Environment and Ecology 37 (3) : 664—672, July—September 2019
Website: environmentandecology.com ISSN 0970-0420

Diversity and Distribution of Lichens in Murlen National Park of Mizoram, India

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Received 8 January 2019 ; Accepted 11 February 2019 ; Published on 4 March 2019

Abstract Lichens are widely distributed in all the geographical region of the world. Likewise, in India, the Indo-Burma region is fully blessed with the Lichen diversity. Thus, a survey was made to evaluate the lichens diversity and distribution in Central Part of Murlen National Park (MNP), Mizoram. Based on collected data, the present study enumerated 20 lichens species which belonging to 15 genera and 10 families. The family Parmeliaceae showed the highest number of species. Moreover, the growth form was dominated by crustose compared to foliose and fruticose. The richness of lichen diversity in this protected area specifies that the need of exploration is still required to establish the lichen database for future studies.

Keywords Crustose, Lichens, Murlen National Park, Mizoram, Parmeliaceae.

Introduction

Lichens are considered as a constant and self-sustaining relationship between fungi as mycobionts and the algal partners as photobionts. As the mycobiont is sole in the symbiotic relationship and it is typically controls the relationship ; lichens are occasionally categorized as a life dependent of fungi (Ranković and Kosanić 2015). Lichens is also known as one of the most positive symbiotic relations of a fungus, a green and / or blue green alga, which can belive everywhere in this planet (Rai et al. 2015). Morphologically, lichens are growing in 3 different growth forms, which are crustose (used to grow attached to the substratum) followed by foliose (used to grow like leafy and slackly attached to the substratum) and lastly fruticose (used to grow like bushes which is hanging or upright growing on substratum) (Gaurav and Upreti 2016). Lichens with their metabolites are also having numerous biological activities such as antimicrobial, antiprotozoal, antiviral, antiproliferative, anti-inflammatory, analgesic, antipyretic, antitermite, antioxidant, cytotoxic, enzyme inhibitory, insecticidal, wound healing, antitumor and in the ecological roles as well as enzyme inhibitory (Yilmaz et al. 2004, Kosanić et al. 2013, Rajan et al. 2016).

India is measured the 5th country around the world with luxuriant biodiversity, which is about 10% of lichen species recorded in the world (Groombridge 1992). The North Eastern Region of India is popularly known for its luxuriant growth of various plants diversity including lower to higher plants and of course lichens too. In connection with researches carried out on exploration of lichens biodiversity in North Eastern region of Himalaya was reported from the states like Arunachal Pradesh, Assam, Manipur,

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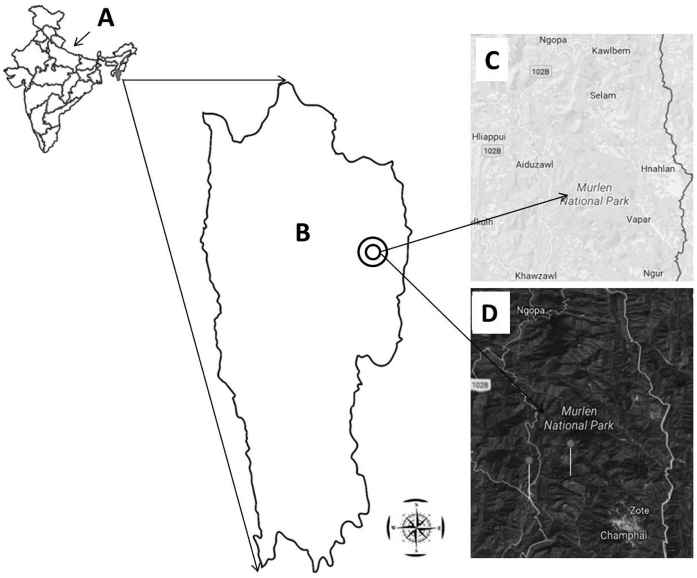


Fig. 1. Overview of the study area-Murlen National Park (C-D), Champhai district Mizoram (B), India (A).

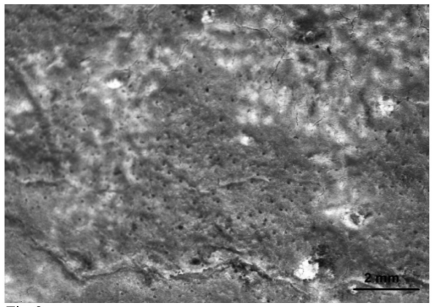
Meghalaya, Nagaland and Sikkim. The previous studies from these states were already showed huge number of lichens species ; moreover, it was also proven by Pinokiyo et al. (2004), Rout et al. (2010), Devi et al. (2015), Singh and Singh (2015), Singh and Singh (2016).

In spite of such a rich diversity of lichen flora but there are still so many region of NER have not been adequately explored in particular Mizoram, Chinlampianga et al. (2013) stated that 2 species of lichens i.e. *Cladonia fruticulosa* Kremp. and *Cladonia submultiformis* Asahina was the first from the state. Further, he documented 10 more species of lichen from different parts of the state. Moreover, Logesh et al. (2015) have reported 159 species from different parts except Central Part of Murlen National Park, Mizoram. Thus, considering all previous studies, it showed a scanty work on documentation of lichens biota from the state. Therefore, the survey has been made for the collection and identification of lichen species in the Central Part of the park at different altitudes.

Materials and Methods

The study area

The Murlen National Park (MNP) is located in Champhai district of Mizoram, India ; and it lies between N 23°32′ 42′′ to 23°41′ 36′′ (Latitude) ; E 92° 13′ 12′′ to 92° 27′ 24′′ (Longitude) and having an altitude of 400 to 1,897 meters (Fig. 1). The total coverage area of the park is 200 km^2. The park is also located around 245 km east of Aizawl district (State Capital). The park is close to the Indo-Myanmar border and is significant for its proximity to the Chin Hills. This park is also known to be one of the dense forests in the country, which allows the sunlight to penetrate at minimal level. MNP is situated at Murlen village, once it was ruled by the chief of Hnahlan. It was declared as National Park in 1991 (Chaudhary 2018). Recently, it has been categorized as one of the National Parks under Category II of United Nations list of Protected Area (PA). It is the last home of Himalayan Black Bear in the Eastern corner of the country. Moreover, it is homely to a variety of floral faunal species that are endemic to Mizoram and the



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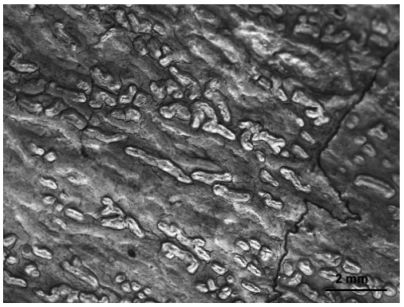

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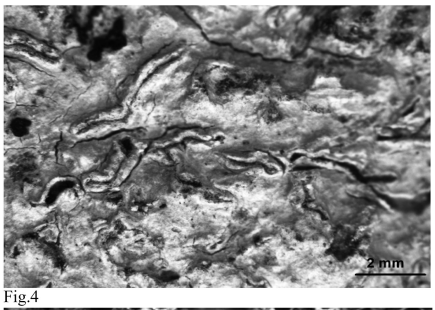

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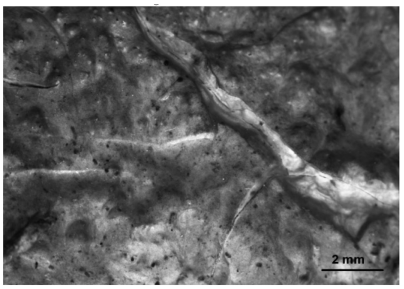

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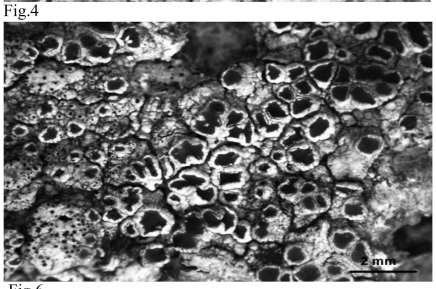

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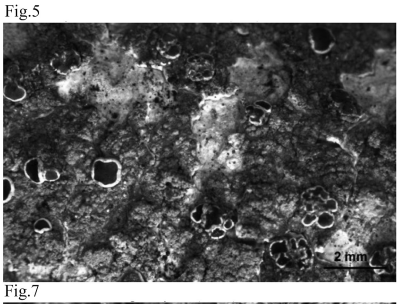

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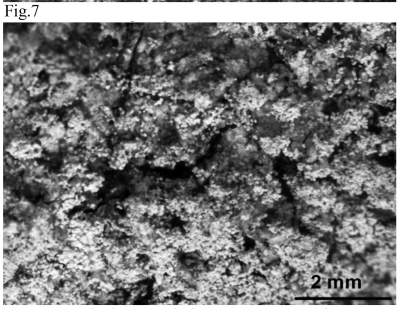


Fig.9

Fig. 2. *Cryptothecia lunulata* (Zahlbr.) Makhija & Patw. **Fig. 3.** *Dioryg mahieroglyphicum* (Pers.) Staiger & Kalb. **Fig. 4.** *Graphis* sp. **Fig. 5.** *Myriotremac landestinum* (Fée) Hale. **Fig. 6.** *Haematomma puniceum* (Sw.) A. Massal. **Fig. 7.** *Lecidea granifera* (Ach.) Vain. **Fig.8.** *Evernia strumcirrhatum* (Fr.) Hale ex Sipman. **Fig. 9.** *Myelochroa xantholepis* (Mont. & Bosch) Elix & Hale.

NER. The forest is a type of Sub-Tropical Semi Evergreen and Semi-Montane type (MoEF 2018). The park is also rich in biodiversity, shelter and protects rare, endangered and threatened species.

Methods

The survey was made in central part of MNP and lichen specimens were collected. The standard proce-

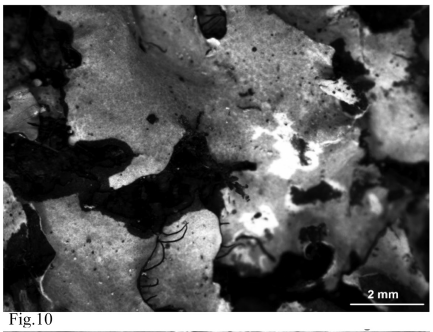
Table 1. Lichen biodiversity in Central Part of MNP, Mizoram.

Sl. No.	Family	Genera	Species	Growth form	Field number
1	Arthoniaceae	*Crytothecia*	*Cryptothecia lunulata* (Zahlbr.) Makhija & Patw.	Crustose	16-030740
2	Graphidaceae	*Diorygma*	*Diorygmahiero glyphicum* (Pers.) Staiger & Kalb	Crustose	16-030760
3	Graphidaceae	*Graphis*	*Graphis* Sp.	Crustose	16-030739
4	Graphidaceae	*Myriotrema*	*Myriotrema clandestinum* (Fée) Hale	Crustose	16-030714
5	Haematomm-ataceae	*Haematomma*	*Haematomma puniceum* (Sw.) A. Massal	Crustose	16-030721
6	Lecideaceae	*Lecidea*	*Lecidea granifera* (Ach.) Vain	Crustose	16-030748
7	Parmeliaceae	*Everniastrum*	*Evernia strumcirrhatum* (Fr.) Hale ex Sipman	Foliose	16-030726
8	Parmeliaceae	*Myelochroa*	*Myelochro axantholepis* (Mont. & Bosch) Elix & Hale	Foliose	16-030708
9	Parmeliaceae	*Parmotrema*	*Parmotrema reticulatum* (Taylor) M.Choisy	Foliose	16-030703
10	Parmeliaceae	*Parmotrema*	*Parmotrema saccatilobum* (Taylor) Hale	Foliose	16-030729
11	Parmeliaceae	*Parmotrema*	*Parmotrema tinctorum* (Despr. exNyl.) Hale	Foliose	16-030702
12	Parmeliaceae	*Usnea*	*Usnea baileyi* (Stirt.) Zahlbr.	Fruticose	16-030743
13	Parmeliaceae	*Usnea*	*Usnea orientalis* Motyka	Fruticose	16-030751
14	Parmeliaceae	*Usnea*	*Usnea undulate* Stirt.	Fruticose	16-030747
15	Physciaceae	*Heterodermia*	*Heterodermia diademata* (Taylor) D. D. Awasthi	Foliose	16-030765
16	Physciaceae	*Heterodermia*	*Heterodermia speciosa* (Wulfen) Trevis.	Foliose	16-030704
17	Pyrenulaceae	*Anthracothe-cium*	*Anthracothecium macrosporum* (Hepp) Müll. Arg.	Crustose	16-030713
18	Ramalinaceae	*Phyllopsora*	*Phyllopsora* sp.	Crustose	16-030746
19	Ramalinaceae	*Ramalina*	*Ramalina conduplicans* Vain.	Fruticose	16-030723
20	Ramboldi-aceae	*Ramboldia*	*Ramboldia manipurensis* (Kr. P. Singh) Kalb, Lumbsch & Elix	Crustose	16-030752

dures were followed for collection (Devi et al. 2015). Further, the processing of specimens like removal of unwanted materials (Bryophytes and substratum) as well as drying by using hot air oven was carried out in Department of Horticulture, Aromatic and Medicinal Plants (HAMP), Mizoram University, Aizawl.

Furthermore, the lichens specimens were identified through comparative studies based on their anatomical, morphological and biochemical observations and it was done at Lichenology Laboratory, CSIR–National Botanical Research Institute (NBRI), Lucknow. The morphological variations of each specimen were studied by using Leica S8APO stereo-zoom microscope, whereas anatomical studies were made by Leica DM500 compound microscope. The microscopic details of each specimen were performed by cutting the transverse section of fruiting bodies, where the cotton blue was used as a staining media and lactophenol as mounting media. The Moreover, the specimens were identified and authenticated with previous literatures on lichens by Awasthi (1993), (2007), Nayaka (2004), Divakar and Upreti (2005), Singh and Sinha (2010), Shukla et al. (2014).

In addition to this, the biochemical studies along with Thin Layer Chromatography (TLC) were also carried out for exact identification of each lichens species. It was totally based on specific color test given by the lichens. In this, the cortex and medulla regions were exhibited the different color when chemical reagents viz. calcium hypochlorite (C), potassium



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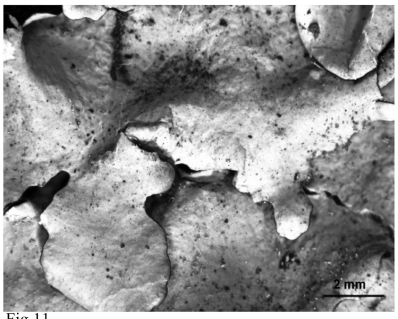

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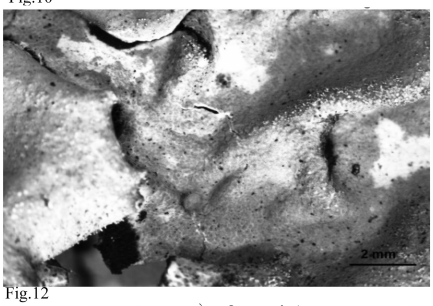

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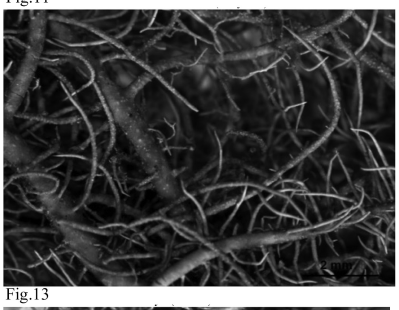
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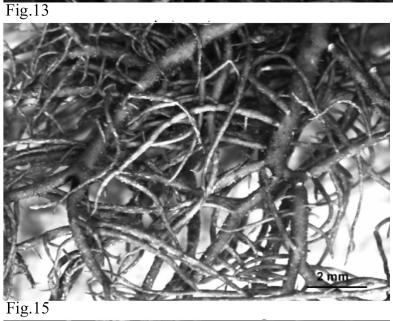

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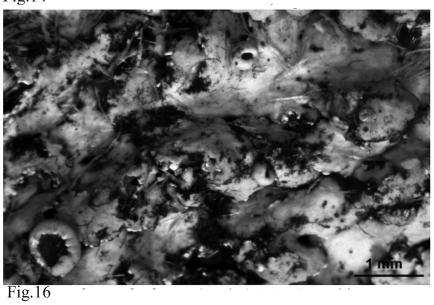

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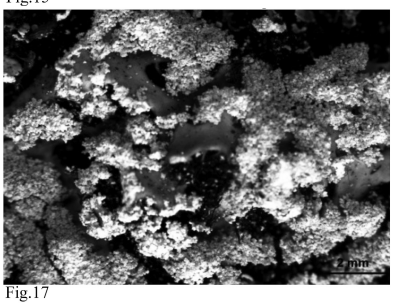
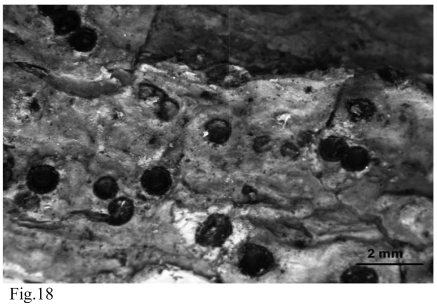


Fig.17

Fig. 10. *Parmotrema reticulatum* (Taylor) M. Choisy. **Fig. 11.** *Parmotrema saccatilobum* (Taylor) Hale. **Fig. 12.** *Parmotrema tinctorum* (Despr. exNyl.) Hale. **Fig. 13.** *Usnea baileyi* (Stirt.) Zahlbr. **Fig. 14.** *Usnea orientalis* Motyka. **Fig. 15.** *Usnea undulata* Stirt. **Fig. 16.** *Heterodermia diademata* (Taylor) D. D. Awasthi. **Fig. 17.** *Heterodermia speciosa* (Wulfen) Trevis.

hydroxide (K) and Steiner's stable Paraphenylene Diamine (PD) was dropped to lichen specimens. In case of TLC, (Walker and James 1980) protocols were followed having solvent system A in a ratio of Toluene 180 : 1–4 Dioxane 60 : Acetic acid 8.

Finally, the identified lichens specimens were properly packed inside a herbarium packet which is specifically made for lichens. The herbarium sheets were categorized with area of collection, date of collection, name of lichens and its family, altitude



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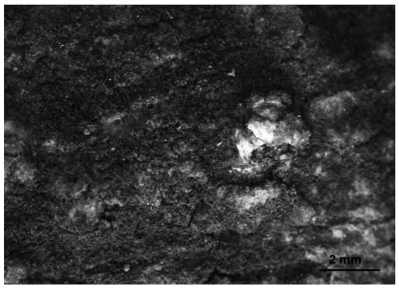

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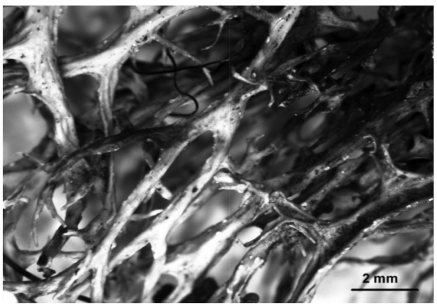

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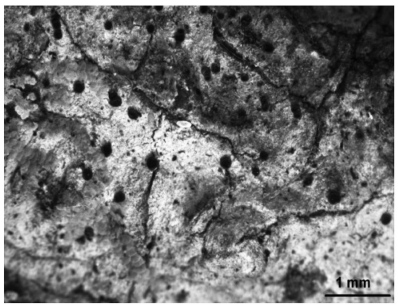

Fig.21

Fig. 18. *Anthracothecium macrosporum* (Hepp) Müll. Arg. **Fig. 19.** *Phyllopsora* sp. **Fig. 20.** *Ramalina conduplicans* Vain. **Fig. 21.** *Ramboldia manipurensis* (Kr. P. Singh) Kalb, Lumbsch & Elix.

and name of collector. After that all the specimens were deposited in lichen herbarium (LWG) of CSIR–NBRI, Lucknow and Department of HAMP, Mizoram University, Aizawl.

Results and Discussion

The present world identified 20 different species of lichens belonging to 15 genera and 9 families from the central part of Murlen National Park, Champhai District of Mizoram State of northeast India (Table 1), (Figs. 2—21). Crustose lichens were found luxuriantly, represented by 9 species followed by foliose having 7 species and fruticose with 4 species respectively. These 3 forms of lichens were consisted of various lichen families. Based on distribution of families, it was found that the family Parmeliaceae possessed highest number of species (8 spp.) which is followed by Graphidaceae with 3 spp. Further, family Physciaceae as well as Ramalinaceae with 2 spp. holds the third position and Arthoniaceae, Hematommataceae, Lecideaceae, Pyrenulaceae and Ramboldiaceae were also contributed 1 sp. in each family. Therefore, the present study showed the vibrant variation of lichen diversity in the study area. (Figs. 22, 23).

The region is dominated with maximum diversity of lichen by the species of *Parmotrema* namely *Parmotrema reticulatum* (Taylor) M. Choisy, *Parmotrema saccatilobum* (Taylor) Hale, *Parmotrema tinctorum* (Despr. exNyl.) Hale and it usually prefer to grow in the moist area under the shady part of the MNP (Dey et al. 2015) followed by *Usnea* viz. *Usnea baileyi* (Stirt.) Zahlbr., *Usnea orientalis* Motyka, *Usnea undulata* Stirt. Since it is known that the lichens are the indicator of pollution particularly *Usnea* sp. highly sensitive to sulfur dioxide. The flourished growth of *Usnea* sp. clearly indicated the healthy vegetation as well as pollution free air in the MNP reserve forest ; the present finding is also supported by Gupta et al. (2016).

The clear observation of lichens sp. was made by Singh and Sinha (2010) were published as the checklist of lichens of India. According to them 480 lichen species were reported from Arunachal Pradesh,

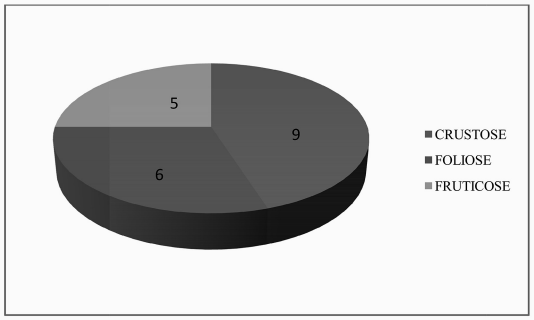

Fig. 22. Distribution of lichens growth forms in Central Part of MNP, Mizoram.

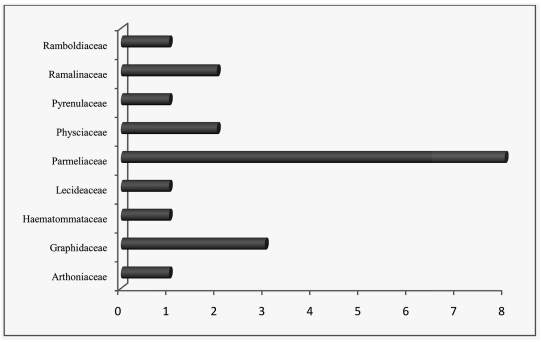

Fig. 23. Dominance of the families concern with species in Central Part of MNP, Mizoram.

150 lichen species from Assam, 295 lichen species from Manipur, 184 lichen species from Meghalaya and lastly 304 lichen species from Nagaland as well. Recently, at the elevation of 1,618 to 4,509 meter, 17 species belonging to 12 genera and 5 families were recorded as new additions to the lichen flora of Arunachal Pradesh State (Debnath et al. 2018).

Furthermore, in case of families' wise observation from Eastern parts of Himalayas as well as North Eastern parts of India, the family Parmeliaceae achieved highest number of species as compared to others (Sinha and Ram 2011). Again, it is notable that acorticolous lichen species namely *Usnea* Dill ex Adans belongs to the family Parmeliaceae exhibited hanging pattern of growth forms on twigs of the branches (Shukla et al. 2014). On the other hand the 2 species of Graphidaceae namely *Graphisma nipurensis* and *Graphis sirohiensis* reported from Manipur were also noteworthy because it also increased the number of spp. in family (Singh and Singh 2014).

A part from this, it is also documented that since time immemorial, the numbers of lichens are used in traditional medicine (Nayaka et al. 2010). Presently, through universal now the researches concentrated on nanoparticles which has to advance a herbo-metallic colloidal nano-formulation with *U. longissima* extract and study its value as anti-quorum sensing (QS) property against *Streptococcus mutans* (Singh et al. 2015). Altogether, it is summarized that lichens are the key primary producers with important linkage to nutrient cycling and forest food chain, moreover, their genetic richness is also more accountable in protected forest area with respect to biodiversity bioprospection (Jovan 2008, Rout et al. 2010).

Therefore, it is an urgent need to document the lichens flora from the each location of the MNP as well as surroundings area, Additionally, conservation strategies must be developed for its sustainable harvesting and future researches.

Conclusion

In the present study, the richness of lichens diversity with identification of 20 different lichen species from central part of Murlen National Park, Mizoram is a valuable contribution in field of lichenology. It's varied range of sp. also reflecting the pollution free atmosphere surroundings to MNP village. Though, the local peoples somehow using few species like *Everniastrum* and *Usnea* in their daily delicacy as well as for medicinal purposes ; but this area is still not much more explored in case of lichens studies. Since, the MNP is located very far from the Aizawl city even more distantly from the local town Champhai, the collection of lichens sp. is only possible in day time. Currently, sustainable measures are started to conserve the floral diversity for setting up the livelihood based on forest resources. Therefore, in connection to this, proper documentation, identifica-

tion and scientific validation will be more important for the analysis of lichens diversity as well as for conservation.

Acknowledgement

The authors are thankful to the authorities of Department of Horticulture, Aromatic and Medicinal Plants, Mizoram University, Aizawl and the Director, CSIR-National Botanical Research Institute, Lucknow for providing the necessary facilities for present research work.

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