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Suresh H.S. & R. Sukumar



How to cite:

Suresh H.S. & R. Sukumar 1999. Phytogeographical Affinities of Flora of Nilgiri Biosphere Reserve. *Rheedia* 9(1): 1–21.

<https://dx.doi.org/10.22244/rheedia.1999.09.01.01>

Published in print: 30.06.1999

Published Online: 01.01.2022



Phytogeographical Affinities of Flora of Nilgiri Biosphere Reserve

H.S. Suresh and R. Sukumar

Center for Ecological Sciences, Indian Institute of Science
Bangalore - 560 012, India

Abstract

Vegetation of the Nilgiri Biosphere Reserve (NBR) was characterized. A total of 5373 individuals above 3.0 cm DBH (Diameter at breast height) belonging to 364 species were enumerated. Phytogeographical affinities of the species was looked into by obtaining information about the species distribution at local and global scale. An analysis of the affinities reveals that NBR flora has strong *Indomalayan* (27.7%) and *Indian* (30.3%) affinities. Flora of moist vegetation types had strong affinities with *Indomalayan* (20.1%); *Indian* (38.6%) and *Indolankan* (9.7%) flora while flora of dry vegetation types had species with *Afrotropical* and *Pantropical* affinities. Tropical montane forest type had maximum number of endemic species (20%) suggesting that the vegetation is highly specialized and requires high priority for conservation.

INTRODUCTION

Nilgiri Biosphere Reserve was established in 1986 by the Department of Environment and Forests as a first step towards conserving the biological diversity of India. The earth summit in Rio de Janeiro called for the urgent necessity to conserve the biological diversity of the tropics. Global concern about the rate of deforestation of tropical forests accelerated in 1980s. According to estimates of Myers (1986) and FAO (1980) an estimated 14-15 million hectares per annum were deforested. The latest estimate of FAO (1993) put this figure as 15 million hectares per annum or 0.9% of the remaining area of 1750 million hectares. The understanding of the tropical plants by the scientific community is very poor. Most of the taxa is either unknown to the biological world or they are underdescribed. Many of the plants could go extinct before they are given a name (Foster and Hubbell, 1990).

Biogeographically western ghats is the most important region and one of the hot spots for speciation in the tropics. It is the confluence of the afro-tropical and Indomalayan biotic zones of the world. Phytogeographically the vegetation of India is analysed into distinct botanical provinces based on criteria like species and familial composition of the flora (Hooker, 1907) and climate (Prain, 1903). Udavardy (1975) divided the Indian subcontinent into twelve distinct biogeographic provinces. Nilgiri biosphere reserve lies in the botanical provinces of Malabar and Deccan. Malabar province lies between the river Tapti in north and Kanyakumari in the

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south. It is a humid tropical belt of mountainous region bearing the fury of the south-west monsoon and hosts a luxuriant seasonal rain forest in the lowland. In the higher reaches of the mountains an unique phyto association of tropical Montane forest and grassland is found. As it progresses east the vegetation gradually changes to moist deciduous to scrub through dry deciduous in the Deccan plateau. The Deccan plateau constitutes a distinct biographical province, but the transformation is not rigid.

In recent years the area under forest cover has drastically reduced (NRSA, 1993) due to various anthropogenic pressures. As a result, drastic changes in the landscape of the western ghats has occurred resulting in the loss of pristine forests (Subhash Chandran and Gadgil, 1993). According to IPCC (1996) global models based on $2 \times \text{CO}_2$ climate project that a substantial fraction of the existing forest will experience climatic condition under which they currently do not exist. Thus a large forested area will undergo change from current forest type to new major vegetation type (for a detailed review refer Ravindranath and Sukumar, 1997). Impact of climate change on the biodiversity is rather speculative at this stage. Thus serious attempts should be made to assess the potential impacts of the climate change on the forest diversity. An improved understanding of impacts of climate change would enable forest managers to develop mitigation and adaption measures to minimize the adverse impacts. Understanding of the phytogeographical affinities would help the forest managers and policy makers in making the right choice of species. This paper addresses the following questions: (1) What is the broad phytogeographical pattern of the Biosphere reserve ? (2) What is the phytogeographical associations of each forest community? How is the pattern of endemism? and also endemism is discussed with special reference to tropical Montane communities.

MATERIAL AND METHODS**Study area**

This study was conducted in the Nilgiri Biosphere Reserve comprising three States of Karnataka, Kerala and Tamil Nadu. The biosphere reserve extends over 5500 sq. km. comprising of the whole of Nilgiri district, parts of Coimbatore plains. To the north is Mysore plateau consisting of Bandipur National Park and Segur plateau. To the west is Wynaad sanctuary, Silent Valley National Park and Nilambur plains. To the south is Attapadi plateau and contiguous stretch of Coimbatore plains (Fig. 1).

Sampling

A standard 0.1 ha sampling method was followed to sample the vegetation. A 250 x 4 meter length transect in strips of 50 meters was laid randomly. All plants above 3.0 cm diameter at breast height were identified and enumerated for their girth, a qualitative estimate of the height and height at first branch was done. At every 10 meters a qualitative estimate of the canopy was done. Samples were collected for the herbarium.

Phytogeographical Affinities

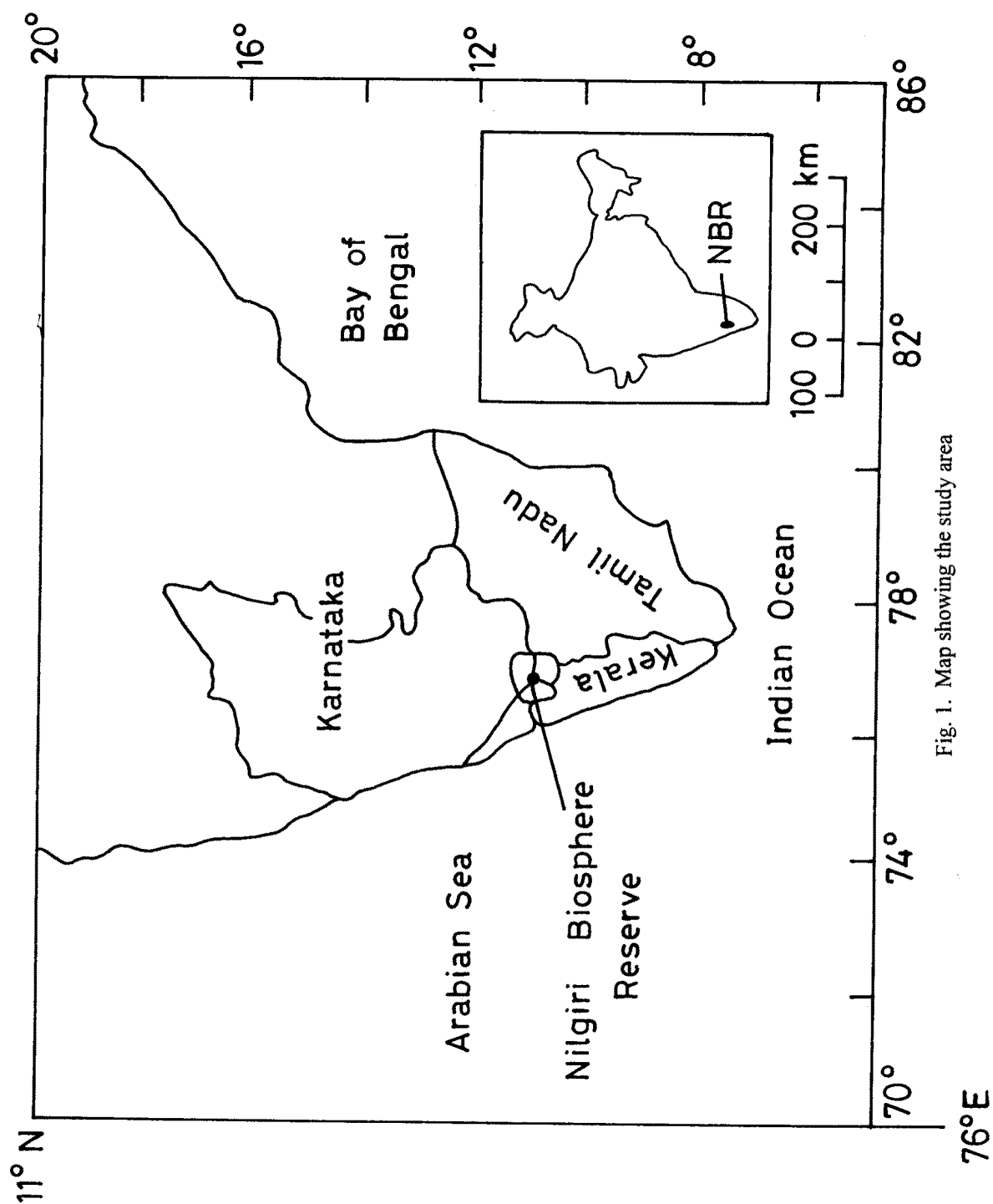


Fig. 1. Map showing the study area

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Data for each forest type regarding species composition was obtained by pooling the data from each 0.1 ha sample from the respective forest types. A master list for each forest type was prepared. The phytogeographical affinity was obtained from different floras and other relevant literature. Data was analysed for various affinities: within forest types and across forest types. 60 such transects were laid randomly in different vegetation types and in different geographical locations.

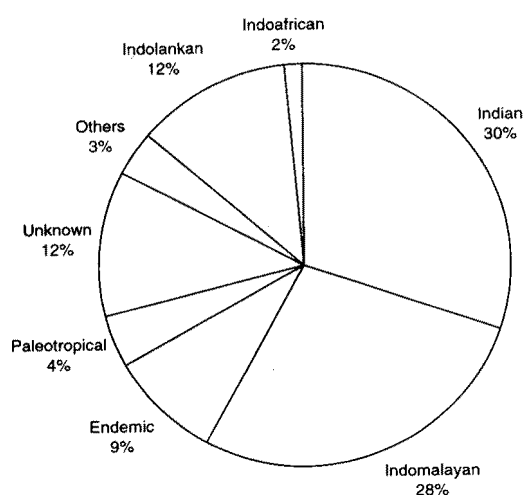
RESULTS AND DISCUSSION

A total of 5373 individuals belonging to 364 species were enumerated in different forest types located in different geographical locations. Biogeography of the Indian sub-continent should be viewed with the understanding of the plate tectonics that has resulted in the current physiography. The floristic elements of India share both Afro-tropical and Tropical-Asian elements. But predominantly they share the affinity with the Indo-malayan realm (Daniel and Nair, 1985). Significant number of species in Nilgiri biosphere reserve showed either Indomalayan (27.78%) or Indian affinities (30.05%), thus corroborating the earlier results on the phytogeographical affinities (Subramanyam and Nayar, 1974; Razi, 1955-56). A total of 11.7% of species constituted unknown category of species whose affinities could not be ascertained as their identity was not certain. However, the conclusions will not change since the species are of either Indian or Indomalayan affinity. Figure 2 represents the percentage of the species showing various affinities when all the samples were pooled together. Analysis of the affinity based on number of individuals represented by various species also shows similar trend. Many individuals are of either Indian (37.4%) or Indomalayan (22.69%). Only 3% of the total number of individuals are in the unknown category. Table 1 presents the data on affinities of various species in each forest type. There are two distinct patterns of the affinity. The drier forest communities had the representations of species from Indo-Pak (0.65%) or Indo-African (2.55%) realm suggesting the migrations of the species from the dry belt, even though majority of the species showed Indomalayan affinity (30.35%). The drier forest communities seemed to be more generalistic in nature accounted for 10% of the species complements having a broad phytogeographical range. Some species predominantly of neotropical origin also had representation. The wetter forest communities were more specialised communities by harbouring more than 50% of the species complements having a narrow geographical range. They also had 18.98% endemic species. The wetter forest communities predominantly show either Indian (33.8%) or Indo-malayan (24.07%) affinity suggesting migrations from more wetter belts.

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Table 1 Phytogeographical Affinities of Various Vegetation Types in Nilgiri Biosphere Reserve (Affinities are in percent)

Affinity	Thorn Scrub	Riverine	Dry Deciduous	Moist Deciduous	Evergreen	Shola
Trop-Asia	0	0	5.49	0	0.84	0
Paleo Tropics	8.69	11.76	4.39	2.94	2.52	1.03
Indopak	0	0	2.19	0	0	0
Indian	28.98	17.64	31.86	27.45	38.65	27.83
Indo African	4.34	3.92	1.09	1.96	0	0
Indo Malayan	27.53	29.41	34.06	29.41	20.16	28.86
Endemic	0	0	4.39	1.96	18.48	19.58
Unknown	8.69	11.76	10.98	18.62	5.88	14.43
Neo Tropics	0	196	0	0	0	0
Pan Tropics	7.24	0	0	0.98	2.52	0

**Fig. 2.** Phytogeographical affinities of Nilgiri Biosphere Reserve

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Affinities of plant species from the dry zone

Many species in this zone show wide distribution. This zone is also characterised by plants belonging to Pakistan and Africa. Plants in the dry deciduous forest zone have either Indian (31.86%) or Indomalayan (34.06%) affinity. Important species forming the association of the forest of peninsula shows following affinities : *Angeissus latifolia* (Indian), *Terminalia crenulata* (Indian) and *Tectona grandis* (Indo-malayan). Other important species like *Dalbergia latifolia*, *Pterocarpus marsupium*, *Ougeinia oojensis*, *Stereospermum personatum* shows affinities with Indian flora. Whereas species like *Cassine glaucum*, *Garuga pinnata*, *Gmelina arborea* and *Schleichera oleosa* shows affinities with Indomalayan flora. This trend is true of understory species also. Species like *Kydia calycina*, *Bridelia retusa*, *Vitex altissima*, *Careya arborea* show affinities with Indian flora. Whereas species such as *Embllica officinalis*, *Cassia fistula*, *Wrightia tinctoria*, *Bauhinia racemosa* show affinities with Indomalayan flora. The dry forest flora has affinities with African tropics with some species in the forests showing the Afro-tropical affinities. Species such as *Grewia tiliifolia* and *Alstonia scholaris* in the canopy and *Xeromphis spinosa* in the understory show African affinities.

The dry thorn forest to a large extent has similar pattern with Indian (28.9%) and Indomalayan (27.5%) elements dominating the flora. Important species forming the facies of the forest *Gyrocarpus jacquini* (tropical), *Acacia chundra* (Indian), *Acacia ferruginea* (Indian), *Acacia leucophloea* Indomalayan. This community also has species of African affinity, for example *Albizia chinensis* a canopy species, *Albizia lebbeck*, *Acacia pennata*. Details of individual species affinity is given in (Tables 1-2).

Table 1: Phytogeographical Affinities of Plants in the Dry Thorn Forest Zone

Species	Family	Affinity
<i>Acacia chundra</i>	Fabaceae	Indolankan
<i>Acacia ferruginia</i>	Fabaceae	Indian
<i>Acacia leucophloea</i>	Fabaceae	Indomalayan
<i>Acacia pennata</i>	Fabaceae	Paleotropical
<i>Ailanthus excelsa</i>	Simorubaceae	Indolankan
<i>Albizia amara</i>	Fabaceae	Indoaffrican
<i>Albizia amara</i>	Fabaceae	Indoaffrican
<i>Albizia chinensis</i>	Fabaceae	Indomalayan
<i>Albizia chinensis</i>	Fabaceae	Paleotropical
<i>Albizia procera</i>	Fabaceae	Indomalayan
<i>Anogeissus latifolia</i>	Combretaceae	Indian
<i>Atlantia hexapetala</i>	Rutaceae	Indian
<i>Azadiracta indica</i>	Meliaceae	Indomalayan

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Species	Family	Affinity
<i>Bauhinia racemosa</i>	Fabaceae	Indomalayan
<i>Butea monosperma</i>	Fabaceae	Indomalayan
<i>Canthium dicoccum</i>	Rubiaceae	Indian
<i>Canthium parviflorum</i>	Rubiaceae	Indian
<i>Capparis grandiflora</i>	Capparaceae	Indian
<i>Capparis zeylanica</i>	Capparaceae	Indomalayan
<i>Carissa carandas</i>	Apocynaceae	Indian
<i>Chloroxylon swietenia</i>	Rutaceae	Indolankan
<i>Chomelia asiatica</i>	Rubiaceae	Indomalayan
<i>Chlausena indica</i>	Rutaceae	Indolankan
<i>Commiphora berryei</i>	Burseraceae	Indian
<i>Commiphora caudata</i>	Burseraceae	Indolankan
<i>Dalbergia lanceolaria</i>	Fabaceae	Indolankan
<i>Dendrocalamus strictus</i>	Poaceae	Indian
<i>Dichrostachys cinerea</i>	Fabaceae	Paleotropical
<i>Diospyros montana</i>	Ebenaceae	Indomalayan
<i>Ehretia canarensis</i>	Boraginaceae	Indian
<i>Casine glauca</i>	Celastraceae	Indomalayan
<i>Emblica officinalis</i>	Euphorbiaceae	Paleotropical
<i>Erythroxylon monogynum</i>	Erythroxylaceae	Indian
<i>Euphorbia antiquorum</i>	Euphorbiaceae	African
<i>Flacourtia indica</i>	Flacourtiaceae	Pantropical
<i>Flacourtia montana</i>	Flacourtiaceae	Pantropical
<i>Gardenia turgida</i>	Rubiaceae	Indian
<i>Givotia rottleriformis</i>	Euphorbiaceae	Indian
<i>Grewia abutilifolia</i>	Tiliaceae	Indomalayan
<i>Gyrocarpus americanus</i>	Hemandiaceae	Pantropical
<i>Hardwickia binata</i>	Fabaceae	Indian
<i>Ixora nigricans</i>	Rubiaceae	Indomalayan
<i>Jatropha glandulifera</i>	Euphorbiaceae	Indoafrian
<i>Mallotus philippensis</i>	Euphorbiaceae	Indomalayan
<i>Maytenus emarginatus</i>	Celastraceae	Indomalayan
<i>Milusa velutini</i>	Annonaceae	Indian
<i>Moringa concanensis</i>	Moringaceae	Indian
<i>Plerostylis opposita</i>	Celastraceae	Indomalayan
<i>Plerostylis wightii</i>	Celastraceae	Indomalayan

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Species	Family	Affinity
<i>Premna tomentosa</i>	Verbenaceae	Indolankan
<i>Prosopis juliflora</i>	Fabaceae	Indomalayan
<i>Pterolobium hexapetalum</i>	Fabaceae	Indian
<i>Rhus mysorensis</i>	Anacardiaceae	Indian
<i>Santalum album</i>	Santalaceae	Indian
<i>Sapindus emarginatus</i>	Sapindaceae	Indolankan
<i>Scutia myrtina</i>	Rhamnaceae	Indolankan
<i>Strychnos potatorum</i>	Loganiaceae	Indolankan
<i>Tamarindus indica</i>	Fabaceae	Tropical
<i>Wrightia tinctoria</i>	Apocynaceae	Indomalayan
<i>Xeromphis spinosa</i>	Aubiaceae	Paleotropical
<i>Ziziphus oenoplea</i>	Rhamnaceae	Pantropics
<i>Ziziphus xylopyrus</i>	Rhamnaceae	Indian

Table 2 : Phytogeographical Affinities of Plants in the Dry Deciduous Forest Zone

Species	Family	Affinity
<i>Acronychia pedunculata</i>	Rutaceae	Indomalayan
<i>Actinodaphne malabarica</i>	Lauraceae	Endemic
<i>Albizia chinensis</i>	Fabaceae	Indomalayan
<i>Albizia lebbek</i>	Fabaceae	Paleotropical
<i>Alseodaphne semecarpifolia</i>	Lauraceae	Indolankan
<i>Anogeissus latifolia</i>	Combretaceae	Indian
<i>Atlantia hexapetala</i>	Rutaceae	Indian
<i>Bambusa arundinacea</i>	Poaceae	Indian
<i>Bauhinia racemosa</i>	Fabaceae	Indomalayan
<i>Bridelia retusa</i>	Euphorbiaceae	Indian
<i>Buchanania lanzan</i>	Anacardiaceae	Indian
<i>Butea monospema</i>	Fabaceae	Indomalayan
<i>Canthium dicoccum</i>	Rubiaceae	Indomalayan
<i>Cassia fistula</i>	Fabaceae	Indomalayan
<i>Cedrela toona</i>	Meliaceae	Tropical Asia-Australia
<i>Chloroxylon swietenia</i>	Rutaceae	Indian
<i>Chomelia asiatica</i>	Rubiaceae	Indomalayan
<i>Cipadessa baccifera</i>	Meliaceae	Indomalayan

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Species	Family	Affinity
<i>Clausena hexapetala</i>	Rutaceae	Indomalayan
<i>Clausena indica</i>	Rutaceae	Indolankan
<i>Commiphora caudata</i>	Burseraceae	Indian
<i>Cordia macleodii</i>	Boraginaceae	Indian
<i>Cordia obliqua</i>	Boraginaceae	Indopak
<i>Cordia wallichii</i>	Boraginaceae	Indian
<i>Cassine glauca</i>	Celastraceae	Indomalayan
<i>Dalbergia latifolia</i>	Fabaceae	Indomalayan
<i>Dalbergia lanceolaria</i>	Fabaceae	Indolankan
<i>Diospyros montana</i>	Ebenaceae	Tropica Asia-Australia
<i>Emblica officinalis</i>	Euphorbiaceae	Paleotropical
<i>Epiprinus mallotiformis</i>	Euphorbiaceae	Endemic?
<i>Eriolaena quinquilocularis</i>	Sterculiaceae	Indian
<i>Erythroxylon monogynum</i>	Erythroxylaceae	Indian
<i>Ficus tsjeckela</i>	Moraceae	Indolankan
<i>Ficus virens</i>	Moraceae	Indomalayan
<i>Givotia rottleriformis</i>	Euphorbiaceae	Indian
<i>Glochidion</i> sp.	Euphorbiaceae	Indopak
<i>Glochidion zeylanicum</i>	Euphorbiaceae	Indomalayan
<i>Gmelina arborea</i>	Verbenaceae	Indomalayan
<i>Grewia tiliifolia</i>	Tiliaceae	Indoafican
<i>Helicteres isora</i>	Sterculiaceae	Tropical Asia-Australia
<i>Ixora nigricans</i>	Rubiaceae	Indomalayan
<i>Kydia calycina</i>	Malvaceae	Indian
<i>Lagerstroemia microcarpa</i>	Lythraceae	Indian
<i>Lagerstroemia parviflora</i>	Lythraceae	Indian
<i>Ligustrum roxburghii</i>	Oleaceae	Indian
<i>Litsea floribunda</i>	Lauraceae	Endemic
<i>Mallotus philippensis</i>	Euphorbiaceae	Tropical Asia-Australia
<i>Milusa velutina</i>	Annonaceae	Indian
<i>Moringa concanensis</i>	Moringaceae	Indomalayan
<i>Morinda</i> sp.	Apocynaceae	Indomalayan
<i>Naringi crenulata</i>	Rutaceae	Indomalayan
<i>Olea dioica</i>	Oleaceae	Indian
<i>Ougenia oojensis</i>	Fabaceae	Indian

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Species	Family	Affinity
<i>Pterocarpus marsupium</i>	Fabaceae	Indian
<i>Radermachera xylocarpa</i>	Bignoniaceae	Indian
<i>Sapindus emarginatus</i>	Sapindaceae	Indolankan
<i>Schlechera oleosa</i>	Sapindaceae	Indomalayan
<i>Schrebera swietenoides</i>	Oleaceae	Indomalayan
<i>Semecarpus anacardium</i>	Anacardiaceae	Indian
<i>Solanum xanthocarpum</i>	Solanaceae	Indomalayan
<i>Strychnos potatorum</i>	Loganiaceae	Indomalayan
<i>Syzygium cumini</i>	Myrtaceae	Tropical Asia-Australia
<i>Tamarindus indica</i>	Fabaceae	Paleotropical
<i>Tectona grandis</i>	Verbenaceae	Indomalayan
<i>Terminalia bellerica</i>	Combretaceae	Indomalayan
<i>Terminalia chebula</i>	Combretaceae	Indian
<i>Terminalia paniculata</i>	Combretaceae	Indian
<i>Terminalia crenulata</i>	Combretaceae	Indian
<i>Trema orientalis</i>	Ulmaceae	Indomalayan
<i>Uvaria racemosa</i>	Annonaceae	Endemic?
<i>Viburnum punctatum</i>	Caprifoliaceae	Indomalayan
<i>Vitex altissima</i>	Verbenaceae	Indian
<i>Wrightia tinctoria</i>	Apocynaceae	Indomalayan
<i>Xeromphis spinosa</i>	Rubiaceae	Paleotropical
<i>Xylia xylocarpa</i>	Fabaceae	Indomalayan
<i>Ziziphus rugosa</i>	Rhamnaceae	Indian
<i>Ziziphus xylopyrus</i>	Rhamnaceae	Indian

Contrasting with the moist formations, the floristic elements show significantly less number of Indolankan affinity suggesting that the species migration from the dry African savanna through the desert of gulf and colonized the dry plains of Deccan plateau. These dry forest formations can be referred to more generalist habitat as they signify species which have wider range. Dry deciduous forest has (4.39 %) of species which show paleotropical distribution, having also large representation in riverine type (11.76%) and thorn scrub (8.69 %).

Affinities of moist formation

The wet evergreen forests on the windward side of the ghats has species typically of either Indian (38.65%) or Indomalayan (20.16%). The canopy species like *Palaquium ellipticum* (In-

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dian), *Cullenia exarillata* (Indian), *Mesua ferrea* (Indian) are some of the examples of Indian affinity. The occurrence of genera like *Poeciloneuron indicum*, *Hydnocarpus* in the canopy and *Apodytes*, *Gomphandra* in the understory are the relics of the *Gondwana* which Indian sub-continent was a part and proves phytogeographically the past connections with the present continents. Evergreen forests has (18.4%) of endemic species. The occurrence of the genus, *Nothopodytes* in the Montane forests indicates the amplitude of the species. This zone has endemics also but not significant proportion of the species (19 %). Endemics are concentrated in the families such as Lauraceae, Annonaceae (*Polyalthia*), Clusiaceae (*Garcinia*, *Calophyllum*). Details of the species affinities are presented in the Table 3-5.

Table 3 : Phytogeographical Affinities of Plants Belonging to Moist Deciduous Forest Zone

Species	Family	Affinity
<i>Albizia odoratissima</i>	Fabaceae	Indomalayan
<i>Allophyllus cobbe</i>	Sapindaceae	Indomalayan
<i>Anogeissus latifolia</i>	Combretaceae	Indolankan
<i>Anthocephalus chinensis</i>	Rubiaceae	Indian
<i>Baccaurea courtalensis</i>	Euphorbiaceae	Indian
<i>Bauhinia malabarica</i>	Fabaceae	Indian
<i>Bauhinia racemosa</i>	Fabaceae	Indian
<i>Bombax ceiba</i>	Bombacaceae	Indomalayan
<i>Bridelia retusa</i>	Euphorbiaceae	Indomalayan
<i>Careya arborea</i>	Lecythidaceae	Indolankan
<i>Casearia esculenta</i>	Flacourtiaceae	Indolankan
<i>Casearia wynadensis</i>	Flacourtiaceae	Indian
<i>Cassia fistula</i>	Fabaceae	Indomalayan
<i>Cassia montana</i>	Fabaceae	Indian
<i>Cinnamomum malabathrum</i>	Lauraceae	Endemic
<i>Cipadessa baccifera</i>	Meliaceae	Indomalayan
<i>Cordia macleodi</i>	Boraginaceae	Indomalayan
<i>Cordia obliqua</i>	Boraginaceae	Indoafican
<i>Cordia wallichii</i>	Boraginaceae	Indian
<i>Cycas circinalis</i>	Cycadaceae	Indian
<i>Dalbergia latifolia</i>	Fabaceae	Indomalayan
<i>Dalbergia lanceolaria</i>	Fabaceae	Indomalayan
<i>Dendrocalamus strictus</i>	Poaceae	Indian
<i>Desmodium pulchellum</i>	Fabaceae	Indomalayan
<i>Dillenia pentagyna</i>	Dilleniaceae	Indomalayan

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Species	Family	Affinity
<i>Diospyros montana</i>	Ebenaceae	Indomalayan
<i>Dolichandrone falcata</i>	Bignoniaceae	Indian
<i>Embolia officinalis</i>	Euphorbiaceae	Paleotropical
<i>Eriolaena quinquelocularis</i>	Sterculiaceae	Indian
<i>Ervatamia heyneana</i>	Apocynaceae	Indian
<i>Ficus religiosa</i>	Moraceae	Indomalayan
<i>Ficus tsjeckela</i>	Moraceae	Indolankan
<i>Flacourtia</i> sp.	Flacourtiaceae	Indian
<i>Garcinia morella</i>	Clusiaceae	Indomalayan
<i>Glochidion velutinum</i>	Euphorbiaceae	Indian
<i>Gmelina arborea</i>	Verbenaceae	Indomalayan
<i>Grewia orbiculata</i>	Tiliaceae	Indian
<i>Helicteres isora</i>	Sterculiaceae	Paleotropics
<i>Grewia tilifolia</i>	Tiliaceae	Indoaffrican
<i>Holigarmna grahamii</i>	Anacardiaceae	Indian
<i>Ixora arborea</i>	Rubiaceae	Indolankan
<i>Ixora nigricans</i>	Rubiaceae	Indian
<i>Kydia calycina</i>	Malvaceae	Indian
<i>Lagerstroemia microcarpa</i>	Lythraceae	Indian
<i>Lannea coramandelica</i>	Anacardiaceae	Indolankan
<i>Leea indica</i>	Leeaceae	Indomalayan
<i>Litsea mysorensis</i>	Lauraceae	Endemic
<i>Macaranga peltata</i>	Euphorbiaceae	Indolankan
<i>Mallotus philippensis</i>	Euphorbiaceae	Indomalayan
<i>Morinda</i> sp.	Apocynaceae	Indomalayan
<i>Naringi crenulata</i>	Rutaceae	Indomalayan
<i>Olea dioica</i>	Oleaceae	Indian
<i>Olea glandulifera</i>	Oleaceae	Indian
<i>Palaquim ellipticum</i>	Sapotaceae	Indian
<i>Pavetta indica</i>	Rubiaceae	Indian
<i>Pterocarpus marsupium</i>	Fabaceae	Indolankan
<i>Radermachera xylocarpa</i>	Bignoniaceae	Indomalayan
<i>Sapindus emarginatus</i>	Sapindaceae	Indolankan
<i>Schleichera oleosa</i>	Sapindaceae	Indomalayan
<i>Schrebera switeinoides</i>	Oleaceae	Indian

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Species	Family	Affinity
<i>Scolopia crenata</i>	Flacourtiaceae	Indomalayan
<i>Semecarpus anacardium</i>	Anacardiaceae	Paleotropical
<i>Solanum torvum</i>	Solanaceae	Pantropical
<i>Sterculia guttata</i>	Sterculiaceae	Indolankan
<i>Stereospermum personatum</i>	Bignoniaceae	Indolankan
<i>Sterculia urens</i>	Sterculiaceae	Indolankan
<i>Syzygium cumini</i>	Myrtaceae	Indomalayan
<i>Syzygium gardneri</i>	Myrtaceae	Indolankan
<i>Tectona grandis</i>	Verbenaceae	Indomalayan
<i>Terminalia bellerica</i>	Combretaceae	Indomalayan
<i>Terminalia paniculata</i>	Combretaceae	Indian
<i>Terminalia crenulata</i>	Combretaceae	Indian
<i>Toona ciliata</i>	Meliaceae	Indomalayan
<i>Trichelia connoroides</i>	Meliaceae	Indian (Pantropical?)
<i>Vitex altissima</i>	Verbenaceae	Indian
<i>Wrightia tinctoria</i>	Apocynaceae	Indomalayan
<i>Xylia xylocarpa</i>	Fabaceae	Indomalayan
<i>Ziziphus rugosa</i>	Rhamnaceae	Indolankan
<i>Ziziphus xylopyrus</i>	Rhamnaceae	Indian

Table 4 : Phytogeographical Affinities of Plants Belonging to Evergreen Forest Zone

Species	Family	Affinity
<i>Achronychia pedunculata</i>	Rutaceae	Indomalayan
<i>Actinodaphne lawsonii</i>	Lauraceae	Endemic?
<i>Actinodaphne malabarica</i>	Lauraceae	Endemic
<i>Aglaia elaeagnoidea</i>	Meliaceae	Indomalayan
<i>Aglaia</i> sp.	Meliaceae	Indomalayan
<i>Agrostistachys bourdillonii</i>	Euphorbiaceae	Indolankan
<i>Agrostistachys meeboldii</i>	Euphorbiaceae	Indolankan
<i>Antidesma menasu</i>	Euphorbiaceae	Indian
<i>Aphanamixis polystachya</i>	Meliaceae	Indomalayan
<i>Apollonias amottii</i>	Lauraceae	Endemic
<i>Artocarpus hirsutus</i>	Moraceae	Indian

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Species	Family	Affinity
<i>Atlantia wightii</i>	Rutaceae	Endemic
<i>Bischofia javanica</i>	Euphorbiaceae	Indomalayan
<i>Calophyllum apetalum</i>	Clusiaceae	Endemic
<i>Calophyllum polyanthum</i>	Clusiaceae	Endemic
<i>Canthium dicoccum</i>	Rubiaceae	Indomalayan
<i>Casearia esculenta</i>	Flacourtiaceae	Indolankan
<i>Casearia ovoides</i>	Flacourtiaceae	Indian
<i>Casearia wynadensis</i>	Flacourtiaceae	Indian
<i>Cinnamomum malabathrum</i>	Lauraceae	Endemic
<i>Cinnamomum sulphuratum</i>	Lauraceae	Endemic
<i>Clerodendron viscosum</i>	Verbenaceae	Indomalayan
<i>Cryptocareya bourdillonii</i>	Lauraceae	Endemic?
<i>Cycas racemosus</i>	Cycadaceae	Endemic
<i>Cassine glauca</i>	Celastraceae	Indomalayan
<i>Daphniphyllum neilgherrense</i>	Euphorbiaceae	Sino-Indomalayan
<i>Democarpus longan</i>	Sapindaceae	Tropical
<i>Diospyros nigrescens</i>	Ebenaceae	Indian
<i>Diospyros oocarpa</i>	Ebenaceae	Indian
<i>Diospyros paniculata</i>	Ebenaceae	Indolankan
<i>Diospyros sylvatica</i>	Ebenaceae	Indolankan
<i>Drypetes elata</i>	Euphorbiaceae	Indian
<i>Elaeocarpus munronii</i>	Elaeocarpaceae	Indian
<i>Elaeocarpus tuberculatus</i>	Elaeocarpaceae	Indomalayan
<i>Epiprinus mallotiformis</i>	Euphorbiaceae	Indian
<i>Erythroxylon moonii</i>	Erythroxylaceae	Indian
<i>Euonymus crenulatus</i>	Celastraceae	Indian
<i>Euonymus umbellatus</i>	Celastraceae	Indian
<i>Eurya nitida</i>	Theaceae	Indomalayan
<i>Farenheitia zeylanica</i>	Euphorbiaceae	Indolankan
<i>Ficus amotiana</i>	Moraceae	Indolankan
<i>Ficus beddomei</i>	Moraceae	Indian
<i>Ficus nervosa</i>	Moraceae	Indomalayan
<i>Garcinia gummigutta</i>	Clusiaceae	Endemic
<i>Garcinia morella</i>	Clusiaceae	Endemic
<i>Garcinia</i> sp.	Clusiaceae	Indian

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Species	Family	Affinity
<i>Garuga pinnata</i>	Burseraceae	Indian
<i>Gomphandra tetrandra</i>	Icacinaceae	Indomalayan
<i>Gordonia obtusa</i>	Theaceae	Indian
<i>Hedyotis</i> sp.	Rubiaceae	Indian
<i>Hereteria papillo</i>	Sterculiaceae	Indian
<i>Holigarna nigra</i>	Anacardiaceae	Indian
<i>Hopea glabra</i>	Dipterocarpaceae	Indian
<i>Hydnocarpus alpina</i>	Flacourtiaceae	Indolankan
<i>Isonandra lanceolata</i>	Sapotaceae	Indolankan
<i>Jatropha glandulifera</i>	Euphorbiaceae	Paleotropical
<i>Lagerstroemia reginae</i>	Lythraceae	Indomalayan
<i>Lasianthus</i> sp.	Rubiaceae	Indian
<i>Leea indica</i>	Leeaceae	Indomalayan
<i>Laportea crenulata</i>	Urticaceae	Paleotropical
<i>Laportea interrupta</i>	Urticaceae	Endemic
<i>Litsea bourdillonii</i>	Lauraceae	Endemic
<i>Litsea floribunda</i>	Lauraceae	Endemic
<i>Litsea insignis</i>	Lauraceae	Endemic
<i>Litsea stocksii</i>	Lauraceae	Endemic
<i>Macaranga peltata</i>	Euphorbiaceae	Indolankan
<i>Mallotus philippensis</i>	Euphorbiaceae	Indomalayan
<i>Moallotus stenanthus</i>	Euphorbiaceae	Indomalayan
<i>Mangifera indica</i>	Anacardiaceae	Tropics
<i>Mastixia arborea</i>	Cornaceae	Indian
<i>Meliosma pinnata</i>	Sabiaceae	Indomalayan
<i>Memecylon heyneanum</i>	Melastomaceae	Indian
<i>Mesua ferrea</i>	Clusiaceae	Indian
<i>Mesua negassaria</i>	Clusiaceae	Indomalayan
<i>Milusa montana</i>	Annonaceae	Indian
<i>Myristica dactyloides</i>	Myristicaceae	Indolankan
<i>Neolitsea scrobiculata</i>	Lauraceae	Indian
<i>Neolitsea zeylanica</i>	Lauraceae	Indomalayan
<i>Nothopegia beddomei</i>	Anacardiaceae	Indian
<i>Olea dioica</i>	Oleaceae	Indian
<i>Oreocnide crenulata</i>	Urticaceae	Indian

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Species	Family	Affinity
<i>Palaquium ellipticum</i>	Sapotaceae	Indian
<i>Persea macarantha</i>	Lauraceae	Indolanakan
<i>Poeciloneuron indicum</i>	Clusiaceae	Indian
<i>Prunus ceylanica</i>	Rosaceae	Indomalayan
<i>Psychotria</i> sp.	Rubiaceae	Indian
<i>Pterogota alata</i>	Sterculiaceae	Indian
<i>Reinwardtiiodendron anamalayana</i>	Meliaceae	Indian
<i>Scolopia crenata</i>	Flacourtiaceae	Indomalayan
<i>Symplocos cochinchinensis</i>	Symplocaceae	Indomalayan
<i>Symplocos marocarpa</i>	Symplocaceae	Indian
<i>Symplocos pulchra</i>	Symplocaceae	Indian
<i>Symplocos</i> sp.	Symplocaceae	
<i>Syzygium densiflorum</i>	Myrtaceae	Indian
<i>Syzygium gardneri</i>	Myrtaceae	Indolankan
<i>Syzygium heyneanum</i>	Myrtaceae	Indian
<i>Syzygium keralensis</i>	Myrtaceae	Endemic?
<i>Syzygium laetum</i>	Myrtaceae	Endemic?
<i>Syzygium munronii</i>	Myrtaceae	Indian
<i>Syzygium negasserium</i>	Myrtaceae	Endemic?
<i>Syzygium</i> sp.	Myrtaceae	
<i>Ternstroemia japonica</i>	Ternstroemiaceae	Indomalayan
<i>Tricalysia apiocarpa</i>	Rubiaceae	Indian
<i>Trichelia connorioides</i>	Meliaceae	Tropical
<i>Turpinia malabarica</i>	Staphyllaceae	Indian
<i>Vernonia arborea</i>	Asteraceae	Indian
<i>Xanthophyllum amottiana</i>	Xanthophyllaceae	Indolankan
<i>Xanthophyllum arnotiana</i>	Rutaceae	Indomalayan

Table 5 : Phytogeographical Affinities of Plants Belonging to Shola Forest Zone

Species	Family	Affinity
<i>Achronychia pedunculata</i>	Rutaceae	Indomalayan
<i>Actinodaphne malabarica</i>	Lauraceae	Endemic
<i>Alseodaphne semecarpifolia</i>	Lauraceae	Endemic

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Species	Family	Affinity
<i>Antidesma</i> sp.	Euphorbiaceae	Indian
<i>Apodytes dimitida</i>	Icacinaeae	Paleotropical
<i>Belishemiedia wightii</i>	Lauraceae	Indian
<i>Celtis tetrandra</i>	Ulmaceae	Indomalayan
<i>Cinnamomum malabathrum</i>	Lauraceae	Endemic
<i>Cinnamomum sulphuratum</i>	Lauraceae	Endemic
<i>Daphniphyllum neilgherrensis</i>	Euphorbiaceae	Indomalayan
<i>Drypetes elata</i>	Euphorbiaceae	Indian
<i>Elaeocarpus oblongus</i>	Elaeocarpaceae	Indian
<i>Elaeocarpus recurvatus</i>	Elaeocarpaceae	Indomalayan
<i>Elaeocarpus tuberculatus</i>	Elaeocarpaceae	Indomalayan
<i>Euonymus crenulatus</i>	Celastraceae	Indian
<i>Euonymus undulatus</i>	Celastraceae	Indian
<i>Eurya nitida</i>	Theaceae	Indomalayan
<i>Excoecarea neilgherrensis</i>	Euphorbiaceae	Indian
<i>Evodia lunu-annkenda</i>	Rutaceae	Indomalayan
<i>Garcinia gummigutta</i>	Clusiaceae	Endemic
<i>Glochidion neilgherrensis</i>	Euphorbiaceae	Endemic
<i>Glochidion velutinum</i>	Euphorbiaceae	Indian
<i>Gordonia obtusa</i>	Theaceae	Endemic
<i>Hydnocarpus alpina</i>	Flacourtiaceae	Indolankan
<i>Illex dentifulata</i>	Aquafoliaceae	Indian
<i>Illex wightiana</i>	Aquafoliaceae	Indian
<i>Isonandra candolleana</i>	Sapotaceae	Indian
<i>Jasminum roxburghi</i>	Oleaceae	Indian
<i>Lasianthus coffeoides</i>	Rubiaceae	Indian
<i>Lasianthus venulosus</i>	Rubiaceae	Indian
<i>Litsea coriacea</i>	Lauraceae	Endemic
<i>Litsea deccanensis</i>	Lauraceae	Endemic
<i>Litsea floribunda</i>	Lauraceae	Endemic
<i>Litsea ghatica</i>	Lauraceae	Endemic
<i>Litsea mysorensis</i>	Lauraceae	Endemic
<i>Litsea stocksii</i>	Lauraceae	Endemic
<i>Litsea wightiana</i>	Lauraceae	Endemic
<i>Mahonia leschenaultiana</i>	Berberidaceae	Endemic
<i>Mallotus philippensis</i>	Euphorbiaceae	Indomalayan

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Species	Family	Affinity
<i>Meliosma simplicifolia</i>	Sabiaceae	Indolankan
<i>Memecylon malabaricum</i>	Melastomaceae	Indian
<i>Michelia nilagirica</i>	Magnoliaceae	Endemic
<i>Microtopis racemosa</i>	Celastraceae	Indolankan
<i>Neolitsea scrobiculata</i>	Lauraceae	Indian
<i>Neolitsea zeylanica</i>	Lauraceae	Indomalayan
<i>Nothapodytes foetida</i>	Icacinaceae	Indomalayan
<i>Nothopegia heyneana</i>	Anacardiaceae	Indian
<i>Photinia indica</i>	Rosaceae	Indomalayan
<i>Phoebe lanceolata</i>	Lauraceae	Indian
<i>Phoebe paniculata</i>	Lauraceae	Endemic
<i>Phoebe wightii</i>	Lauraceae	Endemic
<i>Pittosporum floribunda</i>	Pittosporaceae	Indian, Temperate Asia
<i>Polyalthia cffeoides</i>	Annonaceae	Indolankan
<i>Psychotria congesta</i>	Rubiaceae	Indian
<i>Psychotria bisulcata</i>	Rubiaceae	Indian
<i>Rapanea wightii</i>	Myrsinaceae	Indolankan
<i>Rhododendron nilagiricum</i>	Ericaceae	Endemic
<i>Schefflera macrantha</i>	Araliaceae	Indian
<i>Scolopia crenata</i>	Flacourtiaceae	Indomalayan
<i>Symplocus beddomei</i>	Symplocaceae	Indian
<i>Symplocus cochinchinensi</i>	Symplocaceae	Indomalayan
<i>Symplocus foliosa</i>	Symplocaceae	Indian
<i>Symplocus macrocarpa</i>	Symplocaceae	Indian
<i>Symplocus obtusa</i>	Symplocaceae	Indian
<i>Symplocus rosea</i>	Symplocaceae	Indian
<i>Syzygium amottiana</i>	Myrtaceae	Indian
<i>Syzygium cumini</i>	Myrtaceae	Indomalayan
<i>Syzygium densiflorum</i>	Myrtaceae	Indian
<i>Syzygium montana</i>	Myrtaceae	Indian
<i>Ternstroemia japonica</i>	Ternstroemiaceae	Indomalayan
<i>Trema orientalis</i>	Ulmaceae	Paleotropical
<i>Turpinia nepalensis</i>	Staphyllaceae	Indomalayan
<i>Viburnum</i> sp.	Caprifoliaceae	
<i>Weberc coffecoides</i>	Rubiaceae	Indian
<i>Withania somnifera</i>	Solanaceae	Indoafrikan

Phytogeographical Affinities

The flora of the mountain tops show interesting features. Nilgiris which forms an out crop of western ghats began its uplift during pliocene time and the rise was gradual. The tropical species could evolve and survive under the shola canopy whereas some species of the high latitudes are seen in the grasslands (Meher-Homji, 1988). The sholas have large representation of species which are confined to Indian (27.83%), Indolankan (8.24%) or Indomalayan (28.86%) region. *Daphniphyllum* and *Eurya japonica* are two exceptions being from the high latitudes and yet having representation in the shola. Some Himalayan elements like *Rhododendron*, *Berberis tinctoria*, *Mahonia leschenaultii* and *Gaultheria fragrantissima* are found only in the fringes. The occurrence of *Symplocos* spp. as a major species compliment in these forest patches indicates their sub-tropical or temperate affinities. The uniqueness of the community lies in the fact that tropical montane forests have many species which are restricted to tropical latitudes. Razi (1955-56) reviewed the probable centers of origin of various species found in Mysore hill tops and has shown that species like *Cinnamomum*, *Litsea*, *Meliosma*, *Neolitsea* and *Schefflera* to be of Malayan affinity, *Psychotria* and *Rapanea* of South American, *Pittosporum* of tropical and sub tropical. Thus tropical nature of the species ascertained while species in the open formations like grasslands and fringes seem to have origins in Sino-Himalayan region. Species like *Rubus* has high representation in Europe, Central-Asia, Himalayas, China and Boreal America, hence of temperate stock. Meher-Homji (1967) opines that most of the species of this community are of tropical stock which have restricted phytogeographical range. Some species of the temperate region present are the species with wide ecological amplitude.

According to Ramesh and Pascal (unpublished data), Nilgiri Biosphere Reserve lies in the second high concentration of endemics and has 5.2 % of species endemic. High levels of endemism in the Montane forests is a significant factor. This could be due to the climatic fluctuations that the plateau has experienced (Sukumar *et al.*, 1993). Endemics here are concentrated in the family Lauraceae which dominates the floristic composition of forest patch.

Acknowledgements

We thank Forest departments of Karnataka, Kerala and Tamil Nadu for permission to work in the forests. Thanks are due to Bharanaiah, Shivaji, Bomman, Mohan and Karunakaran for their help in various ways. Financial support from Department of Environment, Ministry of Environment and forest, Govt. of India is thankfully acknowledged.

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