



# Eleven New Records of Lichen to the State of Mizoram, Indo-Myanmar Biodiversity Hot Spot Region, India

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**Abstract** The paper reports the occurrence of eleven species of crustose and foliose lichens for the first time to the state of Mizoram in northeast India. During the course of lichen exploration in the state of Mizoram, the authors collected lichen specimens from Tawi Wildlife Sanctuary, Mizoram, India. After critical examination and thorough consolation of literature, it revealed that 11 species have been discovered as new additions to the lichen flora of the state. The species include *Bacidia connexula* (Nyl.) Zahlbr., *Baculifera curtisii* (Tuck.) Marbach, *Flavoplaca citrina* (Hoffm.) Arup, Fröden and Söchting, *Herpothallon philippinum* (Vain.) Aptroot and Lücking, *Leptogium delavayi* Hue., *Letrouitia trangressa* (Malme) Haff. and Bellem, *Pertusaria pertusa* (L.) Tuck, *Pertusaria pseudococcodes* Müll Arg., *Pyrenula andina* Aptroot, *Sticta fuliginosa* Hoffm. Ach. and *Trichothelium epiphyllum* Müll. Arg. are described. A brief description of each species is provided with distribution, and well supported by illustrations.

**Keywords** Crustose · Foliose · Forests · New addition · Mizoram · Northeast India

## Introduction

The states of Mizoram is situated in the northeast India and one of the most important parts of the Indo-Myanmar biodiversity hot spot [1]. It covers an area of 21,081 km<sup>2</sup> with more than 90% of the evergreen forest vegetation and is at altitudes ranging between 28 and 2000 m above the mean sea level. Mizoram lies between 21° 56' N and 24° 31' N latitudes and 92° 16' E–93° 26' E longitude. It harbors rich and unique diversity of lichen flora in northeastern India due to varied altitude and mountainous topography. The region features a humid climate and plenty of rain in most of the areas. Various types of substrata, such as bark, twigs, leaves, soil, and rocks, provide suitable conditions for the rich growth of lichens in the region.

Though not many, but few important publications were made from Mizoram which include those of Chinlamianga et al. [2] and Logesh et al. [3] reported 166 from the state of Mizoram. Lalremruata et al. [4] further added 18 species of lichens collected from Tawi Wildlife Sanctuary. Recently, Thangjam et al. [5] had reported 22 species of lichen as a new addition from the Mizoram state. However, the lichens of Mizoram state still could not be fully explored because of dense forest, rugged and inaccessible hilly terrain. Vast areas of the state are still unexplored lichenologically. It is, therefore, essential to investigate the unexplored and under-explored areas to know the diversity and to develop suitable conservation measure. Tawi Wildlife Sanctuary located in Aizawl District is one of the oldest protected areas established in 1978.

**Significance statement:** The forests type, topographical and climatic conditions of the state has endowed it with a rich lichen flora, both in luxuriance and species diversity. The present study added 11 new records of lichen species to the state which clearly indicates the rich potential diversity of lichen wealth in Tawi Wildlife Sanctuary in Mizoram, Indo-Myanmar Biodiversity Hotspot Region, India. The newly documented lichens were given with their descriptions.

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Though the sanctuary is bestowed with rich diversity of different groups of plant including lichens, however, only few records of lichen are so far known from the sanctuary [4].

## Material and Methods

Mizoram state, sharing borders of the states of Tripura, Assam and Manipur, shares international borders with the countries of Myanmar and Bangladesh. Several extensive collection expeditions were undertaken in different localities in the Tawi Wildlife Sanctuary. Tawi Wildlife Sanctuary is located in Aizawl District, which lies between 23° 30' 26" N latitude and 92° 57' 58" E longitude (Fig. 1). The area of the sanctuary is 35.75 km<sup>2</sup> and the altitude ranges from 600 to 1890 m above sea level. The average annual rainfall is around 2000–2500 mm. The average temperature in summer ranges from 20 to 30 °C, while in winter, it ranges from 14 to 20 °C. The samples were collected randomly from different altitude across forests. The present study is based on the examination of about 300 specimens of lichens collected during December, 2015 to March, 2018.

The specimens were identified by studying their morphology, anatomy and chemistry which were deposited in the cryptogamic herbarium of Botanical Survey of India, Allahabad (BSA). Morphological characters of thallus were studied using binocular zoom dissection microscope. The reproductive structures, colour, shapes and size of ascospores were examined under stereomicroscope (NIKON SMZ 1500). The chemical reagents used for colour spot test include aqueous potassium hydroxide solution (K), bleaching powder or aqueous solution of

calcium hypochlorite (C) and aqueous solution of parphenyldiamine (P). The voucher specimens have been deposited in the herbaria BSA, Botanical Survey of India, Allahabad and Biodiversity and Ecology Laboratory I, Department of Botany, Mizoram University.

Identification was done using relevant standard keys following important literature on lichens by Awasthi [6, 7], Divakar and Upreti [8], Sinha and Singh [9], Lücking et al. [10], Nash et al. [11, 12] and Singh and Sinha [13].

## Results

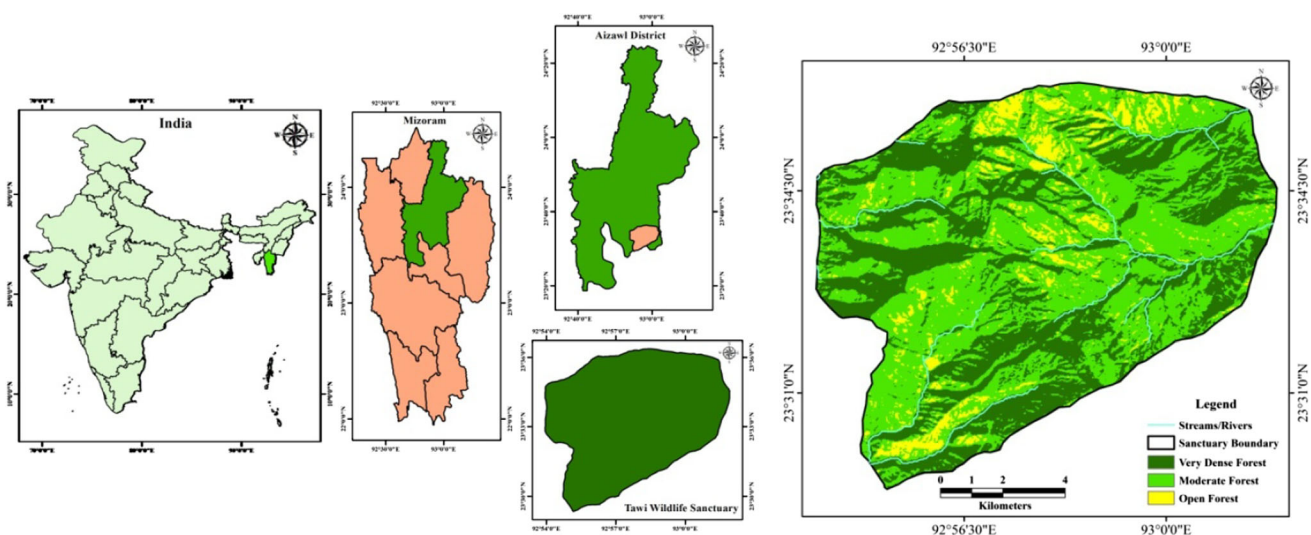
### New Addition to State of Mizoram, Northeast India, India

#### Family: Ramalinaceae

*Bacidia connexula* (Nyl.) Zahlbr., Cat. Lich. Univ. 4: 187, 1926.

= *Lecidea connexula* Nyl., Lich. Japon.: 111, 1890. (Fig. 2a)

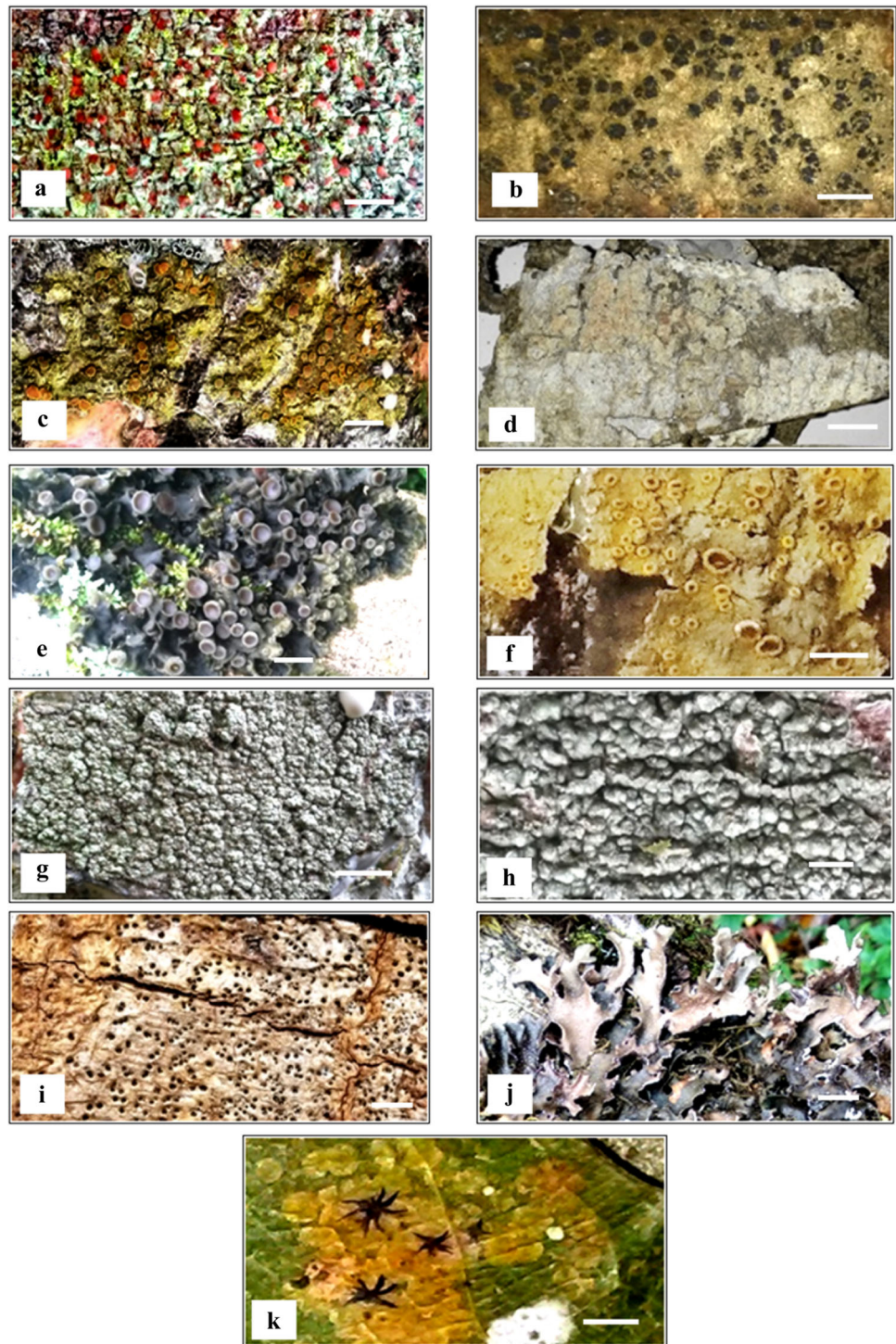
**Remarks** *Bacidia connexula* is characterized by its effuse, ±smooth, cracked, thin, whitish to grey thallus; brown to brownish black ascomata with epruinose disc; colourless to pale yellow exciple; I + deep blue hymenium; simple paraphyses; 8-spored asci; colourless filiform, transversely 5–7-septate, 19–30 µm long ascospores and absence of lichen substances. Anatomically, it resembles *B. fusconigrescens* (Nyl.) Zahlbr., which has granular thallus. In India, it is distributed in Madhya Pradesh and West Bengal hills. It is a new addition to the state of Mizoram.



**Fig. 1** Map showing study area, Tawi Wildlife Sanctuary, Mizoram, India



**Fig. 2** a–k New reports of lichens of Mizoram state.  
**a** *Bacidia connexula*, 8 mm;  
**b** *Baculifera curtisii*, 8 mm;  
**c** *Flavoplaca citrina*, 6 mm;  
**d** *Herpothallon philippinum*, 8 mm; **e** *Leptogium delavayi*, 1.2 cm; **f** *Letrovitia transgressa*, 8 mm; **g** *Pertusaria pertusa*, 6 mm; **h** *Pertusaria pseudococcodes*, 8 mm; **i** *Pyrenula andina*, 5 mm; **j** *Sticta fuliginosa*, 2.5 cm; **k** *Trichothelium epiphyllum*, 8 mm



Specimens examined India, Mizoram, Aizawl district, Tawi Wildlife Sanctuary, 1131 m alt., 20 September 2016, P.C. Lalremruata, 11164 (BSA), 16-00035 (MZUBOT).

**Family: Physciaceae**

*Baculifera curtisii* (Tuck.) Marbach, Biblioth. Lichenol. 74: 119, 2000. (Fig. 2b)

**Remarks** This species is characterized by its crustose, greyish white to dark grey, rimose-verruculose thallus; lecideine, (0.2–) 0.3–0.4 (–0.5) mm in diam. apothecia with plane, soon becoming convex; black, epruinose disc; not interspersed hymenium; simple to sparsely branch paraphyses; 8-spored asci; brown, 1-septate, ellipsoid, 18.5–24.5 × 6.5–8.6 μm ascospores and presence of

norstictic acid, traces of atranorin, dissectic and stictic acid. In morphology and ascospores character, it resembles *Buellia remensa* (Stirt.) Imsh which has small 13–14–16 µm ascospores. It was reported previously from Jammu & Kashmir, Madhya Pradesh, Manipur and Tamil Nadu and is a new report to Mizoram.

Specimens examined India, Mizoram, Aizawl district, Tawi Wildlife Sanctuary, alt. 1237 m, 13 March 2016, *P.C. Lalremruata*, 11181 (BSA), 16-00068 (MZUBOT).

**Family: Teloschistaceae**

*Flavoplaca citrina* (Hoffm.) Arup, Fröden and Söchting, *Nordic JI. Bot.* 31 (1): 44, 2013. (Fig. 2c)

**Remarks** This species is characterized by its crustose, areolate to subsquamulose, margin slightly lobed or notched, without elongated lobes; surface yellow orange, verruculose, sorediate thallus; soredia fine, yellow, in irregular, laminal or marginal soralia; rare, adnate, 0.2–0.3 mm in diam., lecanorine apothecia; 8-spored asci; hyaline, 2 locules, ellipsoid, 11–15 × 5.5–7 µm ascospores and presence of parietin, fallacinal, emodin, teloschistin and parietinic acids. It was previously reported from Jammu & Kashmir, Madhya Pradesh, Maharashtra and Tamil Nadu and is a new report to Mizoram.

Specimens examined India, Mizoram, Aizawl district, Tawi Wildlife Sanctuary, alt. 789 m, 17 January 2018, *P.C. Lalremruata*, 11166 (BSA), 16-00027 (MZUBOT).

**Family: Arthoniaceae**

*Herpothallon philippinum* (Vain.) Aptroot and Lücking, *Biblioth. Lichenol.* 99: 56, 2009. (Fig. 2d)

**Remarks** This species is characterized by the loosely to firmly attached thallus with many calcium oxalate crystals, whitish hypothallus and prothallus, cylindrical pseudoisidia up to 1 × 0.1 mm, and the presence of gyrophoric acid as the secondary metabolites. This species closely resembles with *H. japonicum* (Zahlbr.) G. Thor, but later species differs in having more firmly attached thallus with absence of calcium oxalate crystals, thicker isidia and produces ovoic acid. The species is a new report to Mizoram and was previously reported from Assam and Andaman Island.

Specimens examined India, Mizoram, Aizawl district, Tawi Wildlife Sanctuary, 23° 31.089' N and 92° 56.015' E, alt. 879 m, 21 September 2016, *P.C. Lalremruata*, 11163 (BSA).

**Family: Collemataceae**

*Leptogium delavayi* Hue., *Bull. Soc. Bot. Fr.* 36: 25, 1889. (Fig. 2e)

**Remarks** The species is characterized by the foliose, adnate, pale grey to brownish, tomentose thallus; esorediate, eisidiate 15–20 mm wide lobes; pale grey to brownish on upper side while white to pale brown, tomentum, composed of elongate, cylindrical hyphal cells on lower side; pedicellate apothecia; ellipsoid, muriform 20–36 × 7–12 (–14) µm ascospores and absence of lichen substances. It closely resembles with *L. burgessii* (L.) Mont. which has tomentum composed of spherical cells on lower side of the thallus. This is new report to Mizoram. It was previously reported from Arunachal Pradesh, Himachal Pradesh, Nagaland, Sikkim, Uttarakhand and West Bengal and is a new report to Mizoram.

Specimens examined India, Mizoram, Aizawl district, Tawi Wildlife Sanctuary, alt. 837 m, 20 September 2016, *P.C. Lalremruata*, 11184 (BSA), 16-00045 (MZUBOT).

**Family: Letrouitiaceae**

*Letrouitia transgressa* (Malme) Hafellner and Bellem, *Nova Hedwigia* 35: 710, 1983. (Fig. 2f)

**Remarks** This species is characterized by its effuse, smooth, pale yellow to greenish yellow thallus; rounded to irregular dark orange apothecial disc, biatorine exciple; yellowish brown, K+ purple or violet epithecium; not interspersed hymenium; sparingly branched paraphyses; (4-) 6-spored asci; colourless, oblong-ellipsoid, submuriform ascospores and presence of fragilin, emodin, parietin and 7-choloro-teloschistin. Morphologically, it closely resembles *L. domingensis* (Pers.) Hafellner and Bellem., which has transversely septate ascospores. It is one of the common species in Indian localities and collected growing on bark. *L. transgressa* is reported as a new addition to the lichen flora of Mizoram. It is distributed in Andhra Pradesh, Arunachal Pradesh, Karnataka, Madhya Pradesh, Nagaland, Uttar Pradesh and West Bengal.

Specimens examined India, Mizoram, Champhai district, Murlen National Park, 1187 m alt, 20 August 2017, *P.C. Lalremruata*, 11190 (BSA), 17-00223 (MZUBOT).

**Family: Pertusariaceae**

*Pertusaria pertusa* (L.) Tuck, *Enum. N. America Lich.*: 56, 1845. (Fig. 2g)

**Remarks** *Pertusaria pertusa* is characterized by its crustose, thick, cracked–areolate, verrucose thallus; verruciform ascomata; 3–10 per verruca with conspicuous black sunken ostioles; hyaline, amyloid hamathecium; lax, branched and richly anastomosing paraphysoids; 2-spored asci, smooth-walled, 150–250 µm long ascospores and presence of stictic acid and 4,5-dichlorolichexanthone. Morphologically, it closely resembles *P. pseudococcodes* Müll. Arg., which has smaller ascospores. It was previously



reported from Arunachal Pradesh, Himachal Pradesh, Kerala, Madhya Pradesh, Maharashtra and Rajasthan and is a new report to Mizoram.

Specimens examined India, Mizoram, Aizawl district, Tawi Wildlife Sanctuary, alt. 879 m, 19 September 2016, *P.C. Lalremruata*, 11171 (BSA), 16-00009 (MZUBOT).

***Pertusaria pseudococcodes*** Müll. Arg., Flora, Rogensburg 67: 287, 1884. (Fig. 2h)

**Remarks** This species is characterized by its pale olive-green, slightly cracked, smooth and dull thallus; confluent, flattened-hemispherical, verruciform apothecia; 2-spored asci; smooth, (75–) 85–110 (–120) × 30–40 µm ascospores and presence of stictic acid (major), 4,5-dichlorolichexanthone (minor) and constictic acid (trace). This species is a new report to Mizoram and was previously reported from Madhya Pradesh and Sikkim.

Specimens examined India, Mizoram, Aizawl district, Tawi Wildlife Sanctuary, alt. 879 m, 19 September 2016, *P.C. Lalremruata*, 11183 (BSA), 16-00008 (MZUBOT).

#### Family: Pyrenulaceae

***Pyrenula andina*** Aptroot, Biblioth. Lichenol. 97: 91, 2008. (Fig. 2i)

**Remarks** This species is characterized by its yellowish-grey, smooth, UV+ yellow thallus; immersed to semi-immersed, globose to sub-globose 0.2–0.6 mm diameter perithecia, with apical ostiole, completely carbonized exciple; without oil globules hamathecium; 8-spored asci; 3-septate, 24–40 µm long ascospores. It closely resembles with *P. caryae* R.C. Harris which has large 36–45 µm long ascospores. The species is new report to Mizoram and was previously reported from Manipur and Nagaland.

Specimens examined India, Mizoram, Aizawl district, Tawi Wildlife Sanctuary, alt. 819 m, 16 January 2018, *P.C. Lalremruata*, 11168 (BSA), 17-00152 (MZUBOT).

#### Family: Lobariaceae

***Sticta fuliginosa*** Hoffm. Ach., Meth. Lich. 280, 1803. (Fig. 2j)

**Remarks** This species is characterized by its foliose, monophyllous thallus with irregularly imbricate, 1–3 cm wide lobes; rounded entire margins; greyish to brown, dull upper surface; scrobiculate isidiate; minute, granular to coralloid branched, dark brown to blackish, isidia; cyanobacterial photobiont; lower surface pale brown, erhizinate, densely tomentose; tomentum 0.3–0.5 mm long; sterile 3. Morphologically, it resembles with *S. limbata* (Sm.) Ach. but later species differs in having eroded soralia on margins and upper surface. It grows on the trunks of

trees in subtropical areas and is distributed in Manipur, Nagaland and Tamil Nadu and is a new report to Mizoram.

Specimens examined India, Mizoram, Aizawl district, Tawi Wildlife Sanctuary, alt. 1187 m, 20 October 2017, *P.C. Lalremruata*, 11,189 (BSA), 17–00,213 (MZUBOT).

#### Family: Porinaceae

***Trichothelium epiphyllum*** Mull. Arg., Bot. Jahrb. Syst. Pflanzen 6: 418, 1885. (Fig. 2k)

**Remarks** This species is characterized by its epiphyllous, greenish grey thallus; few, scattered, lens shaped, spreading at base, black perithecia with black brush-shaped, 6–8 stiff long setae near ostiolar region giving a star-like appearance to the perithecium; not interspersed hamathecium; 8-spored asci with hyaline, fusiform, 7-septate, 28–33 × 3.5–5.6 µm ascospores. It closely resembles with *T. montanum* Lücking which has large perithecia with acute to lanceolate setae and rather broad ascospores. This species is a new report for Mizoram. It was previously reported from Andaman and Nicobar Islands, Arunachal Pradesh and Meghalaya. Globally, it has pantropical distribution.

Specimens examined India, Mizoram, Aizawl district, Tawi Wildlife Sanctuary, alt. 947 m, 16 March 2017, *P.C. Lalremruata*, 11169 (BSA), 17-00161 (MZUBOT).

## Discussion

The present study added 11 species to the lichen flora of Mizoram, India viz. *B. connexula*, *B. curtisii*, *F. citrina*, *H. philippinum*, *L. delavayi*, *L. transgressa*, *P. pertusa*, *P. pseudococcodes*, *P. andina*, *S. fuliginosa* and *T. epiphyllum*. Out of 11 species identified, nine species were crustose and two foliose lichen (Table 1).

The northeastern region including Mizoram being under Indo-Myanmar biodiversity hot spot region is the best custodian for valuable lichens. Singh and Sinha [13] firstly reported the presence of *Cladonia fruticulosa* and *Cladonia submultiformis*. Chinlamianga et al. [2] and Logesh et al. [3] made an intensive study of lichens in Mizoram and reported 166 species of lichens within the state. Singh and Pinokiyo [14] also added 21 foliicolous lichens from Mizoram. Later, Lalremruata et al. [4] reported 18 species of lichen from Tawi Wildlife Sanctuary, Mizoram. Recently, Thangjam et al. [5] further added 22 species from Murlen National Park, Mizoram. By the addition of 11 species from the present study, the total number of Mizoram lichen raises up to 240 species.

The study region exhibits sort of microhabitat that harbour luxuriant growth and establishment of lichen species

**Table 1** Lists of newly reported lichens from Mizoram

Species	Family	Growth form	Accession number (BSA)
<i>Bacidia connexula</i>	Ramalinaceae	Crustose	11164 (BSA)
<i>Baculifera curtisii</i>	Physciaceae	Crustose	11181 (BSA)
<i>Flavoplaca citrina</i>	Teloschistaceae	Crustose	11166 (BSA)
<i>Herpothallon philippinum</i>	Arthoniaceae	Crustose	11163 (BSA)
<i>Leptogium delavayi</i>	Collemaaceae	Foliose	11184 (BSA)
<i>Letrouitita transgressa</i>	Letrouitiaceae	Crustose	11190 (BSA)
<i>Pertusaria pertusa</i>	Pertusariaceae	Crustose	11171 (BSA)
<i>Pertusaria pseudococcodes</i>	Pertusariaceae	Crustose	11183 (BSA)
<i>Pyrenula andina</i>	Pyrenulaceae	Crustose	11168 (BSA)
<i>Sticta fuliginosa</i>	Lobariaceae	Foliose	11189 (BSA)
<i>Trichothelium epiphyllum</i>	Porinaceae	Crustose	11169 (BSA)

\*BSA—Botanical Survey of India, Allahabad

on totally different substrata. The present study reveals eleven species of lichen were reported from the protected areas. In distinction, the near reserve forests space tough a great deal of anthropogenic activities like shifting cultivation, enlargement of agriculture, introduction of crops plantation, destruction of natural forest for assortment of wood, infrastructure development and construction that result in declined growth of macrolichens like - *Usnea*, *Everniastrum*, *Ramalina* and *Parmotrema*. Many researchers also have recently become interested in the ethno-medicinal usage of lichen in the hopes of discovering a novel medicine. Despite the discovery of numerous novel medications, many lichen species are still being studied for pharmacological and cosmetic applications. This could result in the loss of valuable lichen resources in the future. Thus, the need of the hour is a holistic approach of anthropogenic activities in a sustainable manner that will restore micro-climatic condition of the lichen flora before its depletion.

## Conclusion

The addition of eleven species of lichens from the present study will help as base line records to lichen flora of Mizoram. The combination of climatic parameters, including edaphic, temperature, precipitation, humidity, altitude and forest type of the study region, promotes the proliferation of lichen flora luxuriantly. A comprehensive exploration of lichens in the remaining unexplored Wildlife Sanctuaries and National Park will definitely further add the number of lichen species to the state of Mizoram as well as India.

**Author contribution** PCL and RL have equally contributed to collections and sampling of lichens. PS and PCL have contributed to identifying and drawing the description of the lichen species. All authors have collaboratively contributed to the manuscript.

## Declarations

**Conflict of interest** The authors declare that they have no conflict of interest.

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