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Diversity and Distribution Pattern of Lichens in the Mid-Elevation Wet Evergreen Forest, Southern Western Ghats, India

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Abstract: *The objective of this study is to document the lichen species and its host specific plant species in mid-elevational wet evergreen forest. This study was carried out mid elevational forest at different canopy gradient forest types within the ranges from 1100 – 1300m, the canopy height varied from 15 to 40 m. The Lichens were enumerated in four different locations at different canopy heights where, temperatures, rainfall and humidity not varied significantly. The sampling was done random quadrats at each site. Total 40 species of lichen belonging to 18 genera and 15 families, of 80% of species were corticolous, 12.5% species were saxicolous, 7.5% species were terricolous. The species 25% of species were grows more than one type of substrate. The results shown that the higher canopy forest recorded maximum lichen species then lower canopy forest. The higher canopy forest Cullenia exarillata alone recorded 30 % of species, then other species substrates.*

Keywords: *Lichens, Cullenia exarillata, Canopy forest, Western Ghats, Terricolous*

1. INTRODUCTION

Lichens are the most successful symbiotic organisms having fungal-algal association and form a thallus that does not resemble either symbiotic in the free living (non-lichenized) state [1].The moist forest of the tropics is especially rich in lichens. The tall tree trunks of the forests contain more number of species because of their best sites in the canopy [2]. South Indian lichens were poorly described, as most of the lichenologists selected either Niligiri or Palini hills for their study [3,4]. The Knowledge of lichens from Karnataka part of Western Ghats was attempted by very few workers [2, 5, 6, 7, 8]. Montane range of in Kalakadu Mundanthurai Tiger Reserve (KMTR), which is part of Agasthyamalai Biosphere Reserve, which has go higher endemism as compare to other parts of the Western Ghats. Kalakad Mundanthurai Tiger Reserve (KMTR), which is eastern slope of the Agasthyamalai Biosphere reserve. The study area receives both southwest and northeast monsoons from May to July and October to December respectively [9]. The rainfall patterns does not much changes over seven year from 2000 to 2010 was average is about 3625 mm and during 2005 the annual rainfall was about 3133 mm. The mean maximum temperatures ranged from 17 ^{0}C to 28 ^{0}C and the minimum temperature from 14 ^{0}C to 19 ^{0}C and annual rainfall ranges from 800 to 4000 mm [10, 9].The primary rain forests are dominated by *Cullenia exarillata, Aglaiabourdillonii* and *Palaquium ellipticum* [9]. In this ecosystem information of the lichen flora of KMTR forests is not available. Hence, the purpose of this study is to inventory lichens species distribution within mid elevations ranges from 1000 to 1350 m. Secondary, enumerating the substrate specific lichens species richness and identify the important tree species in the mid-elevation forest.

2. MATERIALS AND METHODS

This study was carried out in and around Monjolai, Kakachi, and Kodayar area (77°24’ E; 8°32’ N) of Kalakad Mundanthurai Tiger Reserve (KMTR), altitude range between 1100 m and 1300 m. The contiguous tracts of mid-elevation moist deciduous to wet evergreen forests, canopy ranges 15-40 m heights respectively. The dominant species in lower canopy *Wendlandia thyrsiflora, Phyllanthus emblica, Gnidia glauca, Glochidion ellipticum* and higher canopy are *Cullenia exarillata, Aglaiabourdillonii, Palaquium elipticum* & *Myristica beddomei* [9, 11].

The average annual precipitation recorded at three different sources point at Monjolai, Kakachi and Nalmukku tea estate was between 150 cm and 340 cm with minimum of 20 cm rainfall per month (Fig 1). The mean maximum and minimum temperatures are 24^{o}Cand 16^{o}C respectively with two dry seasons between southwest (June-August) and northeast monsoons (October-December). The sampling was preferred only dry seasons during 2007.

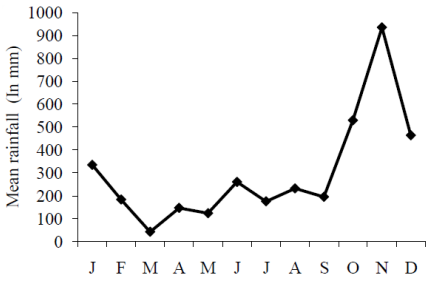

Figure1. *The average annual precipitation in KMTR study area*

The sampling was had done randomly laid five, 10 × 10m quadrats at each elevation. All four sites were considered different elevation gradients. The average rainfall does not vary much but seasonal variations were found across these elevation. In each transect all substrates were thoroughly searched for the occurrence of lichens. Only representative lichen specimens were collected and packed in brown paper bags, brought in polythene bags to the laboratory [12]. The lichen specimens were dried for 1-2 week to remove all moisture content from the sample, identified on the basis of their morphology, type of fruiting bodies, anatomy and chemistry following recent literature [13, 14, 15, 4, 5]. The colour test were performed with the reagent (5% Potassium hydroxide), C (aqueous solution of Calcium hypochlorite) and PD (Paraphenylene diamine). All lichen specimens were preserved in the herbarium of the Department of Botany, Kumadvathi First Grade College, Shimoga, Karnataka. Diversity indices Shannon and Simpson's Diversity index were calculated according to [16]. The relative frequency, relative density index were calculated by referring [17]

Table1. *Habitat details provided at different elevations and its forest canopy*

Study Sites	Localities	Altitude (m)	Forest canopy (m)	Lichen species recorded	Dominated canopy species
1	$08^{0}32$"to $8^{0}31$" - 77^{0} 22"	1270 - 1350	~>30 m	20	*Cullenia exarillata, Aglia, Palaquium eleipticum , drypetus etc*
2	$08^{0}32$" - 77^{0} 22 to 77^{0} 23"	1250 – 1300	~>30 m	15	*Cullenia exarillata, Aglia, Palaquium eleipticum , drypetus etc*
3	$08^{0}33$" - 77^{0} 22 to 77^{0} 23"	1200 - 1300	~>20 m	15	Species varied
4	08º 34" to 8.31" - 77 22"	1100 - 1250	~<20 m	15	Species varied

3. RESULTS AND DISCUSSION

Total 40 lichens species were recorded, which belongs to 18 genera in 15 families (Table 2). The based on the lichen substrata corticolious recored 32 species, followed by five saxicolous and three terricolous (Fig. 2). The foliose were recorded 22 species and followed by 13 fruticose and five crustose species of lichens.

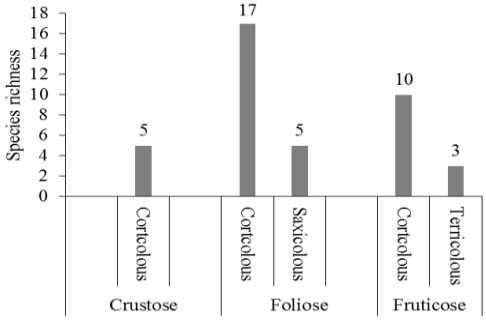

Figure2. *Species richness recorded under different types of lichen forms.*

Table2. *Checklist of lichen recorded at different altitudinal gradients with host specific growth.*

S.No.	Species	Family	Substrate	Growth form	Host	Status*
1	*Dirineria confluens* (Fr.) D.D.Awasthi	Physciaceae	corticolous	foliose	tree	C
2	*Cladonia fruticulosa* Kremp.	Cladoniaceae	terricolous	fruticose	soil	M
3	*Cladonia cartilaginea* Müll. Arg.	Cladoniaceae	terricolous	fruticose	soil	M
4	*Cladonia ramulosa* (With.) J. R. Laundon	Cladoniaceae	terricolous	fruticose	soil	M
5	*Coccocarpia palmicola* (Spreng.) Arv. & D.J. Galloway	Coccocarpiaceae	saxicolous	foliose	rock	C
6	*Everniastrum cirrhatum* (Fr.) Hale ex Sipman	Parmeliaceae	corticolous	foliose	tree	M
7	*Graphis arecae* Vain.	Graphidaceae	corticolous	crustose	bark	C
8	*Heterodermia comosa* (Eschw.) Follmann & Redón	Physciaceae	corticolous	foliose	tree	M
9	*Heterodermia diademata* (Taylor) D.D. Awasthi	Physciaceae	corticolous	foliose	bark	C
10	*Heterodermia dissecta* (Kurok.) D.D.Awasthi	Physciaceae	saxicolous	foliose	rock	C
11	*Heterodermia leucomela*	Physciaceae	corticolous	foliose	tree	M
12	*Heterodermia speciosa* (Wulfen) Trevis	Physciaceae	corticolous	foliose	tree	M
13	*Laurera keralensis* Upreti & Ajay Singh	Trypetheliaceae	corticolous	crustose	bark	R
14	*Leptogium chloromelum* (Sw.) Nyl.	Collemataceae	corticolous	foliose	tree	M
15	*Leptogium austroamericanum* (Malme) C. W. Dodge	Collemataceae	corticolous	foliose	tree	C
16	*Leptogium ulvaceum* (Pers.) Vain.	Collemataceae	corticolous	foliose	tree	M
17	*Nephromopsis isidioidea* (Räsänen) Randlane & Saag	Nephromataceae	corticolous	foliose	branch	R
18	*Parmelia fuscata* P.M. Jørg.	Parmeliaceae	corticolous	foliose	tree	R
19	*Parmotrema praesorediosum* (Nyl.) Hale	Parmeliaceae	saxicolous	foliose	rock	M
20	*Parmotrema reticulatum* (Taylor) M. Choisy	Parmeliaceae	corticolous	foliose	tree	C
21	*Parmotrema tinctorum* (Despr. Ex Nyl.) Hale	Parmeliaceae	corticolous	foliose	tree	C
22	*Phyllopsora parvifolia* (Pers.) Müll. Arg.	Biotoraceae	corticolous	foliose	tree	M
23	*Porina atriceps* (Vain.) Vain.	Trichotheliaceae	corticolous	crustose	tree	C
24	*Porina decamera* Vain.	Trichotheliaceae	corticolous	crustose	tree	M
25	*Parmotrema cristiferum* (Taylor) Hale	Parmeliaceae	corticolous	foliose	tree	C
26	*Pseudocyphellaria aurata* (Ach.) Vain.	Lobariaceae	corticolous	foliose	branch	M
27	*Pseudocyphellaria intricata* (Delise) Vain.	Lobariaceae	saxicolous	foliose	rock	M
28	*Pseudocyphellaria crocata* (L.) Vain.	Lobariaceae	corticolous	foliose	tree	M
29	*Ramalina celastri* (Spreng.) Krog. Swinscow	Ramalinaceae	corticolous	fruticose	tree	R
30	*Ramalina hossei* Vain.	Ramalinaceae	corticolous	fruticose	twig	M
31	*Ramalina hossei* var. *divericata* H.Magn. & G. Awasthi	Ramalinaceae	corticolous	fruticose	twig	M
32	*Ramalina pacifica* Asahina	Ramalinaceae	corticolous	fruticose	tree	M
33	*Sticta sylvatica* (Hunds.)Ach.	Lobariaceae	saxicolous	foliose	rock	M
34	*Thelotrema depressum* Mont.	Thelotremataceae	corticolous	crustose	bark	C
35	*Usnea gabinifera* Asahina	Parmeliaceae	corticolous	fruticose	twig	M
36	*Usnea ghattensis* G.Awasthi	Parmeliaceae	corticolous	fruticose	tree	R
37	*Usnea hirta* (L.) E.H.Wigg.	Parmeliaceae	corticolous	fruticose	tree	R
38	*Usnea orientalis* Motyka	Parmeliaceae	corticolous	fruticose	twig	R
39	*Usnea pangiana* Stirt.	Parmeliaceae	corticolous	fruticose	twig	M
40	*Usnea pseudosinensis* Asahina	Parmeliaceae	corticolous	fruticose	twig	R

Status refer only to KMTR (C-Common, R-Rare, M-Moderate)

The members of families Parmeliaceae(12 species) and Physciaceae (6 species) exhibited the maximum diversity. Among the genera *Heterodermia* (Physciaceae), *Parmotrema* and *Usnea* with five species each showed maximum diversity in the area. *Leptogium chloromelum* and *Parmotrema tinctiorum*are luxuriantly growing in wet evergreen forests. *Coccocarpia, Heterdermia* sp.,*Parmotrema tinctiorum, P. reticulatum* and *Ramalina pacifica*, *Ramalina conduplicans* are rich in dry evergreen forests.

In India about 2050 species are reported and it is distributed in eight lichen graphic regions among Western Ghats is the second highest lichen rich area with ca. 1000 species [18, 19]. A study from Karnataka [5] reported 143 species from Sharavithi river basin which represents 34 macrolichens while in the present study KMTR harboured 40 lichen species belonging to 18 genera and 15 families having rich in lichen diversity. More number of lichens was found on tree bark (corticolous 32 species) than any substratum reflecting the importance of the woody component of the forest as a major lichen habitat. The forests of KMTR dominated by *Cullenia exarillata*, this is one of the species dominate canopy species [9, 10]. The study from the same habitat shown epiphytic load was higher in

Cullenia exarillata than other species [20]. The type of vegetation generally supports the growth of macrolichens. Open canopy which is suitable for formation of crustose and foliose lichens such as *Dirinaria, Pyxine, Lecanora, Heterodermia, Parmotrema, Usnea, Ramalina* and several other species [21, 6]. Macrolichens were documented in similar habitats of costal Brazil [22] and in South Eastern Australia [23].

PLATE - I

Heterodermia dissecta **(Kurok.) D.D. Awasthi**

Heterodermia diademata **(Taylor) D. D. Awasthi**

Heterodermia speciosa **(Wulf.) Trevis**

Parmotrema praesorediosum **(Nyl.) Hale**

Ramalina hossei var.divericata **H. Magn. & G. Awasthi**

Usnea pseudosinen**sis Asahina**

The distributional pattern of lichens is also depends on micro climatic conditions such as light, water relations and isolation [24, 25]. They [26] found that over 64% species of lichens occurred on woody component in two clearly landscapes of Chopta-Tungnath and Nanda Devi Biosphere reserve in India. Our study indicated that among the lichen growth forms, foliose lichens showed (58 %) predominance in the area followed by fruticose (30 %), corticolous lichens represented about 80 % followed by saxicolous (13 %) and tericolous (7 %) lichen species (Fig 3). Ecological factors play an important role in the growth, development and diversity of lichens species [27, 28]. We observed that the host specificity of macrolichens as they were dominant on the tree branches, bark and were found lower antetity in soil conditions. Most of the lichens prefer tree bark as their substratum, some lichen are more specific to their host [28, 29].

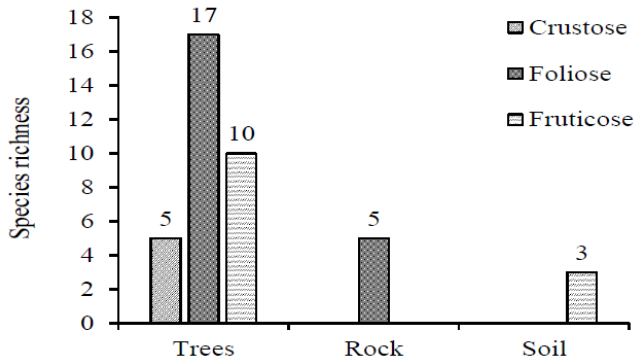

Figure3. *Lichen recorded in different substratum respective lichen forms.*

Little exploration regarding collection of lichens has been so far carried out in this region, when compare to other parts of India. In this attempt we have enumerate the lichen flora of KMTR and collected 40 species of lichens from 15 families. A majority of the lichen species are found to favour wood. This will be the baseline data for the KMTR. This brings out the importance of woody microhabitats in promoting lichen species diversity. It will very helpful for conservation the lichens diversity in sanctuary and it will helpful for further bio monitoring studies in the area.

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