



DIVERSITY DISTRIBUTION OF LICHENS FROM MARUTHAMALAI HILLS OF TAMIL NADU, INDIA

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The paper reports the occurrence of 31 species of lichens belonging to 21 genera and 11 families for the first time to the Maruthamali hills, the part of Western Ghats in Tamil Nadu, South India. The distribution of each species and distinguishing characters facilitated their identification. The majority of the species belonged to crustose form (65%) followed by foliose (32%) and leprose (3%). The family Physciaceae was leading by 23 % followed by Parmeliaceae (19%). Many lichen species (58%) were recorded at 450 m altitude. It is concluded that the many localities in the Western Ghats still remains relatively unexplored and these areas are subjected to further exploration for new discovery and new additions

Key words: Crustose, Foliose, Leprose, Parmeliaceae, Physciaceae, Western Ghats.

Introduction

The present study area Maruthamalai Hills is in Coimbatore District of Tamil Nadu, which is located in Southern Western Ghats of India. India is endowed with variety of endemic and threatened angiosperms. Sinha et al.¹ have reported that 2712 lichen species are distributed in India. Tamil Nadu one of the hyper diversity states of the country representing 785 species of lichens²⁻⁴ and locates at the geographical area of 22,429 km². The study area lies at the latitude and longitude between 76°45' and 76°55' E and 11°0' and 115' N. The hills lie with elevation ranges from 340 m to 975 m. Mean annual rainfall is between 500 and 2000 mm. The deciduous forests of Maruthamalai hills possesses diverse vegetation with a total number of 201 species of plants affiliated to 153 genera⁵. Maruthamalai hills holds nearly fifteen endemic plant species used in medicine by the indigenous people. A recent literature described that the plant species from Maruthamalai hills have been

continuously depleting and due to the fact that absence of scientific records, traditional knowledge about the medicinal importance of plants is vanishing⁶. No attempt has been attempted so far to comprehensively document the existing lichen flora of Maruthamalai hills which possesses unique floral components in its wide range of natural habitats. Therefore, the present survey is the first lichen survey report in the Maruthamalai Hills, the part of Western Ghats, Tamil Nadu, India. The Maruthamalai one of the high ranges in the Western Ghats, lies on the boundaries of Tamil Nadu (Coimbatore district) and Kerala (Idukki, Palakkad and Thrissur districts) states. The elevation of the hills is maximum of about 975 m above MSL. The ecological changes or changes in annual rainfall and in vegetation throw light in realizing the composition and type of lichen species in the Maruthamalai hills. The study also identified the sites with rich lichen diversity and occurrence of

dominant lichen growth forms and families. The detailed survey report with reference to species diversity and their related substrate specificity was recorded in varied elevation gradients to summarize the lichen wealth of the Maruthamalai Hills. The earliest lichen survey on the Western Ghats of Tamil Nadu described a rich lichen species in Tamil Nadu state on comparison with other states such as Tripura (30) species, Mizoram (182 species), Nagaland (334 species), Manipur (374 species), Assam (424 species), Arunachal Pradesh (612 species) and Sikkim (634 species). The scientific observations confirmed that the pollution levels have increased many folds than a decade ago in Maruthamalai hills⁷. The hills pose great pressure due to forest fire and human interference. It is most important to restore the ecosystem. Realizing the hazards of extinction and importance of its biological activities, an extensive exploration was executed to document the lichen flora of the study site. Balaji and Hariharan⁸ reported 6% of total lichen species colonized on rock followed by 0.8% on soil and one single species on bark and rock substratum in Siruvani hills, Coimbatore, Tamil Nadu the part of Western Ghats in India. This region has 4 lichen species found in moist deciduous forest 3 in dry deciduous forest.

Material & Methods

The lichen specimens collected from Maruthamalai hills, India were preserved in the herbarium of Bharathiar University, Coimbatore. Over the period of project duration between October 2018 and December 2019 lichen explorations were conducted in such localities. Representative voucher samples for all the lichens were identified by investigating their morphological and anatomical characters and samples were collected from different altitude across the hills: Foothills zone I (450 m), Foothills zone II (500 m), Temple zone I (550 m), Temple zone II (600 m). Recent floras and literature were referred for identification of

lichen species apart from standard Awasthi's^{9,10} identification manual and Orange et al.¹¹. For studying colour reactions, chemical reagents (K, C, KC and PD) were directly applied to thallus on cortex and medullary region. The bioactive compounds were recovered from lichen thallus using acetone solvent by immersing a fragment of thallus in solvent. The compounds obtained from lichen fragment were applied to silica gel coated on TLC plate. The mobile phase is TDA solvent (Toluene 180 ml, 1, 4, Dioxane 45ml, Acetic acid 5 ml). The identification of morphological, anatomical and chemical features of lichen were confirmed by matching their features with herbarium samples preserved at LWG, NBRI, Lucknow.

Results and Discussion

Total lichen species collected from four major sites of Maruthamalai representing 31 species belonged to 21 genera and 11 families (Table 1.) (Fig. 5.). Three species accounted for 10% of total lichen diversity were identified up to species level and 28 were identified to genus level. The existence of a rich number of lichen species may be explained due to the prevalence of drought and moderate humid ecosystems which might have triggered the lichen species to produce defense mechanisms of secondary metabolites as a "survival of the fittest" for their establishment. Among 31 species, crustose form was leading with 20 (65%) species followed by foliose lichens 10 species (32%) and leprose 1 (3%) (Fig. 1.). The predominant family diversity showed that the Physciaceae was leading by 7 species (23%) found at an altitude above 410 m MSL (Fig. 2.). The species belonging to Physciaceae are *Buellia*, spp., *Buellia confuse*, *Buellia curtisii*, *Heterodermia obscurata*, *Physcia stellaris*, *Pyxine cocoes*. Among the lichen genera *Buellia* spp., *Parmotrema* spp., and *Lecanora* spp., is dominant with 3 species each, followed by *Dimeralla* spp., and *Caloplaca* spp., (2) and rest of them are

one in each. The lichens belonging to Parmeliaceae were *Bulbothrix tabacina*, *Parmelina quercina*, *Parmotrema praesorediosum*, *P. andinum* and *P. melanothrix*. Taxonomically well-represented families include Candellariaceae, Chrysothricaceae, Ectolechiaceae, Graphidaceae, Gylacteaceae, Lecanoraceae, Parmeliaceae, Physciaceae, Pertusariaceae, Pilocarpaceae and Teloschistaceae with 1, 1, 1, 5, 2, 3, 6, 2, 7, 1 and 2 species respectively. The 5 families viz., Candellariaceae, Chrysothricaceae, Ectolechiaceae, and Pilocarpaceae showed one single species each in the entire study area. The lichen species belonged to the family Parmeliaceae (19%) showed second leading diversity in the present study. The substrate specificity of lichen species showed that corticolous (87%) was leading over saxicolous (10%) followed by one species *Heterodermia obscurata* occurring on both corticolous and saxicolous (3%) (Fig. 3.).

This study showed that the majority of the lichens (58 %) were adapted to survive at 450 m MSL in Maruthamalai foot hills I. The (Fig. 4.) showed that 12.9 per cent of lichen diversity were from Foot hills II (500 m MSL) and 9.7 percent were from Maruthamalai temple zone I, (550 m MSL). Maruthamalai temple zone II (600 m MSL) has 19.35 % (6 species) of total lichen diversity.

The following species attached to *Acacia planifrons* were *Buellia curtisii*, *Bulbothrix tabacina*, *Byssoloma leucoblepharum*, *Canopar meliapustuscens*, *Graphisrimulosa* var. *parallela*, *Heterodermia obscurata*, *Parmotrema melanothrix* and *Parmelina quercina*. The species attached to bark of *Pongamia pinnata* L. were *Dimerlla nepalensis*, *D. pineti*, *Lecanora alba*, *L. perplexa*, *Parmotrema praesorediosum* and *Parmotrema andinum*. The *Albizia lebbek* L., *Albizia odoratissima* L.F. were dominated by *Dirinaria applanata*. The following species recorded from

Peltophorum pterocarpum DC were *Buellia* sp., *B.confuse*, *Lecanora* spp., *Lopadium* spp., *Pertusari acolorata*, and *Pertusaria* spp. The bark of *Acacia ferruginea* DC. supported the growth of *Chyrsothrix chlorina*, *Physcia stellaris* and *Pyxine coccus*. The occurrence of three species on *Cassia siamea* Lam. were *Sarcographa subtriosa* and *Candellaria concolor*. The present study has shown a positive correlation between lichens and host plant relationship and thus suggests that the bark of host plant might contain ideal pH. This is supportive in agreement to the reports published by Sequiera and Kumar¹².

Key to *Fungus* species

- 1.Thallus sterile..... Group I
- 1b.Thallus fertile.....2
- 2a. Thallus crustose.....Group II
- 2b. Thallus foliose.....Group III
- Group I
- 1a. Thallusleprose,.....*Chrysothrix*
- 1b. Thallus not leprose.....*Pertussaria*
- Group II
- 1a. Apothecial disc wide open.....2
- 1b.Apothecia ellipsoid to elongate
- lirellate, simple or branched.....3
- 2a. Ascocarp immersed in stroma.....4
- 2b. Ascocarp not immersed in stroma.....5
- 3a. Spores persistently colourless,
- lirellate simple or branch.....*Graphis*
- 3b. Spores light brown to brown on
- maturity, lirellate simple or
- branched.....*Phaeographis*
- 4a. Spres 3 – 11 septate, ascocarps round
- to linear simple or branched, often much
- crowded colourless spores*Glyphis*
- 4b. Spores 3-11 spetate, ascocarp simple or
- branched brown colour spores... *Sarcographa*
- 5a. Ascocarplecidine, spores typically 1
- spetate, thick walled..... *Buellia*
- 5b. Ascocarp completely with
- thallineexciple.....6
- 6a. Thallus corticolous.....7
- 6b. Thallus saxicolous, apothecia with
- thalline orange red exciple*Caloplaca*
- 7a. Transversely septate spores.....8
- 7b. Simple spores or muriform9
- 8a. Spores 1 septate apothecial disc yellow

or orange*Dimerella*

8b. Spores transversely 1-3 septate

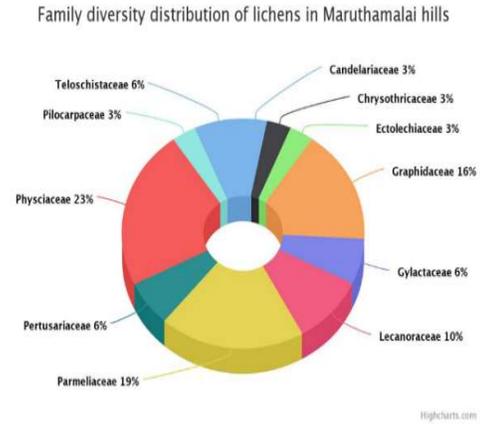
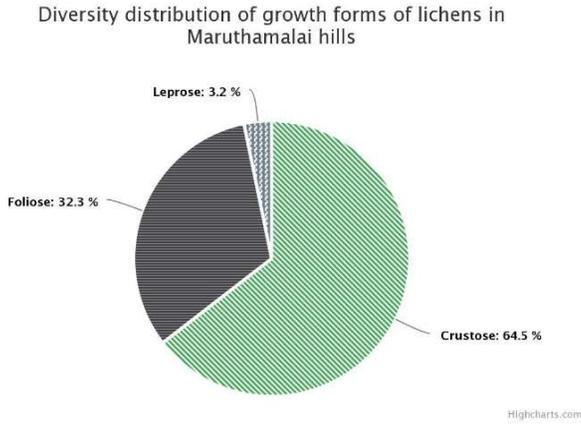


Fig. 1. – Diversity distribution of growth forms in Maruthamalai hills

Fig. 2. – Family diversity distribution of saxicolous lichens in Maruthamalai hills

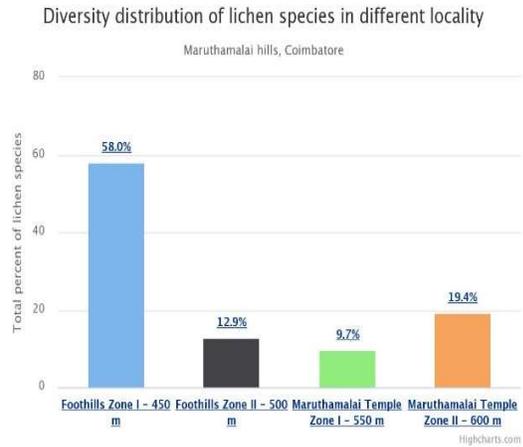
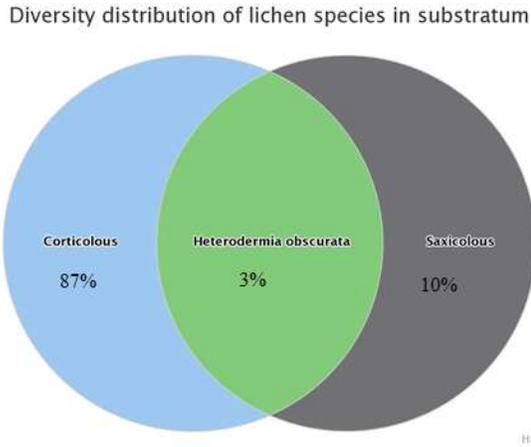


Fig. 3.–Substrate Specificity of lichen species in Maruthamalai hills

Fig. 4. – Diversity distribution of lichen species in different locality

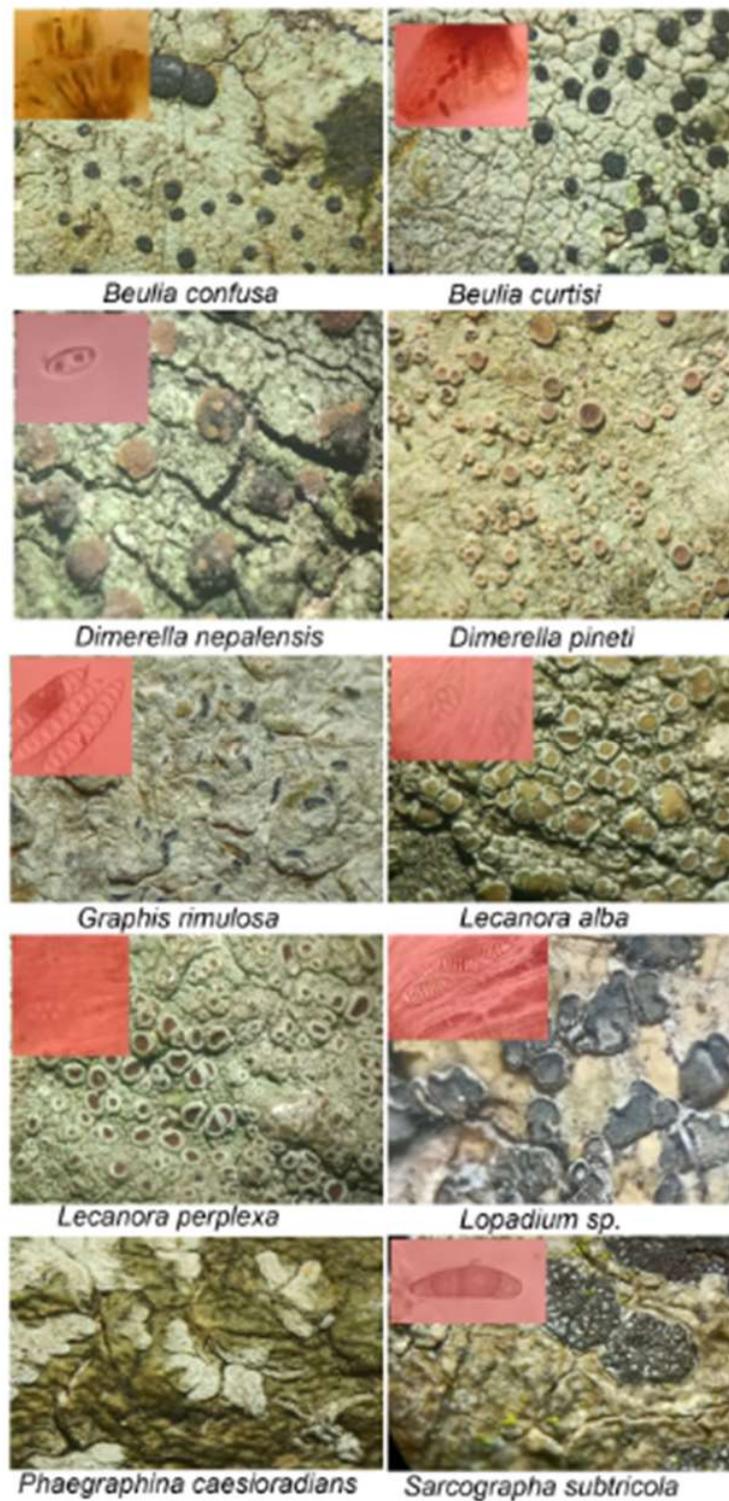


Fig. 5.—Pictorial representation of few lichen species collected in the study area

S. No	Lichen Diversity of Maruthamalai hills	Family	Substratum	Altitude	Location	Forms	Name of the plant species
1	<i>Chrysothrix chlorina</i>	Chrysothricaceae	Corticolous	465 m	Foothills zone I	Leprose	<i>Acacia ferruginea</i> DC. <i>Azadirachta Indica</i> A.
2	<i>Buellia spp.</i> ,	Physciaceae	Corticolous	463 m	Foothills zone I	Crustose	<i>Peltophorum pterocarpum</i> DC.
3	<i>Buellia confuse</i>	Physciaceae	Corticolous	473 m	Foothills zone I	Crustose	<i>Peltophorum pterocarpum</i> DC.
4	<i>Buelliacurtisii</i>	Physciaceae	Corticolous	485 m	Foothills zone I	Crustose	<i>Acacia planifrons</i> Wight & Arn. <i>Peltophorum pterocarpum</i> DC.
5	<i>Bulbothrix tabacina</i>	Parmeliaceae	Corticolous	460 m	Foothills zone I	Foliose	<i>Acacia planifrons</i> Wight & Arn.
6	<i>Byssoloma leucoblepharum</i>	Pilocarpaceae	Corticolous	496 m	Maruthamalai Temple Zone I	Crustose	<i>Acacia planifrons</i> Wight & Arn.
7	<i>Caloplaca exsecuta</i>	Teloschistaceae	Saxicolous	588 m	Maruthamalai Temple Zone II	Crustose	Rock
8	<i>Caloplaca vitellinula</i>	Teloschistaceae	Saxicolous	612 m	Maruthamalai Temple Zone II	Crustose	Rock
9	<i>Candellaria concolor</i>	Candelariaceae	Corticolous	462 m	Foothills zone I	Crustose	<i>Cassia siamea</i> Lam.
10	<i>Canoparmelia pustulescens</i>	Parmeliaceae	Corticolous	460 m	Foothills zone I	Foliose	<i>Acacia planifrons</i> Wight & Arn.
11	<i>Dimerella nepalensis</i>	Gyalectaceae	Corticolous	480 m	Foothills zone I	Crustose	<i>Pongamia pinnata</i> L.
12	<i>Dimerella pineti</i>	Gyalectaceae	Corticolous	485 m	Foothills zone II	Crustose	<i>Pongamia pinnata</i> L.
13	<i>Dirinara applanata</i>	Physciaceae	Corticolous	465 m	Foothills zone II	Foliose	<i>Albizia lebbeck</i> L. <i>Albizi aodoratissima</i> L.F.
14	<i>Glyphisscy phulifera</i>	Graphidaceaea	Saxicolous	458 m	Foothills zone I	Crustose	<i>Azadirachta indica</i> A.
15	<i>Graphisg lauconigra</i>	Graphidaceaea	Corticolous	460 m	Foothills zone I	Crustose	<i>Cassia siamea</i> Lam. <i>Acacia planifrons</i> Wight & Arn.
16	<i>Graphisrimulosavar parallela</i>	Graphidaceaea	Corticolous	462 m	Foothills zone I	Crustose	<i>Acacia planifrons</i> Wight & Arn.
17	<i>Heterodermia obscurata</i>	Physciaceae	Corticolous/Saxicolous	495 m	Maruthamalai Temple Zone I	Foliose	<i>Acacia planifrons</i> Wight & Arn. /Rock
18	<i>Lecanora alba</i>	Lecanoraceae	Corticolous	522 m	Maruthamalai Temple Zone II	Crustose	<i>Pongamia pinnata</i> L.
19	<i>Lecanora perplexa</i>	Lecanoraceae	Corticolous	508 m	Maruthamalai Temple Zone II	Crustose	<i>Pongamia pinnata</i> L.
20	<i>Lecanora spp.</i> ,	Lecanoraceae	Corticolous	488 m	Foothills zone I	Crustose	<i>Peltophorum pterocarpum</i> DC.
21	<i>Lopadium spp.</i> ,	Ectolechiaceae	Corticolous	490 m	Foothills zone II	Crustose	<i>Peltophorum pterocarpum</i> DC.
22	<i>Parmelina quercina</i>	Parmeliaceae	Corticolous	456 m	Foothills zone I	Foliose	<i>Acacia planifrons</i> Wight & Arn.

23	<i>Parmotrema praesorediosum</i>	Parmeliaceae	Corticolous	456 m	Foothills zone I	Foliose	<i>Pongamia pinnata</i> L.
24	<i>Parmotrema andinum</i>	Parmeliaceae	Corticolous	455 m	Foothills zone I	Foliose	<i>Pongamia pinnata</i> L. <i>Acacia planifrons</i> Wight & Arn.
25	<i>Parmotrema melanothrix</i>	Parmeliaceae	Corticolous	457 m	Foothills zone I	Foliose	<i>Acacia planifrons</i> Wight & Arn.
26	<i>Pertusariacolorata</i>	Pertusariaceae	Corticolous	517 m	Maruthamalai Temple Zone II	Crustose	<i>Peltophorum pterocarpum</i> DC.
27	<i>Pertusariasp</i>	Pertusariaceae	Corticolous	498 m	Maruthamalai Temple Zone II	Crustose	<i>Peltophorum pterocarpum</i> DC.
28	<i>Phaeographina caesioradians</i>	Graphidaceaea	Corticolous	453 m	Foothills zone I	Crustose	<i>Azadiracta indica</i> A.
29	<i>Physcia stelarisi</i>	Physciaceae	Corticolous	470 m	Foothills zone I	Foliose	<i>Acacia ferruginea</i> DC.
30	<i>Pyxin ecocoes</i>	Physciaceae	Corticolous	460 m	Foothills zone II	Foliose	<i>Acacia ferruginea</i> DC. <i>Albizia lebbek</i> L.
31	<i>Sarcographas ubtriosa</i>	Graphidaceaea	Corticolous	500 m	Maruthamalai Temple Zone I	Crustose	<i>Cassia siamea</i> Lam.

.....*Byssoloma*
 9a. Simple spores.....*Lecanora*
 9b. Muriform spores.....*Lopadium*
 Group III
 1a. Thalluserhizinate.....*Dirinaria*
 1b. Thallusrhizinate, lobes round to subround.....2
 2a. Thallus ciliate, pycnoconidia cylindrical, bacilliform, filiform or fusiform.....*Canoparmelia*
 2b. Thallus ciliate found in axillary or marginal region.....3
 3a. Thallus lobes with marginal bulbate cilia, thallus grey to grey brown K+ yellow.....*Bulbothrix*
 3b. Thallus lobes with normal cilia.....4
 4a. Thallus with axillary ciliate, lobes 1-5mm wide.....*Parmelina*
 4b. Thallus ciliate in entire margin or eciliate.....5
 5a. Lobe margins are erhizinatethallus grey to darker grey, with or without maculae.....*Parmotrema*
 5b. Lobe margin are rhizinate, apothecia lecanorine, K+.....6
 6a. Thallus UV-.....7
 6b. Thallus UV+ Medulla yellow to Ochraceous K+purple.....*Pyxine*
 7a. Zeorine present in medulla, K+ yellow,

atraonin present.....*Heterodermia*
 7b. Zeorin absent in medulla, thallus grey, K+ yellow, atranorin present.....*Physcia*
 A number of lichens have been found to be associated with the economic importance. Maruthamalai hills is a well-known pilgrimage site in Tamil Nadu which escaped serious attention of lichenologist until the recent years. Some sites in Maruthamalai hills which were seen to be once covered by thick vegetation were now found to be left deserted. Earlier works have also reported that the diversity of vegetation in South Western Ghats belonging to Tamil Nadu is abruptly vanishing due to global warming and human anthropogenic activities. Lichens in Maruthamalai hills are found to be associated with the bark of various trees, rocks and varieties of substrates. Many aspects of altitude variation and their species diversity relationship have remained unexplored the reason may be due to the lack of permit to these forest sites. Therefore, the present study was conducted to study the lichen diversity distribution of Maruthamali hills found at the 600 m altitude of Western Ghats and intensive and extensive lichen diversity

survey was done to update and document the existing lichen database.

In the present lichens survey, a total of 31 different lichens species were identified between July 2019 and February 2020 from four localities of the Maruthamalai hills of Tamil Nadu, India. Richness of lichen species for the study sites represented variation in their growth forms and inhabiting features on type of rocks. Total lichen species collected from four major sites of Maruthamalai representing 31 species belonged to 21 genera and 11 families. This is the pioneering work with the lichens to explore the species diversity in the present study area. Three species accounted for 10% of total lichen diversity were identified up to species level and 28 were identified to genus level. Nayaka¹³ recorded the results of lichen survey carried out in Tamil Nadu. The results showed that the state was dominated by 812 species. It was evident that the major regions of Western Ghats run through the state Tamil Nadu. Therefore, the results convinced that the study area has rich in lichen diversity.

The Maruthamalai hills was dominated by following woody trees which showed *Acacia torta*, *Albizza amara*, *A. lebbek*, *Azadirachta indica*, *Chromolaena odorata*, *Commiphora caudata*, *Erythroxylo monogynum*, *Euphorbia antiquorum*, *Fluggea leucopyrus*, *Pterolobiu mindicum*, *Szygium cumini* and *Zizyphus oenoplia* in the Maruthamalai hills. This is similar to the work reported by Paulsamy⁵ who showed the presence of *Azadirachta indica*, *Erythroxylo nmonogynum*, *Fluggea leucopyrus* and *Szygium cumini* in the present study.

The altitude variation was related with the total lichen species diversity and the altitude at 450 m MSL showed the highest total number of species (58%) followed by 600 m (19%). This is similar to the report shown by Ponnurugan et al.¹⁴. Previous works have shown a strong

positive correlation between the impact of altitude against lichen species diversity and substrate specificity. The present study also suggested that the lichen species were abundant in the ideal altitude conditions and the reasons may be due to the possession of optimum humid atmosphere and pollution free environment.

The form diversity study shows the crustose form was leading followed by foliose. The present study is in line with the findings reported by Nayaka&Upreti¹⁵. Based on the family diversity study, it is concluded that the physciaceae family was leading over Parmeliaceae. But Nayaka & Upreti¹⁵ showed lichen diversity belonged to Parmeliaceae was maximum in Nilgiris and Palani Hills. The reason may be due to the presence of abiotic factor variations such as humidity, annual rainfall, available moisture, sun shine, natural vegetations etc.

Conclusion

Diversity distribution of lichens were assessed in Maruthamalai hills. The paper recorded the occurrence of 31 species of lichens belonging to 21 genera and 11 families. The species are reported for the first time to the Maruthamalai hills, the part of Western Ghats in Tamil Nadu, South India. Based on the results, it can be concluded that these species can be subjected to further investigations to prove any other bioprospecting activities.

Acknowledgements

The authors are grateful to Dr. Rajendran, Head, Department of Botany for support and encouragement. Authors are grateful to Dr. Sanjeeva Nayaka, National Botanical Research Institute, Lucknow for his noble guidance in identification of lichen.

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