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Epiphyte host relationship of macrolichens in the tropical wet evergreen forests of Silent Valley National Park, Western Ghats, India

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Abstract: The paper deals with epiphyte host relationship of macrolichens in the west-coast tropical evergreen forests and the subtropical broad-leaved hill forests of Silent Valley National Park. Of the 104 taxa recorded in the two habitats, 69 species occurred in the west-coast tropical evergreen forests and 68 species in the subtropical broad-leaved hill forests. These forest types mostly support cyanolichens. Lichens prefer several host species in the west-coast tropical evergreen forests, but the percentage of occurrence of macrolichens on hosts is greater in the subtropical broad-leaved hill forests. Host species such as *Palaquium ellipticum, Litsea floribunda, Antidesma montanum, Poeciloneuron indicum, Myristica montanum, Euonymus angulatus, Flacourtia montana* were found to be important host plants.

Resumen: El artículo trata de la relación epifita-hospedador para los macrolíquenes en los bosques perennifolios tropicales de la costa occidental y los bosques de colina subtropicales de hoja ancha del Parque Nacional Silent Valley. De los 104 taxa registrados en los dos hábitats, 69 estuvieron presentes en los bosques perennifolios tropicales de la costa oeste, y 68 especies en los bosques de colina subtropicales de hoja ancha. Los bosques de estos tipos soportan principalmente cianolíquenes. Los líquenes prefieren varias especies hospedadoras en los bosques perennifolios tropicales de la costa oeste, pero el porcentaje de presencia de macrolíquenes sobre los hospedadores es mayor en los bosques de colina subtropicales de hoja ancha. Se encontró que *Palaquium ellipticum*, *Litsea floribunda*, *Antidesma montanum*, *Poeciloneuron indicum*, *Myristica montanum*, *Euonymus angulatus, Flacourtia montana* son plantas hospedadoras importantes.

Resumo: Este artigo trata da relação epífita hospedeiro de macro líquenes em florestas tropicais sempreverdes na costa ocidental e das florestas de montanha subtropicais de folhosas no Park Nacional de Sillent Valley. Dos 104 taxa registados nos dois habitats, 69 espécies ocorreram nas florestas tropicais sempreverdes da costa ocidental e 68 espécies nas florestas subtropicais de folhosas nas colinas. Estes tipos florestais suportam principalmente líquenes azuis. Os líquenes preferem como hospedeiros várias espécies nas florestas tropicais sempreverdes da costa ocidental, mas a percentagem de ocorrências dos macro-líquenes nos hospedeiros é maior nas florestas de montanha de folhosas subtropicais. Foi encontrado que as espécies hospedeiras mais importantes eram a *Palaquium ellipticu*m*, Litsea floribunda, Antidesma montanum, Poeciloneuron indicum, Myristica montanum., Euonymus angulatus, Flacourtia montana*

Key words: Cyanolichens, epiphytic lichens, nilgiri biosphere reserve, phorophytes, silent valley national park, tropical evergreen forests.

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Introduction

Forests support vascular plants and also provide a suitable niche for non vascular plants such as, liverworts, mosses and lichens. Among these, lichens have attracted much attention recently as indicators of air quality, biodiversity and climate change (McCune *et al.* 1997). Lichens are among the most widely distributed and dominant groups of organisms in the world, and cover as much as eight per cent of the earth's surface (Ahmadjian 1995). These little plants are the most successful symbiotic organisms on earth and can grow on almost anything and anywhere. They are found colonizing on rocks, soil, trunks and branches of tree, animal shells, bones, insect's backs, humus, synthetic material, bricks, cement, concrete roofs and walls, glass and iron. (Brightman & Seaward 1978; Hale 1983; Schroeter & Sancho 1996; Sipman 1994).

In a heterogeneous forest land, the diversity of lichens is variable, as the supporting host trees provide space for different types of lichens. Some lichens show preference for certain trees mostly based on the nature of bark and its microclimatic and chemical conditions. Understanding the host preferences is an important aspect in lichen ecology as these organisms play an essential functional role in forest ecosystems. In addition, a knowledge of the degree of host specificity of lichens serves a useful purpose in the estimation of their diversity and conservation.

Although there are several publications available on the lichen-phorophyte relationships from European and other countries, only scanty information (Dudgeon 1923; Upreti 1996; Upreti & Chatterjee 1999) is available for Indian lichens. The aim of this paper is to elucidate the microhabitat and host specificity of macrolichens, and to evaluate the important host species exploited by them.

Materials and methods

Study site

Silent Valley National Park is an undisturbed contiguous patch of tropical rain forest in the Nilgiri hills of southern Western Ghats. The valley encompasses various types of forests, cascading small streams and rivulets, exquisite flowers, beautiful birds, wild animals and the misty mountains, which adorn this natural landscape in its pristine condition. The area comes under the core zone of Nilgiri Biosphere Reserve - India's first Biosphere Reserve. The park with its adjoining plateau has been identified as one of the biodiversity hot spots in Kerala owing to its floristic and faunal wealth, which can be compared with any other biodiversity hot spot elsewhere in the world (Sequiera 2003).

The valley has been bereft of human settlements due to adverse climate and inaccessibility of the area. The area, covering 89.52 km^2 , lies between 11°00′ and 11°15′ north latitude, and 76°15′ and 76°35′ east longitude, and is closed on all sides with high and continuous ridges along the borders. The area is characterized with tropical climate benefited by both the south-west and the north-east monsoons, with a mean annual temperature of 21.09°C and maintains a relative humidity of more than 70 per cent throughout the year. The vegetation in the valley is unique in many respects and 5 forest types, *viz.* west-coast tropical evergreen forest, southern subtropical broad-leaved hill forest, southern montane wet temperate forest, southern subtropical savanna and montane wet grassland, have been recognized (Basha 1999; Champion & Seth 1968).

Sampling and data analysis

About 75 per cent of total area of the National Park is covered by west-coast tropical evergreen forests and southern subtropical broad-leaved hill forests. Therefore, in this study only these two vegetation types were included using the common term 'tropical wet evergreen forests'. According to the extent of these forest types, 54 quadrats, each 10 m x 10 m in size, in the west-coast tropical evergreen forests and 20 in the southern subtropical broad-leaved hill forests, distributed over major altitudinal and mesohabitat conditions, were laid out randomly for sampling.

The substrate for lichens in the study area was classified as tree, rock and soil microhabitats. Further, trees were separated as trunk and canopy regions as they possess different types of lichens. Abundance of each macrolichen was recorded under each microhabitat. Host tree species (phorophytes) were identified with the help of published floras (Manilal 1988; Vajravelu 1990). Unidentified host species were represented by its

family or generic name or by its morphological condition. Sorenson's (1948) similarity index was used to compare epiphytes found on different host trees. Only host species which supported five or more macrolichen species were selected for the similarity analysis. Similarly, macrolichens that occurred on five or more host plants were selected for similarity analysis. Dendrogram was prepared by average linkage method using the program SPSS 10.

Results

Habitat and lichens

Of the 104 taxa recorded from the two habitats, 69 species were found in the west-coast tropical evergreen forests and 68 species in the subtropical broad-leaved hill forests. About 33 species were common to both the forest types. The west coast tropical evergreen forests harboured 36 exclusive species while 35 species were exclusive to the subtropical broad-leaved forests (Fig. 1). As many as 17 species of lichens with green alga as photobiont and 16 species with blue-green alga as photobiont were common to the two forest types. However, the abundance and frequency of cyanolichens were greater than green-algal lichen species, and therefore, the cyanolichens had broader niche with respect to their habitat preference.

Microhabitat and lichens

Four major microhabitats *viz.* tree trunk, rock, soil and canopy branches are identified from each of the forest types. The trunk region of trees and canopy branches had different lichen species. Of the total 104 species recorded from all the microhabitats of the two forest types, tree trunk supported 54 species, rock 49 species and canopy branches harboured 57 species of macrolichens. Just one species, *Leptogium cyanescens*, occurred in soil microhabitat in the west-coast tropical evergreen forests with one individual. Regarding the microhabiat specificity, 19 species occurred exclusively on tree trunks, 12 species on rocks and 36 species were confined to canopy branches. On the tree trunks as well as on rocks, majority of the lichens observed were cyanolichens. However, these cyanolichens were replaced by green-algal foliose and fruticose lichens on canopy branches (Fig. 2).

Phorophytes and lichens

As many as 81 different host plant species were recorded from the 54 plots and 959 trees sampled in the west coast tropical evergreen forests (Appendix Table 1). However, only 365 plants (38 per cent) actually supported lichens in their particular niche. A total of 2153 lichen individuals were recorded from these host plants which belong to 40 different species of macrolichens. Among the host plants, *Palaquium ellipticum* supported the highest number of lichens

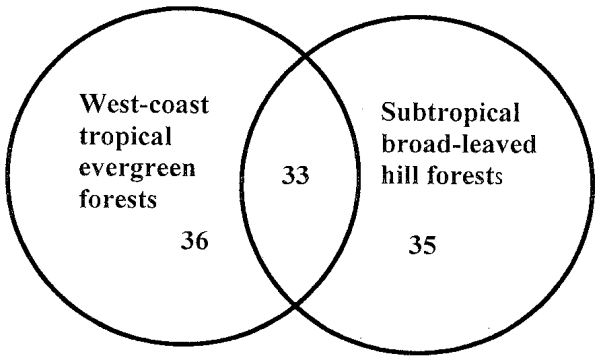

Fig. 1. Distribution of macrolichens in the tropical wet evergreen forests.

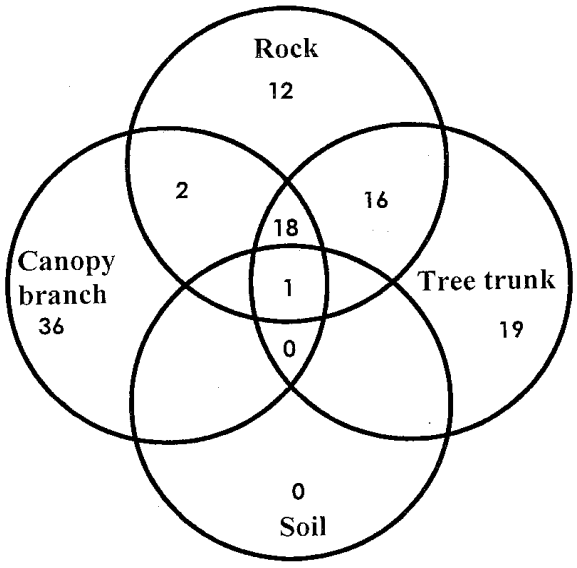

Fig. 2. Distribution of macrolichnes in each microhabitat.

with 16 species, followed by *Litsea floribunda* (12), *Antidesma menasu* (12), on an unidentified tree (12), *Poeciloneuron indicum* (11) and *Myristica dactylioides* (11). The remaining host trees haboured less than 7 lichen species on their trunk. Tree species such as, *Albizia procera, Ardisia pauciflora, Canarium strictum, Cinnamomum sulphuratum, Debregesia* sp., *Dysoxylum malabaricum, Elaeocarpus munronii, Eurya nitida, Flacourtia indica, Garcinia gummi-gutta, Glyptopetalum zeylanicum, Ilex gardeneriana, Lannea coromandaliana*, *Leea indica, Litsea coreacea, L. ghatica, L. stocksii, Mallotus tetracoccus, Polyalthia coffeoides, Psychotria beddomei*, and one Lauraceae member were inhabited by only a single lichen species. *Poeciloneuron indicum* had about 245 lichen individuals on its trunk followed by *Litsea floribunda* (194), one unidentified tree species (143), *Palaquium ellipticum* (128), *Myristica dactyiloides* (100), *Calophyllum polyanthum* (98), *Elaeocarpus tuberculatus* (82), *Antidesma menasu* (76), *Holigarna nigra* (59), *Syzygium mundagum* (57) and *Syzygium munronii* (50) . On average, 5.89 individuals of lichens occurred per tree sampled in the west coast tropical evergreen forests.

The result is much different for the subtropical broad-leaved hill forests. From the 20 quadrats 347 trees were sampled, of which, 243 individuals belonging to 59 species supported lichens (Appendix Table 2). A total of 1655 macrolichen individuals were recorded. Host trees, *Litsea floribunda* and an unidentified tree species, harboured the highest number of lichens with 11 and 12 species, respectively, followed by *Litsea stocksii* (9), *Ilex wightiana* (8), *Syzygium cumini* (8*), Ardisia pauciflora* (7), while about 20 host trees supported just one macrolichen. The number of macrolichens was high on *Litsea floribunda* with 176 individuals on 22 trees followed by an unidentified tree with 138 individuals on 24 trees, *Euonymus angulatus* (112 individuals on 16 trees), *Flacourtia montana* (75 individuals on 6 trees), *Calophyllum austro-indicum* (69 individuals on 9 trees), *Litsea stocksii* (68 individuals on 11 trees), *Cinnamomum malabatrum* (65 individuals on 8 trees), *Litsea ghatica* (61 individuals on 9 trees). Therefore, a single tree in the subtropical broad-leaved hill forest harboured an average of 6.81 lichens on its trunk. The percentage of occurrence of lichens on host plants in subtropical broad-leaved hill forests was 70.02, which is twice than that of west-coast tropical wet evergreen forests.

From the 74 quadrats sampled in the two forest types, a total of 116 host species and 53 different lichen species with a total of 3808 individuals were identified. The mean density of macrolichens that occurred on the host plants in the two forest types was 12345 individuals ha^{-1}.

Host specificity

Some macrolichen species showed specificity to a particular host tree which could be attributed to various ecological conditions. About eight species of macrolichens were found to have a narrow niche and were host specific in the west-coast tropical wet evergreen forests (Table 1), whereas species such as *Leptogium* sp., *Phyllopsora corallina, Leptogium denticulatum, L. pichneum, L. cyanescens* and *Collema* sp. had a broad niche since they preferred 43, 41, 37, 24, 18 and 10 host plants, respectively. In the subtropical broad-leaved hill forests, 9 species of macrolichens occurred exclusively on specific tree species (Table 2), while 7 species occurred on 10 or more host plants. Among these, *Leptogium denticulatum* had the widest niche and was found growing on 32 different host plants.

Species similarity

Among the 81 host plants identified from the evergreen forests, only 24 were inhabited by five or more lichen species. Among them, highest similarity in the composition of lichens was seen between the hosts *Casearia esculenta* & *Elaeocarpus tuberculatus*. However, occurrence of

Table 1. Lichen species and their specific hosts in the west-coast tropical wet evergreen forests.

Lichen species	Host species
Cladonia cartilaginea	*Sapium insigne*
Collema auriculatum	*Ficus microcarpa*
Everniastrum vexans	*Sapium insigne*
Heterodermia flabellata	Dry tree (Tree 2)
Heterodermia togashii	*Syzygium mundagum*
Hypotrachyna infirma	*Macaranga indica*
Myelochroa indica	*Ficus* sp.
Sticta praetextata	*Litsea floribunda*

Table 2. Macrolichen species and their specific hosts in the subtropical broad-leaved hill forests.

Macrolichens species	Host species
Coccocarpia pellita	*Ilex wightiana*
Collema auriculatum	*Antedesma menasu*
Heterodermia speciosa	*Litsea floribunda*
Leptogium chloromelum	*Ardisia pauciflora*
Leptogium austro-americanum	*Ilex wightiana*
Parmelinopsis expallida	*Myristica dactylioides*
Phaeophyscia ciliata	*Gomphandra tetandra*
Sticta weigelii	*Syzygium munronii*
Usnea sp.	*Syzygium munronii*

the highest number of same macrolichen species was recorded between hosts *Litsea floribunda* and an unidentified tree. These two hosts shared 10 lichen species. It was followed by *Antidesma menasu* & *Litsea floribunda* (9 species), *Myristica dactyloides* & *Palaquium ellipticum* (9 species), *Antidesma menasu* & *Myristica dactyloides* (7 species), *Casearia esculenta* & *Elaeocarpus tuberculatus* (6 species), *Casearia esculenta* & *Schleicheria oleosa* (6 species), *Antidesma menasu* & *Holigarna nigra* (6 species) and others (Table 3). Species of the genera *Leptogium, Sticta, Coccocarpia, Collema* and *Phyllopsora* were dominant in the observed pattern of grouping.

The 13 species of macrolichens selected for the similarity analysis were cyanolichens except for the genus *Phyllopsora*. The analysis showed that highest similarity existed in the species *Phaeophyscia ciliata* & *Sticta cyphellulata* with 57.1% similarity in their host preference followed by *Leptogium* sp. & *Phyllospora corallina* (56.9%), *Leptogium denticulatum* & *Leptogium* sp. (52.8%), *Coccocarpia erythroxyli* & *Phaeophyscia ciliata* (51.1%). *Leptogium* sp. & *Phyllopsora corralina* had 22 common hosts and *Leptogium* sp. &

Table 3. Sorenson's similarity coefficient of host species in the west-coast tropical evergreen forests.

Host species	Sorenson's coefficient	Similar species
Casearia esculenta & *Elaeocarpus tuberculatus*	0.857	6
Litsea floribunda & Unidentified tree	0.783	10
Antidesma menasu & *Calophyllum polyanthum*	0.778	7
Casearia esculenta & *Schleicheria oleosa*	0.774	6
Antidesma menasu & *Hologarna nigra*	0.738	6
Antidesma menasu & *Litsea floribunda*	0.695	9
Bischofia javanica & *Casearia esculenta*	0.683	5
Neolitsea scrobiculata & *Poeciloneuron indica*	0.667	5
Myristica dactyloides & *Palaequim ellipticum*	0.640	9
Cinnamomum malabatrum & *Syzygium munronii*	0.600	3
Litsea laevigata & *Saprosma fragrans*	0.600	3
Actinodaphne companulata & *Cinnamomum malabatrum*	0.600	3
Bischofia javanica & *Clerodendrum cerratus*	0.595	4
Antidesma menasu & *Myristica dactyloides*	0.593	7
Antidesma menasu & *Neolitsea scrobiculata*	0.558	4
Bischofia javanica & *Persia macrantha*	0.531	3
Ficus microcarpa & *Polyalthia fragrans*	0.500	3
Antidesma menasu & *Bischofia javanica*	0.500	4
Antidesma menasu & *Litsea laevigata*	0.448	4
Actinodaphne companulata & *Antidesma menasu*	0.423	4
Actinodaphne companulata & *Ficus microcarpa*	0.341	1
Sapium insigne & *Syzygium mundagum*	0.182	1
Actinodaphne companulata & *Sapium insigne*	0.160	0

Leptogium denticulatum had 21 common hosts. The hierarchical grouping of these species according to their host preference is given in Fig. 3.

A total of 14 tree species was selected for the analysis in the subtropical broad-leaved hill forests. Among these, *Euonymus angulatus* &

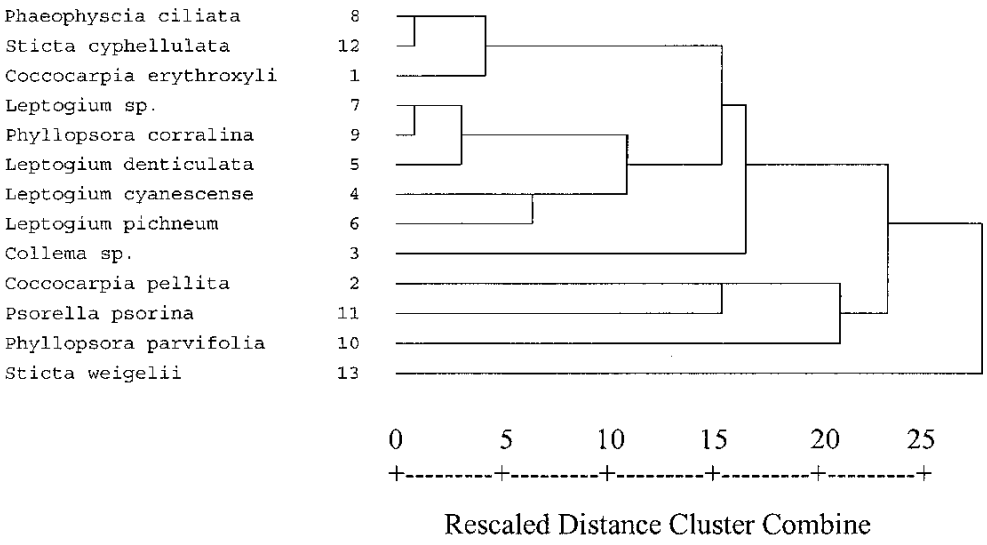

Fig. 3. Host preferences of macrolichens in the west-coast tropical evergreen forests.

Table 4. Sorenson's similarity coefficient of host plants in the subtropical broad-leaved hill forests.

Host species	Sorenson's Coefficient	Similar Species
Euonymus angulatus & *Litsea ghatica*	0.909	5
Neolitsea scrobiculata & *Nothopegia racemosa*	0.800	4
Ardisia pauciflora & *Flacourtia montana*	0.769	5
Diospyros nilagirica & *Euonymus angulatus*	0.764	4
Litsea floribunda & Unidentified tree	0.696	8
Ardisia pauciflora & *Diospyros nilagirica*	0.678	4
Litsea stocksii & *Syzygium cumini*	0.625	5
Cinnamomum malabatrum & *Litsea stcksii*	0.615	4
Ardisia pauciflora & *Michelia champaka*	0.614	3
Calophyllum austroindicum & Neolitsea scrobiculata	0.600	3
Ardisia pauciflora & *Cinnamomum malabatrum*	0.565	3
Ardisia pauciflora & *Litsea floribunda*	0.539	5
Ardisia pauciflora & *Ilex wightiana*	0.485	3
Ardisia pauciflora & *Calophyllum austroindicum*	0.415	2
Ardisia pauciflora & *Syzygium munronii*	0.383	3
Antidesma menasu & *Ardisia pauciflora*	0.328	3
Antidesma menasu & *Gomphandra tetrandra*	0.230	1

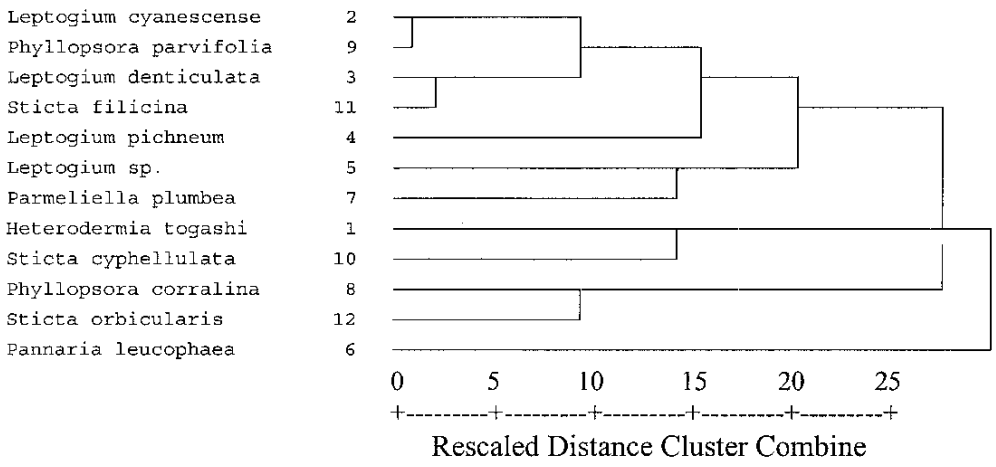

Fig. 4. Host preferences of macrolichens in the subtropical broad-leaved hill forests.

Litsea ghatica showed highest similarity (0.909) with 5 macrolichens common to them. Besides that, about 11 host pairs showed more than 50 per cent similarity in their lichen composition (Table 4). The highest number (10) of macrolichen species were common to *Litsea floribunda* and an unidentified tree. Majority of the lichen species involved in the pattern of clustering possessed cyanophyceae members as their photobionts.

From the 12 macrolichen species selected for the similarity analysis in this forest type , the species *Leptogium cyanescens* & *Phyllopsora parvifolia* showed the highest host similarity (0.634), and occurred on 13 tree species, followed by *Leptogium denticulatum* & *Sticta filicina* (0.607) with 17 hosts, *Phyllopsora corallina* & *Sticta orbicularis* (0.500) with 4 hosts, *Leptogium cyanescens* & *Leptogium denticulatum* (0.495) with 14 hosts (Fig. 4).

Discussion

Habitat and lichens

A forest is a habitat with complex ecological gradients. It is an important habitat for a rich assemblage of epiphytes, such as lichens. Lichen community changes as a forest changes or develops. Both in the tropical west coast evergreen and subtropical broad-leaved hill forests, blue-green algal lichens were common and dominant. Foliose members with green-algal photobionts, such as, members of the family Parmeliaceae and Physciaceae were either attached to the upper canopy branches or on rocks with sufficient canopy openings or near the ecotone region, which would receive enough light and wind. This canopy preference shows their high photophilic tendency. According to Halonen *et al.* (1991), the preference of photophilic epiphytic lichens in open sunny areas in pine and spruce trees of Finland, is due to their effectiveness of distribution of the vegetative reproductive structure. About 60 per cent of macrolichens in the west coast tropical evergreen forests were cyanolichens and these were mostly attached to the trunks of trees and on shady rocks. In the subtropical broad-leaved hill forests also cyanolichens held a substantial share (23%). Cyanolichens are more sensitive to environmental stress than many green-algal lichens. They are known to be sensitive to altered microclimatic conditions at forest edges (Hedenås 2002; Sillett 1994). The temperature is cooler and environment more humid inside the forests than in the open. Moreover, the branches of trees intercept rain and provide shade, leading to successful growth of cyanolichens in the evergreen as well as in the subtropical broad-leaved hill forests. Observational and experimental evidences show that microclimatic factors are of utmost importance in determining the distribution and performance of macrolichens (Hoffman & Kazmierski 1969; Kershaw & Rose 1971; Yarranton & Green 1966; Yarranton 1975).

Microhabitat and lichens

The trunk region of trees harboured different morphological forms of lichens, however, cyanolichens were found to be more specific, as they mostly preferred microhabitat having maximum shade. This may be attributed to the shade loving nature of these species. The presence of foliose members with green alga and fruticose members in the trunk region can be attributed to canopy openings. However, species such as, *Phyllopsora corallina* and *Psorella isidiophora* are shade tolerant inspite of having green-algal component. In the rock substratum, most of the species are green-algal foliose with a few cyanolichen species. Canopy branches possess mostly fruticose members and green-algal foliose members. It is because of the variations in light intensities in the canopy regions. The efficiency of these species in the canopy could be explained by their ability to tolerate high levels of light (Kermit & Gauslaa 2001).

Phorophytes and lichens

Microhabitat preferences of particular lichens are responsible for their differential distribution. Host trees such as , *Litsea flori bunda* (Lauraceae), *Antidesma menasu* (Euphorbiaceae), *Poeciloneuron indicum* (Clusiaceae), *Myristica dactyloides* (Myristicaceae), *Palaquium ellipticum* (Sapotaceae), *Calophyllum polyanthum* (Clusiaceae), *Holigarna nigra* (Anacardiaceae), *Syzyigium* spp. (Myrtaceae) supported maximum number of individuals and species of macrolichens. These trees are well distributed in the evergreen forests. However, inspite of their abundance in the vegetation, only a small fraction of trees actually harboured lichens on their trunk. Many of these tree have barks which are somewhat smooth or utmost medium to rough in texture. Aspect of trees, nature of bark substratum, bark pH, nutrient status, water holding capacity and buffer capacity are considered important factors which determine the distribution of lichens in host trees (Barkman 1958; Bates 1992; Coppins 1984; Eversman *et al.* 1987; Halonen *et al.* 1991; John & Dale 1995; Kermit & Gauslaa 2001; Kuusinen 1996; Pederson 1980). Influence of stand age and height of tree trunk are also important factors influencing the composition of lichens. When compared to other vegetation types, the height of bole is greater in the evergreen forest. Bark texture is almost same in all tree species except for some medium rough bark trees (Hale 1952; Hyvarinen *et al*. 1992; John 1992; Rose 1974).

The subtropical broad-leaved hill forests harbour both the arboreal elements characteristic of the west coast tropical evergreen as well as the montane wet temperate forests. Temperature, rainfall, humidity and altitude also vary from those of the west-coast evergreen and the montane wet temperate forests. Hosts such as, *Antidesma menasu, Ardisia pauciflora, Cinnamomum malabatrum, Diospyros nilagirica, Euonymus angulatus, Flacourtia montana, Ilex wightiana, Litsea floribunda, Litsea ghatica, Litsea stocksii, Syzygium cumini, Syzygium munronii* and *Gomphandra tetrandra,* support a substantial number of macrolichens. Some of the above hosts are also distributed in the west-coast tropical evergreen and montane wet temperate forests. Most of them had rough bark but straight bole. Although, the arboreal elements of the evergreen as well as the montane wet temperate forests are present in the subtropical broad-leaved hill forests, their lichen composition was different. According to Schmitt & Slack (1990), epiphytic lichens change hosts in different climatic regimes, even when the same host trees are present. Hale (1955) also reported similar host specificity pattern of lichens in the upland forests of Wisconsin. In the Silent Valley National Park, macro and microclimatic conditions and bark characteristics of trees vary depending on the forest types and altitude. Although, light factor is important in the distribution of lichens, the availability of light is low inside the forests. Bruiteg (1993) observed that frequency, duration and form of precipitation are important for the distribution of lichens. In addition to precipitation, mist and fog may cause humid conditions even where precipitation is low (Sequiera 2003).

Species similarity

In the west-coast tropical evergreen forests, macrolichen members of the family Collemataceae, Stictaceae and species such as *Phaeophyscia ciliata, Phyllopsora corallina, Phyllopsora parvifolia* and *Coccocarpia erythroxyli* are widely distributed. All these are cyanolichens except for the species of *Phyllopsora*. The distribution of species is responsible for the characteristic cluster

pattern and high similarity values observed in hosts such as, *Casearia esculenta, Elaeocarpus tuberculatus, Litsea floribunda, Antidesma menasu, Calophyllum polyanthum,* etc. In the subtropical broad-leaved hill forests, members of Collemataceae, Stictaceae and species of the genus *Phyllopsora* show broad microhabitat preferences. Hosts such as, *Euonymus angulatus, Litsea ghatica, Neolitsea scrobiculata, Nothopegia racemosa, Ardisia pauciflora, Litsea floribunda, Diospyros nilagirica,* etc. show high similarity in lichen composition. This is correlated with the distribution of above said macrolichen members.

Sorenson's indices of similarity among the lichens for the preferences of host species in different forests varied. As suggested by Adams & Risser (1971), the response of a lichen species to a host species can vary dramatically from one tree to the other. Some lichen associations prefer greater number of host species than others. Associations of *Leptogium* sp. & *Phyllopsora corralina, Leptogium denticulatum* & *Leptogium* sp., *Leptogium pichneum* & *Leptogium cyanescens* in the subtropical broad-leaved hill forests prefer greater number of host species. This reveals their wide ecological tolerance.

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Appendix Table 1. Host plants of lichens in the west-coast tropical evergreen forests.

Host species	No. of trees sampled	No. of lichen species	No. of lichen individuals	% of trees having lichens
Actinodaphne companulata Hook.f.	14	5	48	42.8
Aglaia elaengnoidea (A.Juss.) Benth.	9	2	26	44.4
Albizia procera (Roxb.) Benth.	1	1	12	100
Annonaceae (Tree 1)	3	5	11	100
Antidesma menasu (Tul.) Miq.*ex* Muell.-Arg.	32	12	76	56.3
Ardisia pauciflora Heyne *ex* Roxb.	3	1	1	33.3
Artocarpus heterophyllus Lam.	2	3	21	50
Atlantia racemosa Wight	1	2	4	100
Bischofia javanica Blume	5	6	21	80
Calophyllum austroindicum Kosterm. *ex* Stevens	3	2	11	66.7
Calophyllum polyanthum Wall. *ex* Choisy	21	7	98	42.8
Canarium strictum Roxb.	1	1	2	100
Casearia esculenta Roxb.	9	8	48	66.7
Cinnamomum malabatrum (Burm.f.) Blume	25	6	22	20
Cinnamomum sulphuratum Nees	12	1	3	8.3
Clerodendrum serratum (L.) Moon	6	7	20	83.3
Climber (Climber 1)	3	3	7	100
Cullenia exarrillata Robyns	18	3	30	27.8
Debregeasia sp.	1	1	3	100
Dimocarpus longan Lour.	11	3	38	36.4
Diospyros malabaricum (Desr.) Kostel.	4	2	9	75
Dry tree (Tree 2)	3	5	17	100
Drypetes elata (Bedd.) Pax.& Hoffm.	10	4	15	30
Dysoxylum malabaricum Bedd.*ex* Hiern	12	1	2	8.3
Elaeocarpus munronii (Wight) Mast.	11	1	2	9.1
Elaeocarpus tuberculatus Roxb.	17	6	82	35.3
Eurya nitida Korth.	3	1	13	66.7
Ficus laevis Blume	2	2	2	100
Ficus microcarpa L.f.	1	7	15	100
Ficus sp.	3	3	14	33.3
Flacourtia indica (Burm.f.) Merr.	5	1	5	20
Garcinia gummi-gutta (L.) Robs.	8	1	2	25
Garcinia morella (Gaertn.) Desv.	18	2	9	16.7
Garcinia pictorius (Roxb.) D.Arcy	6	4	29	66.7
Glochidion fagifolium Bedd.	3	3	24	66.7
Glyptopetalum zeylanicum Thw.	4	1	7	75
Heritiera papilio Bedd.	1	2	5	100

Contd…

Appendix Table 1. Continued

Host species	No. of trees sampled	No. of lichen species	No. of lichen individuals	% of trees having lichens
Holigarna beddomei Hook.f.	21	5	29	23.8
Holigarna nigra Bourd.	44	7	59	29.5
Hopea glabra Wight & Arn.	10	4	22	40
Ilex gardneriana Wight	2	1	2	50
Lannea coromandelica (Houtt.) Merr.	1	1	12	100
Lauraceae (Tree 3)	1	1	7	100
Leea indica (Burm.f.) Merr.	1	1	7	100
Liana (Climber 2)	1	2	6	100
Litsea coreacea (Heyne *ex* Meisner) Hook.f.	4	1	1	25
Litsea floribunda (Blume) Gamble	57	12	194	49.1
Litsea ghatica Sald.	1	1	4	100
Litsea laevigata (Nees) Gamble	10	5	17	30
Litsea stocksii (Meisner) Hook.f.	20	1	4	5
Macaranga indica Wight	4	3	9	50
*Mallotus philippensis (*Lam.) Muell.-Arg.	2	2	6	50
Mallotus tetracoccus (Roxb.) Kurz	1	1	4	100
Mastixia arborea (Wight) Bedd.	5	2	4	20
Meliosma simplicifolia (Roxb.) Walp.	3	2	1	33.3
Memecylon sp.	1	2	5	100
Mesua ferrea L.	16	3	9	25
Myristica dactyloides non Gaertn.	94	11	100	23.4
Neolitsea scrobiculata (Meisner) Gamble	8	5	30	87.5
Palaquium ellipticum (Dalz.) Baill.	93	16	128	21.5
Persia macrantha (Nees) Kosterm.	11	7	36	45.5
Poeciloneuron indicum Bedd.	107	11	245	41.1
Polyalthia coffeoides (Thw. *ex* Hook.f. & Thoms.) Hook.f. & Thoms.	1	1	3	100
Polyalthia fragrans (Dalz.) Bedd.	12	5	19	50
Polyalthia sp.	1	2	2	100
Psychotria macrocarpa Hook.f.	1	1	4	100
Sapium insigne (Royle) Benth.	2	6	14	100
Saprosma fragrans Bedd.	2	5	17	100
Schleichera oleosa (Lour.) Oken	18	6	22	44.4
Semecarpus anacardium L.f.	3	2	9	66.7
Shrub 1	3	2	11	100
Small tree (Tree 4)	2	3	28	100
Syzygium hemisphericum (Wight) Alston	9	3	17	44.4
Syzygium jambos (L.) Alston	3	2	4	66.7
Syzygium lanceolatum (Lam.) Wight & Arn.	10	2	15	20
Syzygium laetum (Buch.- Ham.) Gandhi	5	2	14	40
Syzygium mundagam (Bourd.) Chithra	9	5	57	100
Syzygium munronii (Wight) Chandrab.	14	5	50	35.7
Syzygium neesianum Arn.	4	3	21	75
Ternstroemia japonica (Thumb.) Thumb.	8	2	8	25
Unknown (Tree 5)	43	12	143	41.9

Appendix Table 2. Host species of lichens in the subtropical broad-leaved hill forests.

Host species	No. of tress sampled	No. of lichen species	No. of lichen individuals	% of trees having lichens
Actinodaphne bourdillonii Gamble	1	1	4	100
Actinodaphne companulata Hook.f. var. *campanulata*	5	2	13	40
Antidesma bunius (L.) Spreng.	1	1	6	100
Antidesma menasu (Tul.) Miq. *ex* Muell.-Arg.	5	5	14	80
Ardisia pauciflora Heyne *ex* Roxb.	9	7	35	88.9
Artocarpus heterophyllus Lam.	3	1	5	100
Calophyllum austroindicum Kosterm *ex* Stevens	9	5	69	100
Calophyllum polyanthum Wall. *ex* Choisy	1	3	27	100
Casearia esculenta Roxb.	1	1	7	100
Cinnamomum malabatrum (Burm.f.) Blume	11	5	65	72.7
Climber (Climber 1)	2	2	7	100
Daphniphyllum neilgherrense (Wight) K.Rosenth.	1	4	7	100
Diospyros malabarica (Desr.) Kostel.	1	1	4	100
Diospyros nilagirica Bedd.	8	5	24	62.5
Dry tree (Tree 1)	2	1	3	100
Elaeocarpus munronii (Wight) Mast.	2	4	8	100
Euodia lunu-ankenda (Gaertn.) Merr.	4	1	11	50
Euonymus angulatus Wight	21	6	112	76.2
Eurya nitida Korth.	3	1	7	66.7
Flacourtia montana Graham	8	6	75	75
Garcinia gummi-gutta (L.) Robs.	9	3	22	33.3
Gomphandra coriacea Wight	3	1	1	66.7
Gomphandra tetrandra (Wall.) Sleumer	3	6	31	100
Holigarna beddomei Hook.f.	4	2	15	50
Ilex wightiana Wall. *ex* Wight	4	9	43	100
Ixora elongata Heyne *ex* G. Don	3	4	45	100
Lasianthus ciliatus Wight	2	1	11	100
Lepisanthes tetraphylla (Vahl) Radhlk	1	1	6	100
Litsea coriacea (Heyne ex Meisner*)* Hook.f.	1	1	1	100
Litsea floribunda (Blume) Gamble	27	11	176	81.5
Litsea ghatica Sald.	15	6	61	60
Litsea laevigata (Nees) Gamble	5	3	27	100
Litsea stocksii (Meisner) Hook.f.	18	9	68	61.1
Mastixia arborea (Whight) Bedd.	4	2	10	50
Michelia nilagirica Zenk.	5	6	51	100
Microtropis ramiflora Wight	5	3	17	60
Myristica dactylioides non Gaertn.	14	4	21	50
Neolitsea scrobiculata (Meisner) Gamble	5	5	29	100
Nothopegia racemosa (Dalz.) Ramam.	8	5	45	87.5
Palaquium ellipticum (Dalz.) Baill.	6	4	11	50
Pavetta breviflora DC.	1	1	1	100
Poeciloneuron indicum Bedd.	8	2	11	50

Contd…

Appendix Table 2. Continued

Host species	No. of tress sampled	No. of lichen species	No. of lichen individuals	% of trees having lichens
Psychotria globicephala Gamble	5	4	17	60
Psychotria nigra (Gaertn.) Alston	5	1	12	40
Rapanea wightiana (Wall. ex DC.) Mez	1	4	26	100
Saprosma foetens (Wight) K.Schum.	8	4	52	87.5
Saprosma fragrans Bedd.	2	2	14	100
Schefflera capitate (Wight & Arn.) Harms	1	1	3	100
Schefflera rostrata (Wight) Harms	2	2	7	50
Schefflera venulosa (Wight & Arn.) Harms	1	1	5	100
Schleichera oleosa (Lour.) Oken	1	1	5	100
Syzygium cumini (L.) Skeels	10	8	56	80
Syzygium munronii (Wight) Chandrab.	15	6	42	20
Turpinia cochinchinensis (Lour.) Merr.	3	2	21	66.7
Unknown (Tree 2)	38	12	138	63.2
Vaccinium leschenaultia Wight	1	1	7	100
Vaccinium neilgherrense Wight	1	1	5	100
Vernonia arborea Buch.-Ham.	3	3	15	100
Vernonia sp.	1	1	24	100