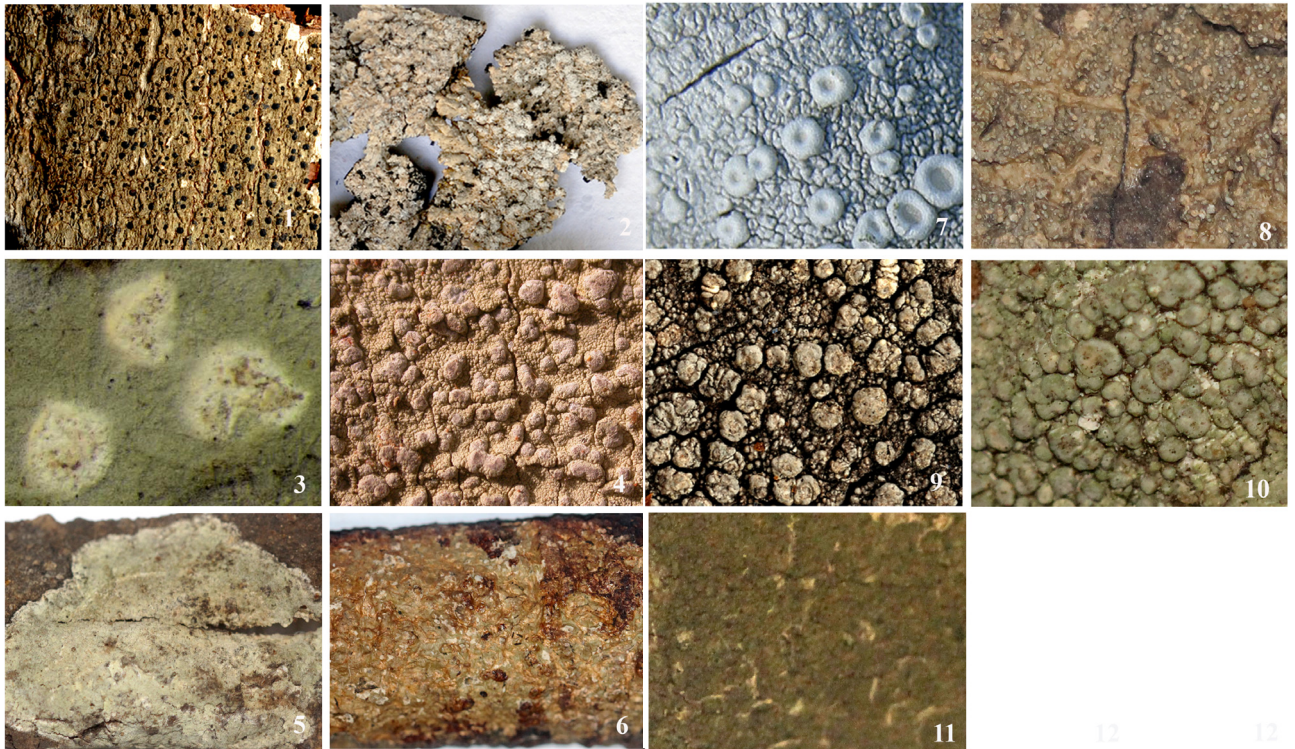


Fig. 1. *Bacidia personata* Malme. **2.** *Chrysothrix chlorina* (Ach.) J. R. Laundon **3.** *Cryptothecia candida* (Kremp.) R. Sant. **4.** *Cryptothecia emergens* Makhija & Patw. **5.** *Cryptothecia nilghiriensis* Patw. & Makhija **6.** *Letrouitia aureola* (Tuck.) Haf. and Bellem. **7.** *Ochrolechia africana* Zahlbr. **8.** *Pertusaria coronata* (Ach.) Th. Fr. **9.** *Pertusaria quassiae* (Fée) Nyl. **10.** *Pertusaria subdepressa* Müll. Arg. **11.** *Phyllopsora manipurensis* (Müll. Arg.) Müll. Arg.

Distribution: Hafellner (1981) reported this species from Kodaikanal, Tamil Nadu. Recently, Satapathy *et al.* (2021) reported from Odisha. It is widely distributed in Africa and Tropical America (Awasthi and Srivastava 1989).

Specimens examined: Rosemala, Kollam, KERALA, June 28, 2006, H. Biju, LWG 06-008463, TBGT 718.

7. *Ochrolechia africana* Vain.

(Ochrolechiaceae)

(Fig. 7)

Thallus corticolous, crustose, pale white to grey, verrucose, up to 0.5 mm thick. Apothecia dense, 0.5–1.0 mm across, sessile, constricted at base, disc pale brown, concave to plane, pruinose, margin distinct, rounded, entire. Epithelium pale brown, 40–80 µm thick, hymenium 200 µm, pale yellowish; ascospores 25–50 × 18–30 µm.

Chemistry: Thallus C+ orange red, KC+ orange red to red. TLC: lichexanthone present.

Remarks: When lichexanthone is present, *O. africana* may be confused with *O. mexicana* Vain., but the former differs from the latter in having a C– cortex, usually pruinose discs and lacking an excipular ring around the disc.

Distribution: In India, the species is reported from Andhra Pradesh (Mohabe *et al.* 2017), Karnataka, Madhya Pradesh and Tamil Nadu (Awasthi and Tewari 1987). Outside India, it is reported from South Australia (Kantvilas 2019), Bolivia (Kukwa *et al.* 2013), Bhutan, Thailand, Africa, North and South America (Singh and Sinha 2010), Brazil (Käffer *et al.* 2016), Malaysia (Paukov *et al.* 2017), Panama (Etayo and Aptroot 2017), Reunion Island (Van den Boom *et al.* 2011) and Sri Lanka (Weerakoon and Aptroot 2014).

Specimens examined: Sairandhri, SVNP, Palghat, KERALA, alt. 1020 m, September 18, 2006, P.S. Jothish, TBGT 1066, LWG s. n.

8. *Pertusaria coronata* (Ach.) Th. Fr.

Porina coronata Ach.

(Pertusariaceae)

(Fig. 8)

Thallus corticolous, crustose, brownish grey, thin to moderately thick, continuous, often bordered by a pale brown prothallus; upper surface smooth to warty, rimose to cracked; isidia present, isidia unoriented, more cylindrical, often thinner, decumbent. Apothecia up to 1.5 mm diam.,

few; disc punctiform. Asci 2-spored. Ascospores 100–140 × 40–55 µm.

Chemistry: Thallus P+ orange, K+ yellow, KC+ yellow, C–; TLC: Coronaton, Stictic, ± norstictic and ± Constictic acid.

Remarks: *Pertusaria coronata* is close to *P. coccodes* (Ach.) Nyl. but differs in having different chemistry. *P. coronata* produces coronaton and stictic acid complex, which gives a P+ orange reaction of the thallus, whereas *P. coccodes* has norstictic acid, which gives a K+ yellow changing to red reaction.

Distribution: The species exhibit its distribution in Arunachal Pradesh, Karnataka, Sikkim (Singh and Sinha 2010), Odisha (Satapathy *et al.* 2021) and Uttarakhand (Mishra and Saini 2016). Outside India, it is also widely distributed in Europe, United Kingdom (Singh and Sinha 2010), Italy (Gheza *et al.* 2021), Sardinia (Rizzi *et al.* 2011) and Turkey (Kocakaya *et al.* 2009).

Specimens examined: On the way to Athirumala, ABP, Trivandrum, alt. 950 m, April 24, 2006, H. Biju, TBGT 470, LWG s. n.

9. *Pertusaria quassiae* (Fée) Nyl.

Porina quassiae Fée

(Pertusariaceae) (Fig. 9)

Thallus corticolous, crustose, greenish grey, verrucose, 120–140 µm thick, fertile verrucae single to confluent, concolorous with the thallus, constricted at base, hemispherical to irregular in outline; apex tubercled, depressed; ostioles dark; apothecia 2–4 immersed in each verrucae, rounded to flask shaped; Epithecium colorless; asci 2–3 spored, cylindrical to clavate, 210–245 × 30–50 µm; ascospores uniseriate, oblong–ellipsoid, 80–120 × 25–45 µm.

Chemistry: Cortex/Medulla K+ yellow to red, C–, KC–, P+ orange; TLC: Constictic, norstictic and Stictic acids and atranorin.

Remarks: *Pertusaria quassiae* differs from closely related to *P. concinna* Erichsen and *P. cinchonae* Müll. Arg. in having tubercled-verrucose thallus and fertile verrucae.

Distribution: In India, the species is distributed in Arunachal Pradesh, Andaman & Nicobar Islands, Andhra Pradesh, Himachal Pradesh, Jammu & Kashmir, Karnataka, Madhya Pradesh, Maharashtra, Nagaland, Sikkim (Singh and Sinha 2010), Assam (Daimari *et al.* 2021), Mizoram (Logesh *et al.* 2015), Odisha (Nayak *et al.* 2016), Uttar Pradesh (Nayaka *et al.* 2011), Uttarakhand (Joshi *et al.* 2011) and West Bengal (Sen 2014). Outside India, it is reported from Nepal and Sri Lanka (Singh and Sinha 1994).

Specimens examined: Kolahalameedu, Vagamon, Kottayam, March 25, 2006, H. Biju, TBGT 416, LWG s. n.; Dam site, Rosemala, Kollam, June 28, 2006, H. Biju, TBGT 716, LWG s. n.; Braemore, Trivandrum, KERALA, November 9, 2006, H. Biju, TBGT 1342, LWG s. n.

10. *Pertusaria subdepressa* Müll. Arg.

(Pertusariaceae) (Fig. 10)

Thallus corticolous, crustose, ashy grey, epiphloedal, rugulose, 100–120 µm thick; fertile verrucae constricted at base, concolorous with the thallus, single to 2–3 aggregated, scattered, hemispherical to globose, up to 1 mm wide, 0.5 mm high, apex smooth, flat to depressed, ostioles many, dark coloured, plane to often sunken; apothecia 2–6 in each verrucae, rounded 0.25 mm wide at base; Epithecium pale yellow, asci 8-spored, cylindrical, 200–220 × 35–45 µm, ascospores ellipsoid 45–65 × 15–30 µm.

Chemistry: Cortex/Medulla K+ yellow to red, C–, KC–, P–; TLC: Perlatolic acid.

Remarks: *Pertusaria subdepressa* is closely related to *P. acuta* Müll. Arg. but differs from it in having K+ yellow thallus and in having perlatolic acid.

Distribution: In India, the species is distributed in Nagaland, Tamil Nadu (Singh and Sinha 1994) and Uttarakhand (Mishra and Saini 2016). Outside India, it is reported from Sri Lanka (Singh and Sinha 1994).

Specimens examined: Padinjarethara, Wayanad, KERALA, alt. 750 m, March 15, 2006, M.C. Riju, TBGT 418, LWG s. n.

11. *Phyllopsora manipurensis* (Müll. Arg.) Müll. Arg.

Psora manipurensis Müll. Arg.

(Ramalinaceae) (Fig. 11)

Thallus corticolous, squamulose, prothallus white; squamules 0.1–0.2 mm wide; upper side yellowish white to greenish grey, lacking isidia. Apothecia to 0.5 mm in diam.; hypothecium brown; ascospores 8–12 × 2–3 µm.

Chemistry: Atranorin and unknown triterpenes.

Remarks: It is close to *P. subcrustacea* in having adnate squamules and in the absence of lichen substance but differs from it having smaller ascospores in the presence of a white prothallus.

Distribution: The taxon is endemic to India and is reported from Goa (Randive *et al.* 2018) Karnataka, Maharashtra, Madhya Pradesh, Manipur, Meghalaya, Sikkim, Uttarakhand (Singh and Sinha 2010) and Odisha (Swarnalatha 2018).

Specimens examined: Unnikadavu, Athirumala, ABP, Trivandrum, alt. 1000m, April 27, 2006, H. Biju, TBGT 569, 573; LWG 06-009676, 06-009604.

DISCUSSION

At present, the state of Kerala represents a total of 810 species of lichens which were compiled through various publications and contributions (Vohra *et al.* 1982; Patwardhan 1983; Kumar 2000; Easa 2003; Sequiera 2003, 2007; Singh and Sinha 2010; Biju *et al.* 2010, 2014a, b, 2021; Pandit *et al.* 2012; Joshi *et al.* 2016, 2018; Bajpai *et al.* 2018; Zachariah *et al.* 2018, 2019, 2020, Purushothaman *et al.* 2021, Anilkumar *et al.* 2022). Thus, the floristic account of lichens available from the montane forests of Kerala will be helpful for the identification of the different lichen taxa, assessment of biological resources, and baseline for monitoring which in turn creates awareness among the students, common people, forest officials and authorities regarding the importance of lichens and actions to be taken to conserve their diversity. These species should be conserved as they are prone to become vulnerable and threatened due to the over exploitation of forest lands and destruction of the host trees in their natural habitat. However, the extensive and intensive survey will add more taxa. The present exploration of montane forests of Kerala state is the first attempt to get a clear picture of the status of lichen diversity in the State.

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