FLORISTIC PATTERNS ALONG THE WESTERN GHATS OF INDIA[1]

ROLLA SESHAGIRI RAO[2]

ABSTRACT. Eight representative areas along the 1200 km of the Western Ghats were studied in detail. A progressive increase in evergreen and reduction in deciduous forest occurs from north to south correlated with increasing rainfall and shortening of the dry season. Characteristic floristic patterns occur and although some species are of widespread distribution there is a high rate of endemism.

Natural vegetation expresses the whole environment (climate, topography, geology and soils) and hence studies of vegetation composition leading to the production of vegetation maps can form a basis for land use. Knowledge of vegetation types and the environmental factors to which they are linked allow rational development of range management, forestry, conservation, watershed management, etc.; matters of great importance in the tropical and sub-tropical parts of the world.

The present paper concentrates on floristic composition, the most basic parameter for segregating units of vegetation as it deals intensively with the inherent nature of each unit. In combination with information of other types the data presented could be used under the Hill Ecosystem programme to delineate suitable land units along the Western Ghats for proper conservation and land management.

AREAS STUDIED

While undertaking general studies on the vegetation and flora of the Western Ghats special attention was paid to the following selected localities (see map, fig. 1): (1) Surguna–Peint–Harsul (Nasik dist.), (2) Junnar Ghats–Bhimashankar, (3) Khandala–Sakarpathar (Poona dist.), (4) Mahabaleshwar (Satara dist.), (5) Phonda–Ambolighat (Ratnagiri dist.), (6) Goa Ghats, (7) Agumbe Ghats (Shimoga dist.) and (8) Bhagmandala–Mercara Ghats (Coorg dist.). Areas 1–5 are in Maharashtra State; 7 and 8 are in Karnataka State.

Floristic studies in each locality were carried out over a considerable area, covering the representative habitats of lower and upper slopes, valleys and the characteristic flat or bald hill tops of the Sahyadris of Maharashtra and the Western Ghats of Goa territory and Karnataka.

The collections and other data relating to the study are deposited in the herbarium of Western Circle, Botanical Survey of India, Poona.

[1] This paper forms a part of the contributions dedicated to Mr B. L. Burtt on the occasion of his 65th birthday. Due to delays in communication it could not be included in the main commemoration part [36(2)] and is therefore presented here.

[2] Dept of Botany, Andhra University, Waltair, India. (Formerly Botanical Survey of India, Howrah).

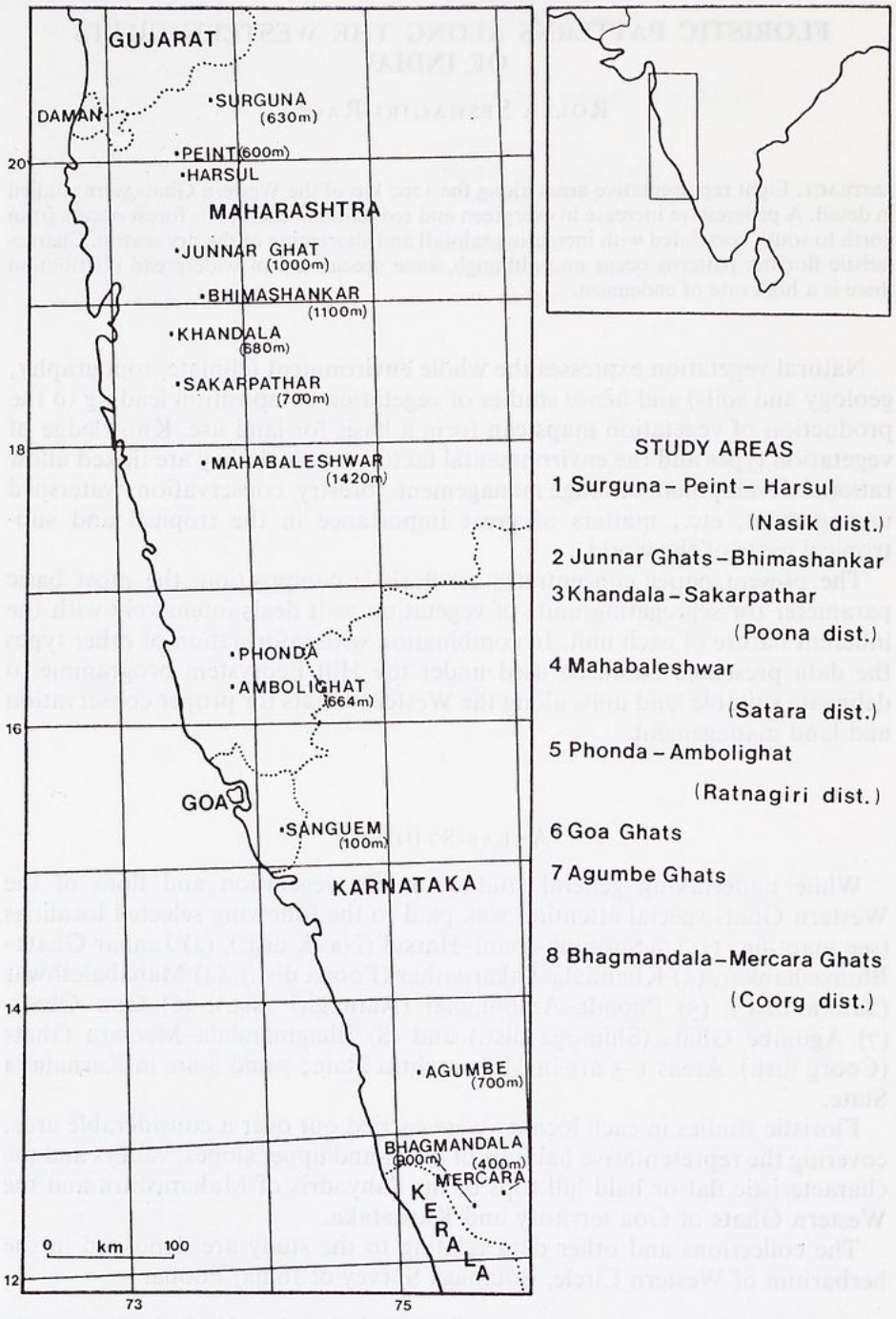

FIG. 1. The Western Ghats of Maharashtra, Goa and Karnataka.

Environment

GEOGRAPHY AND TOPOGRAPHY. The Western Ghats lie between 12° 0′ and 20° 30′ N forming a narrow strip facing the Arabian Sea (fig. 1). They are about 1200 km in length from north to south and 5–10 km broad, with a wide range of altitude from 300–1500 m (excluding high crests). Along the Sahyadris (the northern part of the ghats within Maharashtra State) isolated, conical, flat-topped hills occur with steep sides marked with distinct striations; their form is due to the morphology and mode of weathering of the Deccan Traps. In contrast the ghats south of Amboli and Goa present rather gradual slopes, without striations. Though the major rivers flow eastward, the general drainage is westward to the Arabian sea and a large number of perennial forest streams have scoured deep into their beds forming steep, vertical, wall-like sides.

Though the range of altitude considered in this paper is from 300–1500 m, in Maharashtra there are a few barren, rocky peaks rising up to 1650 m which harbour only an extremely sparse flora.

GEOLOGY. In general, the whole of the Deccan Trap is formed of basalt rock with little variation in composition. The ghats consist of old crystalline rocks: granites and gneisses, considered to be of archean age, are the chief geological formations, but they are frequently traversed by other rock series, namely, schists, quartzites, etc. The gneisses are of biotite type. Lateritic formations are of widespread occurrence and are found largely in a belt at varying depths on the hills.

Whereas the northern part of the ghats has regular horizontal strata of varying thickness separated by thin snow-white quartz layers, the southern part has amygdaloid of different depths with granite, gneiss, quartz, slate, laterite, shale, etc.

SOILS. The following are the main groups of soils along the Western Ghats (excluding the coastal belt): (1) laterites (high and low level); (2) red loam; (3) medium black soils (on flat hill tops); (4) red gravelly soils; (5) mixed red and black soils.

Red acidic soils derived from micaceous granite and gneiss cover a major part of the ghats and are sometimes found mixed with other soils. Their texture varies from sandy loam to clayey loam and the nutrient holding capacity is low. Laterite soils are more acid, relatively much poorer in nutrient content, and have a low base exchange capacity. Medium black soils are typically found on plateaux and are generally of hard clay texture. The valleys usually have deep, red, gravelly soils with good humus content (for further details see Seth & Yadav, 1960).

CLIMATE. The area under study is generally influenced by the south-west monsoon. In addition, the ghat zone in Karnataka receives the north-east monsoon during October to January. Hence the mean annual rainfall varies from 2350 mm in the north to 7450 mm in the south; normally July and August are the months which receive the maximum amount of rainfall. The mean annual temperature varies from 24°C in the north to 20°C in the south. Generally April and May are the hottest and December and January the coldest months of the year. Data on mean temperature, rainfall and length of rainy and dry seasons are presented in Table 1.

TABLE I

Climatic data for the Western Ghats

	Altitude (m)	Mean annual temp. (°C)	Mean annual rainfall (mm)	Mean daily temp. of coldest month (°C)	Absolute minimum temp. (°C)	Rainy period in months	Dry period in months
MAHARASHTRA:							
Peint (Nasik dist.)	600	23	2352	18	6	4	8
Khandala (Poona dist.)	680	24	4900	20	9	4	8
Mahabaleshwar (Satara dist.)	1420	20	6226	18·6	6	4–5	7–8
Amboli (Ratnagiri dist.)	664	21	7446	19·5	6	5–6	6–7
GOA:							
Sanguem	100	26·5	4100	24	14·8	5–6	6–7
KARNATAKA:							
Agumbe (Shimoga dist.)	700	21	6602	19·5	9	7–8	4–5
Bhagmandala (Coorg dist.)	900	20·2	6032	19	9	7–8	4–5

Vegetational Observations

The main types of forest vegetation observed from north to south along the Western Ghats can be summarized as shown below.

		Lower slopes (300–800 m alt.)	Higher slopes and tops (800–1500 m alt.)
1.	Surguna–Peint–Harsul ranges	Deciduous	Stunted semi-evergreen
2.	Junnar–Bhimashankar Ghats	Deciduous	Stunted semi-evergreen
3.	Khandala–Sakarpathar Ghats	Deciduous	Stunted semi-evergreen
4.	Mahabaleshwar	Deciduous	Stunted semi-evergreen
5.	Phonda–Ambolighat	Deciduous	Tall semi-evergreen and evergreen
6.	Goa Ghats	Deciduous	Tall semi-evergreen and evergreen
7.	Agumbe Ghats	Tall evergreen	Evergreen and sholas*
8.	Bhagmandala–Mercara Ghats	Tall evergreen	Evergreen and sholas*

* Sholas are ravines harbouring patches of stunted, evergreen trees and shrubs.

The vegetation shows a north to south variation which can be closely correlated with climate. Occurrence of evergreen forest vegetation is dependent on humid conditions and in the more arid climate of the northern Sahyadris such forest only occurs as low, stunted, semi-evergreen patches isolated along the upper slopes of the ghats and surrounded by the deciduous forest of the lower slopes. As one goes southwards along the Sahyadris the area of semi-evergreen forest increases, forming a wider band on the upper slopes, culminating in the tropical, low, semi-evergreen canopy of the Mahabaleshwar Ghats. This steady change correlates with the increase in rainfall and decrease in the length of the dry period.

The species composition of the semi-evergreen/evergreen forest also becomes richer as one goes south. Typical giant trees of the evergreen forests such as species of *Calophyllum*, *Hopea*, *Canarium*, *Mammea* and several others begin to appear along the Phonda–Ambolighat and Goa Ghats: at first occurring in small numbers mixed with deciduous species which form the majority of the stand.

The Phonda–Ambolighat and Goa Ghats are the northern limit of completely evergreen vegetation on the Western Ghats. Further south, in the Agumbe Ghat area and in the Coorg Ghats, typical evergreen forests of entirely different floristic pattern predominate, with only a very few deciduous species occurring on the lower slopes—and these generally associated with biotic interference. It is, however, not uncommon to find patches of mixed deciduous vegetation in areas of true evergreen forest and this is due (a) to the presence of soils which have very low water retaining capacity because of coarse texture, or (b) to previous forest clearance having opened up the habitat and made conditions more extreme. Occurrence of such pockets of deciduous forest is more marked along the Western Ghats of Karnataka State, where the rainfall is confined to a relatively short period, than in the more humid evergreen forests of Eastern India.

Thus the vegetation of the Western Ghats shows the typically tropical relationship to climate: the more humid the climate, the more luxuriant is the vegetation and the poorer the soils—all other conditions being equal. Such a paradox of luxuriant tropical vegetation occurring on leached and impoverished soils is due to the immense amount of minerals in circulation within the closed cycle of nutrients and immobilized within the vegetation itself. Thus almost the whole nutrient capital is contained in the living plant mass of the forest, which after death is quickly mineralised and the nutrients immediately absorbed by plant roots. No leaching of nutrients into the ground-water takes place in spite of high rainfall.

Total precipitation and length of dry season are two factors, which have to be taken into account in considering vegetation patterns. Lauer (1952) indicates that the duration of the dry season rather than the total precipitation is of decisive importance in determining the occurrence of different vegetation types in the tropics. Walter (1964) argues that this statement is not quite correct. He says that both the total rainfall and the duration of the drought are important: the former more for the drier vegetation types and the latter more for the humid forest types. His statement is vividly illustrated by his diagram showing the distinct pattern and grouping of the important forest types in India [the evergreen, semi-evergreen, deciduous (both wet and dry),

thorny scrub, and desert] when plotted in relation to yearly rainfall and the length of dry season (fig. 2). Comparison of the data given in Table 1 with fig. 2 shows that the forests of the Western Ghats in general have a much greater annual rainfall than the tropical evergreen rain forests plotted by Walter but this is usually offset by a much longer dry period.

Floristic Observations

The floristic data for the eight areas are summarized in the lists given in Table 2. For the purposes of this study species showing characteristic geographical differences in distribution are the most important and some common widespread species which occur in many of the areas are not listed, although some are mentioned below in (i).

The results of the investigation can be studied from a number of standpoints of which the following are particularly interesting: (i) patterns of widespread distribution, (ii) flora of extreme habitats, (iii) sudden changes in vegetation related to local differences in substratum, (iv) species replacement, and (v) endemism.

(i) *Patterns of widespread distribution.* A few tree species characteristic of the semi-evergreen type of forest also occur along lower slopes (300–800 m) in the Sahyadris and extend south even to the evergreen forest belt of the Karnataka Ghats. They are: *Schleichera oleosa*,* *Miliusa tomentosa*, *Pongamia pinnata*, *Trema orientalis*, *Syzygium cumini*, *Ixora bracteata*, *Xeromphis spinosa* and shrubs and climbers such as *Leea indica*, *Jasminum malabaricum*, *Tylophora dalzellii* and a few others. Other tree species like *Memecylon umbellatum*, *Carallia brachiata*, *Xantolis tomentosa*, *Olea dioica*, *Mimusops elengi*, *Mammea suriga*, *Sageraea laurifolia*, *Amoora lawii*, *Actinodaphne angustifolia* and *Ansistrocladus heyneanus* are restricted to the higher slopes above 800 m as representative components of the semi-evergreen belt of the Sahyadris but also extend to the evergreen forests of the Karnataka Ghats. Other distribution patterns also occur: some species such as *Nanothamnus sericeus* and *Brachiaria semiundulata*, extend southwards to the Nilgiri and Palni hills and others like *Indochloa clarkei* northwards to Parasnath and Mt Abu from the Sahyadris; whereas *Torenia thouarsi*, *Gastrochilus albo-lutea* and *Isachne clarkei* extend from the Karnataka Ghats towards eastern India as far as the Naga hills. *Poeciloneuron indicum* presents a peculiar trend in distribution: it begins to appear along the south Kanara belt and extends as far as the Kerala Ghats only in disjunct patches; thus it is characteristically restricted to the southern part of the Western Ghats.

A few species exhibiting luxuriant growth in the evergreen forests of the Karnataka Ghats also occur under identical climatic conditions in the tropical rain forests of Assam and its surroundings. A few typical examples of giant tree species in this category are: *Acrocarpus fraxinifolius*, *Aglaia roxburghiana*, *Aphanamixis polystachya*, *Artocarpus lakoocha*, *Bischofia javanica*, *Toona ciliata*, *Dipterocarpus turbinatus*, *Dysoxylum binectariferum*, *Michelia champaca* and *Tetrameles nudiflora*. Similarly, there are several genera common to both the evergreen forests of the Western Ghats and Eastern

* A full list of species mentioned with authorities and families is given in the appendix.

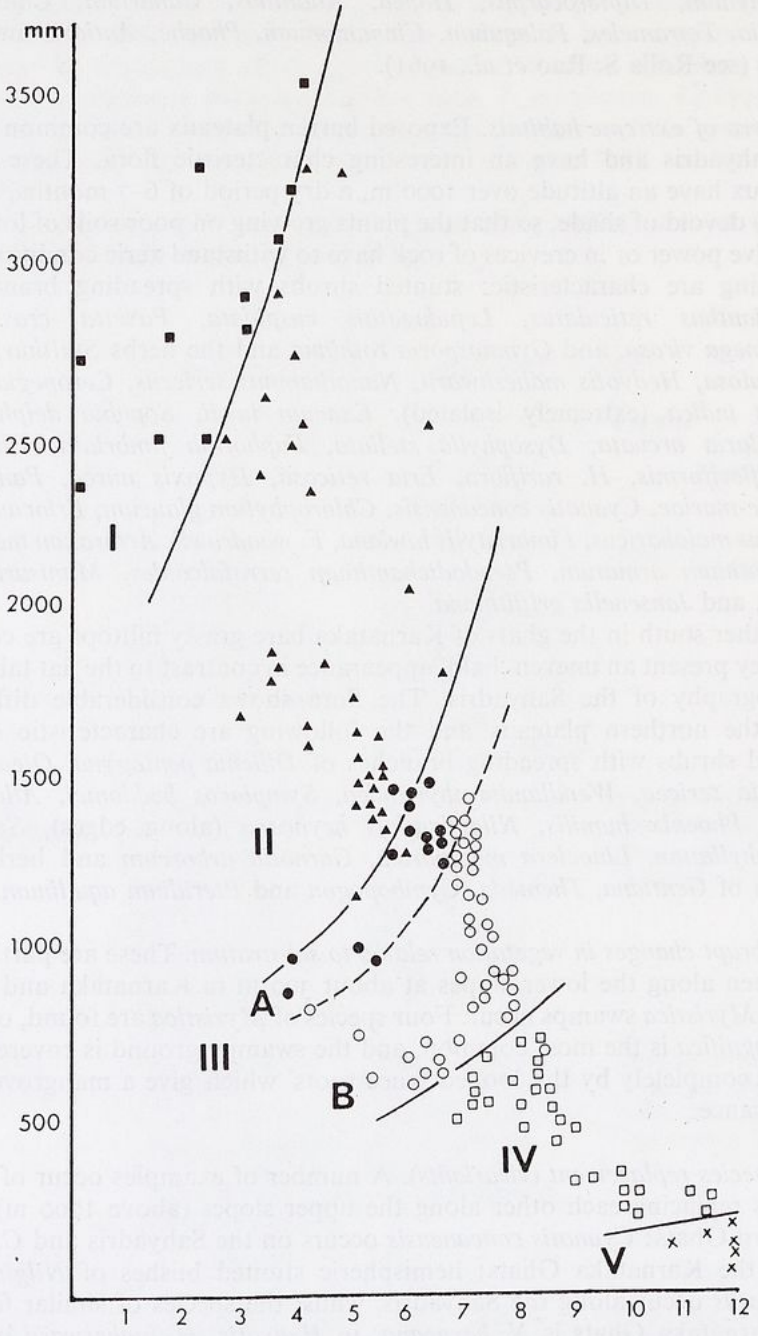

FIG. 2. The relation of forest types in India (following Champion's classification) to yearly rainfall in mm (vertical axis), and length of dry season in months (horizontal axis). I, Tropical evergreen rain forest; II, Tropical semi-evergreen rain forest; III, Deciduous (Monsoon) forest (A, wet, and B, dry); IV, Thorny scrub (incl. grasslands); V, Desert. [After H. Walter (1971), Fig. 123, p. 212, reproduced by permission of Oliver & Boyd, Edinburgh].

India although a considerable variation in species occurs; examples are *Calophyllum*, *Dipterocarpus*, *Hopea*, *Ailanthus*, *Canarium*, *Chickrassia*, *Carallia*, *Tetrameles*, *Palaquium*, *Cinnamomum*, *Phoebe*, *Antiaris* and *Artocarpus* (see Rolla S. Rao *et al.*, 1961).

(ii) *Flora of extreme habitats.* Exposed barren plateaux are common only in the Sahyadris and have an interesting characteristic flora. These treeless plateaux have an altitude over 1000 m, a dry period of 6–7 months, and are mostly devoid of shade, so that the plants growing on poor soils of low water retentive power or in crevices of rock have to withstand xeric conditions. The following are characteristic: stunted shrubs with spreading branches of *Nilgirianthus reticulatus*, *Lepidagathis cuspidata*, *Pavetta crassicaulis*, *Securinega virosa*, and *Gymnosporia rothiana* and the herbs *Smithia hirsuta*, *S. setulosa*, *Hedyotis maheshwarii*, *Nanothamnus sericeus*, *Ceropegia rollae*, *Frerea indica* (extremely isolated), *Exacum lawii*, *Sopubia delphinifolia*, *Utricularia arcuata*, *Dysophylla stellata*, *Euphorbia fimbriata*, *Habenaria grandifloriformis*, *H. rariflora*, *Eria reticosa*, *Hypoxis aurea*, *Pancratium sanctae-mariae*, *Cyanotis concanensis*, *Chlorophytum glaucum*, *Eriocaulon* sp., *Cyperus malabaricus*, *Fimbristylis lawiana*, *F. woodrowii*, *Arthraxon meeboldii*, *Dichanthium armatum*, *Pseudodichanthium serrafalcoides*, *Manisuris forficulata*, and *Jansenella griffithiana*.

Further south in the ghats of Karnataka bare grassy hilltops are common but they present an uneven 'bald' appearance in contrast to the flat table-land physiography of the Sahyadris. The flora shows considerable differences from the northern plateaux and the following are characteristic species: stunted shrubs with spreading branches of *Dillenia pentagyna*, *Olea dioica*, *Atylosia sericea*, *Wendlandia thyrsoidea*, *Symplocos beddomei*, *Allophyllus cobbe*, *Phoenix humilis*, *Nilgirianthus heyneana* (along edges), *Syzygium caryophyllatum*, *Linociera malabarica*, *Garnotia arboreum* and herbaceous species of *Gentiana*, *Themeda*, *Cymbopogon* and *Pteridium aquilinum*.

(iii) *Abrupt changes in vegetation related to substratum.* These are particularly well seen along the lower slopes at about 300 m in Karnataka and Kerala where *Myristica* swamps occur. Four species of *Myristica* are found, of which *M. magnifica* is the most common, and the swampy ground is covered more or less completely by the looped 'knee roots' which give a mangrove forest appearance.

(iv) *Species replacement* (*vicariants*). A number of examples occur of related species replacing each other along the upper slopes (above 1000 m) of the Western Ghats: *Cyanotis concanensis* occurs on the Sahyadris and *C. obtusa* along the Karnataka Ghats; hemispheric stunted bushes of *Nilgirianthus reticulatus* occur along the Sahyadris, whilst the species of similar form on the Karnataka Ghats is *N. heyneana*; in *Hedyotis*, *H. maheswarii* is found on the Sahyadris and *H. stocksii* along the Karnataka Ghats.

(v) *Endemism.* The Western Ghats have a considerable endemic flora consisting of more than 100 species. A few interesting examples are: *Frerea indica*, *Senecio hewrensis*, *Iphigenia stellata*, *Dicanthium panchganiense*, *D. maccannii*, *Pancratium sanctae-mariae*, *Arisaema caudatum*, *Bhidea burnsiana*,

Belosynapsis kewensis, *Euphorbia erythroclada*, *Habenaria* spp. and a few genera of grasses. In addition about 25 species and one genus have been found in the Western Ghats and described as new during the last ten years. Among these may be mentioned *Alysicarpus vasavadae*, *Smithia agharkari*, *Leucas deodikarii*, *Ischaemum raizadae*, *Isachne borii*, *I. mysorensis*, *Chlorophytum bharuchae*, *Tarenna agumbensis*, two species of *Arthraxon*, four species each of *Ceropegia* and *Manisuris*, and the genus *Seshagiria* with one species, *S. sahyadrica*.

Such a high degree of endemism suggests that evolution must be very active in many areas of the Western Ghats.

TABLE 2

Characteristic Species of the Study Areas

A. DECIDUOUS FOREST OF LOWER SLOPES (300–800 m)

	Trees	Shrubs (incl. climbers)	Herbs
1. Surguna-Peint-Harsul.	*Tectona grandis* *Sterculia urens* *Garuga pinnata* *Anogeissus latifolia* *Terminalia crenulata* *Bombax ceiba* *Lagerstroemia parviflora* *Wrightia tinctoria*	*Holarrhena antidysenterica* *Carissa congesta* *Celastrus paniculata* *Embelia tsjariamcottam* *Woodfordia fruticosa* *Combretum ovalifolium* *Acacia torta* *Jasminum malabaricum*	*Crotalaria nana* *Triumfetta annua*
2. Junnar-Bhimashankar	*Dillenia pentagyna* *Cassine glauca* *Bridelia squamosa* *Cassia fistula* *Flacourtia indica* *Sterculia guttata* *Firmiana colorata* *Heterophragma quadriloculare*	*Colebrookea oppositifolia* *Cissus woodrowii* *Euphorbia neriifolia* *Acacia chundra* *Mimosa hamata* *Zizyphus rugosa* *Melanthesa retusa*	*Sida rhombifolia* *Monsonia senegalensis* *Senecio hewrensis* *Arisaema murrayi*
3. Khandala-Sakarpathar	*Hymenodictyon excelsum* *Holoptelea integrifolia* *Casearia graveolens* *Dalbergia latifolia* *Dalbergia lanceolaria* *Gmelina arborea*	*Butea parviflora* *Entada pursaetha* *Calycopteris floribunda* *Leea edgeworthii* *Mucuna prurita* *Vernonia divergens*	*Heracleum concanense* *Pimpinella adscendens* *Bidens biternata* *Elephantopus scaber*
4. Mahabaleshwar	———	———	———
5. Phonda-Ambolighat	*Bauhinia racemosa* *B. malabarica* *Albizzia odoratissima* *Meyna laxiflora* *Mitragyna parvifolia* *Stereospermum personatum* *Gmelina arborea*	*Gymnosporia rothiana* *Dendrolobium triangulare* *Helicteres isora* *Pavetta crassicaulis* *Mackenziea integrifolia* *Ventilago madraspatana* *Zizyphus oenoplia* *Teramnus labialis*	*Urena lobata* *Atylosia lineata* *Eranthemum roseum* *Anisomeles heyneana* *Pogostemon purpurescens* *Costus speciosus* *Crotalaria albida*

A. DECIDUOUS FOREST OF LOWER SLOPES (300–800 m) (cont.)

	Trees	Shrubs (incl. climbers)	Herbs
6. Goa Ghats	*Miliusa tomentosa* *Zizyphus mauritiana* *Lannea coromandelica* *Albizzia lebbeck* *Terminalia paniculata* *Madhuca longifolia* *Strychnos nuxvomica*	*Capparis zeylanica* *Grewia serrulata* *Desmodium gangeticum* *Flemingia strobilifera* *Lasiosiphon eriocephalus* *Melanthesa retusa* *Boehmeria scabrella* *Xeromphis spinosa*	*Polycarpaea spicata* *Salomonia ciliata* *Sida acuta* *Corchorus acutangulus* *Impatiens kleinii* *Blumea membranacea* *Exacum bicolor*

B. SEMI-EVERGREEN FOREST OF UPPER SLOPES (800–1500 m)

1. Surguna-Peint-Harsul	*Syzygium cumini* *Xeromphis spinosa* *Terminalia chebula* *Schleichera oleosa* *Ficus racemosa*	*Carvia callosa* *Pavetta crassicaulis* *Securinega virosa* *Acacia pennata*	*Fleurya interrupta* *Smithia bigemina* *Pouzolzia zeylanica*
2. Junnar-Bhimashankar	*Atlantia racemosa* *Olea dioica* *Xantolis tomentosa* *Actinodaphne angustifolia* *Memecylon umbellatum* *Diospyros montana* *Pittosporum floribundum*	*Murraya paniculata* *Diploclisia glaucescens* *Thelepaepale ixiocephala* *Capparis longispina* *Allophyllus serratus*	*Smithia hirsuta* *Senecio grahami* *Conyza leucantha*
3. Khandala-Sakarpathar	*Segeraea laurifolia* *Flacourtia montana* *Mammea suriga* *Aphanamyxis polystachya* *Mimusops elengi* *Garcinia indica* *Antiaris toxicaria* *Celtis cinnamomea*	*Ventilago bombaiensis* *Mackenziea integrifolia* *Nilgirianthus reticulatus* *Osyris wightiana* *Elaeagnus conferta* *Hiptage benghalensis*	*Delphinium dasycaulon* *Impatiens* sp. *Pimpinella multiradiata* *Peucedanum grande* *Anotis lancifolia*
4. Mahabaleshwar	*Memecylon talbotianum* *Symplocos beddomei* *Ficus virens* *F. rumphii* *Cinnamomum* sp. *Litsea* sp. *Artocarpus hirsuta* *Alseodaphne semicarpifolia*	*Ligustrum perrottetii* *Rauvolfia densiflora* *Scutia circumscissa* *Wagatea spicata* *Embelia ribes*	*Cardamine trichocarpa* *Impatiens* sp. *Anotis calycina* *Gynura cusimbua* *Arisaema caudatum* *Dichanthium* sp. *Dendrobium* sp. *Aerides* sp.

5. Phonda-Ambolighat	*Dysoxylon binectariferum*	*Decaschistia triloba*	*Flemingia congesta*
	Garcinia talbotii	*Grewia ritchiei*	*Impatiens* sp.
	Nothapodytes foetida	*Murraya* sp.	*Adenostemma lavenia*
	Maba nigrescens	*Ochna squarrosa*	*Nilgirianthus lupulinus*
	Diospyros candolleana	*Lapisanthes tetraphylla*	*Leucas ciliata*
	Calophyllum elatum	*Connarus wightii*	
	Holigarna arnottiana	*Turrea villosa*	
	Hydnocarpus wightiana	*Syzygium phillyraeoides*	
	Syzygium caryophyllatum	*Salacia chinensis*	
6. Goa Ghats	*Hydnocarpus laurifolia*	*Capparis baducca*	*Angiopteris evecta*
	Garcinia indica	*Microcos paniculata*	*Lygodium flexuosum*
	Hopea wightiana	*Psychotria dalzellii*	*Pteris vittata*
	Canarium strictum	*Paramignya monophylla*	*Thelypteris setigera*
	Euphoria longana	*Salacia oblonga*	*Waltheria indica*
	Nothopegia dalzellii	*Ixora coccinea*	*Naregamia alata*
	Syzygium hemisphericum	*Cayratia* sp.	*Hedyotis auricularia*
	Aporosa lindleyana	*Kedrostis rostrata*	
	Artocarpus heterophyllus	*Vitex trifolia*	

C. EVERGREEN FOREST, UPPER AND LOWER SLOPES (300–1500 m)

7. Agumbe Ghats	*Poeciloneuron indicum*	*Lansium anamallayanum*	*Impatiens* sp.
	Dipterocarpus indicus	*Humboldtia brunonis*	*Knoxia wightiana*
	Vateria indica	*Polyalthia coffeoides*	*Argostemma courtallense*
	Mesua ferrea	*Unona pannosa*	*Mycetia acuminata*
	Elaeocarpus oblongus	*Webera corymbosa*	*Neurocalyx wightii*
	Hopea parviflora	*Strobilanthes* sp.	
	Dysoxylum malabaricum	*Calamus* sp.	*Vernonia ornata*
	Palaquium ellipticum	*Arenga wightii*	*Belosynapsis vivipara*
	Calophyllum elatum	*Pinanga dicksonii*	*Miquelia dentata*
	Persea macrantha	*Pandanus tectorius*	*Adenia palmata*
	Lophopetalum wightianum	*Ochlandra travancorica*	*Cassytha capillaris*
	Actinodaphne hirsuta	*Oxytenanthera nigrociliata*	
	Chrysophyllum roxburghii		
	Euphoria longana		
	Memecylon angustifolium		
8. Bhagmandala-Mercara Ghats	*Dipterocarpus turbinatus*	*Olea dioica*	*Elettaria cardamomum*
	Calophyllum apetalum	*Vepris bilocularis*	*Curcuma* sp.
	Knema attenuata	*Hugonia bellii*	*Dendrobium* sp.
	Acrocarpus fraxinifolius	*Adenia palmata*	*Oberonia* sp.
	Elaeocarpus tuberculatus	*Gardneria ovata*	*Aerides sp.*
	Xanthophyllum flavescens	*Calamus* sp.	*Acampe wightiana*
	Cinnamomum zeylanicum	*Oxytenanthera* sp.	*Pleopeltis membranacea*
	Carallia brachiata		*Drymaria quercifolia*
	Albizzia chinensis		*Osmunda regalis*

Selected Bibliography

ARORA, R. K. (1960a). Climatic climax along the Western Ghats. *Indian Forester* 86:435–439.

——(1960b). The Botany of Coorg forests. I. *Proc. Nat. Acad. Sci. India (Allahabad)* Sect. B. 30:289–305.

——(1961). The forests of North Kanara District: I—Scrubs. *J. Indian Bot. Soc.* 40:187–200.

——(1963). The forests of North Kanara District: III—Evergreen Type. *J. Indian Bot. Soc.* 42:38–60.

——(1964a). The Botany of Coorg forests. II. *Proc. Nat. Acad. Sci. India (Allahabad)* Sect. B. 34:100–112.

——(1964b). Vegetation in relation to climate and soil—A correlation of factors for North Kanara forests. *l.c.* 34:361–368.

——(1965). Ecological notes on the vegetation of Coorg District, Western Ghats. *Indian Forester* 91:722–742.

ASHTON, P. S. (1965). Some problems arising in the sampling of mixed rain forest communities for floristic studies. *Symposium on ecological research in humid tropics vegetation.* (Sarawak, 1963, UNESCO): 235–240.

BHARUCHA, F. R. (1956). Vegetation types of the humid tropics and their sub-divisions including methods of study. *Study of Tropical Vegetation: Proceedings of Kandy Symposium:* 204.

CHAMPION, H. G. (1936). A preliminary survey of the Forest types of India and Burma. *Indian Forest Rec. Bot.* 1, no. 1.

CHERIAN, P. J. & PATASKAR, R. D. (1969). Studies on the vegetation of Surgana–Harsul ranges of the Sahyadries, Nasik District, Maharashtra. *Bull. Bot. Surv. India.* 11:381–397.

GREIG-SMITH, P. (1965). Notes on the quantitative description of humid tropical forest. *Symposium on ecological research in humid tropics vegetation.* (Sarawak, 1963, UNESCO): 227–234.

KADAMBI, K. (1939). The montane evergreen forest, Bisale Region. *Indian Forester* 65:189–201.

——(1941). The evergreen ghat rain forest; Agumbe-Kilandur zone. *l.c.* 67: 184–203.

——(1950a). Evergreen, montane forests of the Western Ghats of Hassan District, Mysore State. *l.c.* 76:18–30.

——(1950b). *Op. cit., l.c.* 76:121–132.

LAUER, W. (1952). Humide und aride Jahreszeiten in Afrika und Sudamerika und ihre Beziehungen zu den Vegetations Qurteln. *Bonner Geogr. Abh.* 9.

PURI, G. S. & MAHAJAN, S. D. (1960). The study of the evergreen vegetation of Mahabaleshwar area. *Bull. Bot. Surv. India* 2:109–137.

QURESHI, I. M. (1965a). Tropical rain forests of India and their silviculture and ecological aspects. *Symposium on ecological research in humid tropics vegetation.* (Sarawak, 1963, UNESCO): 120–136.

——(1965b). The need for standardisation of phyto-sociological and physico-ecological methods in ecological research. *l.c.*: 262–270.

REDDY, B. V. (1968). *The Flora and Vegetation of Sakarpathar–Ambavane region on the Western ghats of India, Poona Dist., Maharashtra State.* (MS.*).

* All MSS. cited are lodged as bound volumes in the Library of the Western Circle, Botanical Survey of India, Poona.

RICHARDS, P. W. (1957). *Tropical rain forest.* Cambridge University Press, London.

ROLLA, S. RAO (in press). Flora of Goa, Diu, Daman and Nagarhaveli. *Rec. Bot. Surv. India.* 21(2).

——& BILLORE, K. V. (1972). *Flora of Thana Dist., Maharashtra State.* (MS.*).

——& HEMADRI, K. (1970). *Flora of Junnar ghats and surroundings, Poona Dist., Maharashtra State.* (MS.*).

——& KULKARNI, B. G. (1967). The Phonda–Ambolighat range of Ratnagiri District, Maharashtra State—An interesting zone of phytogeographical significance. *Proc. Indian Sci. Cong. Botany Section.*

——, WADHWA, B. M. & ANSARI, M. Y. (1961). Comparative studies on the distribution of some useful trees of tropical evergreen forests in the Western and Eastern parts of India. *Indian Forester* 87:220–241.

SANTAPAU, H. (1967). The Flora of Khandala on the Western Ghats of India. *Rec. Bot. Surv. India* 16, No. 1 (3rd ed.).

SETH, S. K. & YADAV, J. S. P. (1960). Soils of the tropical moist evergreen forests of India: 1—soils of the Western Ghats. *Indian Forester* 86:406–407.

SUNDARARAGHAVAN, R. (1971). *The Flora and vegetation of Agumbe and surroundings of Shimoga Distt., Karnataka.* (MS.*).

STEENIS, C. G. G. J. (1956). Rejuvenation as a factor for judging the status of vegetation types: the biological nomad theory. *Study of Tropical Vegetation: Proceedings of Kandy Symposium:* 212–215.

VINCENT, A. J. (1965). Tropical evergreen rain forest ecology. *Symposium on ecological research in humid tropics vegetation.* (Sarawak, 1963, UNESCO): 241–248.

WALTER, H. (1964a). Die Vegetation der Erde in oko-physiologischen Betrachtung. Band I. Die tropischen und subtropischen Zonen, (with a contribution by) H. Flohn. (3rd ed.), Gustav Fischer: Jena.

——(1964b). The role of ecology in the development of tropical and subtropical regions. *Proc.* X *Int. Bot. Congress:* 69–80.

——(1971). *Ecology of Tropical and Subtropical Vegetation* (English translation of 1964a). Oliver & Boyd. Edinburgh.

WEBB, L. J. (1965). The influence of soil parent materials on the nature and distribution of rain forests in South Queensland. *Symposium on ecological research in humid tropics vegetation.* (Sarawak, 1963, UNESCO): 3–14.

APPENDIX

Authors and families of species mentioned in the text.

Acacia chundra (Roxb.) Willd., *Leg./Mim.*
A. pennata (L.) Willd.
A. torta (Roxb.) Craib
Acampe wightiana Lindl., *Orch.*
Acrocarpus fraxinifolius Wt., *Leg./Mim.*
Actinodaphne angustifolia Nees, *Laur.*
A. hirsuta Hook. f.
Adenia palmata Engl., *Passif.*
Adenostemma lavenia (L.) Ktze., *Caryoph.*
Aerides sp., *Orch.*
Aglaia roxburghiana Miq., *Meli.*
Albizzia chinensis (Orb.) Merr., *Leg./Mim.*
A. lebbeck (L.) Benth.
A. odoratissima (L.f.) Benth.
Allophyllus cobbe Bl., *Sapind.*
A. serratus (Roxb.) Radlk.

* All MSS. cited are lodged as bound volumes in the Library of the Western Circle, Botanical Survey of India, Poona.

Alseodaphne semicarpifolia Nees, *Laur.*
Alysicarpus vasavadae Hemadri, *Leg./Pap.*
Amoora lawii (Wt.) Bedd., *Meli.*
Angiopteris evecta (Forst.) Hoffm., *Aspid.*
Anisomeles heyneana Benth., *Lab.*
Anogeissus latifolia Bedd., *Combret.*
Anotis calycina Wall., *Rub.*
A. lancifolia (Dalz.) Hook. f.
Ansistrocladus heyneanus [Wall. ex] Graham
Antiaris toxicaris (Pers.) Leschen., *Mor.*
Aphanamixis polystachya (Wall.) Parker, *Meli.*
Aporosa lindleyana Baill., *Euph.*
Arenga wightii Griff., *Palm.*
Argostemma courtallense Arn., *Rub.*
Arisaema caudatum Engl., *Arac.*
A. murrayi (Graham) Hook.
Arthraxon meeboldii Stapf, *Gram.*
Artocarpus heterophyllus Lam., *Mor.*
A. hirsuta Lam.
A. lakoocha Roxb.
Atlantia racemosa Wt. & Arn., *Rut.*
Atylosia lineata Wt. & Arn., *Leg./Pap.*
A. sericea Benth.

Barleria prattensis Santapau, *Acanth.*
B. racemosa Lam.
Bauhinia malabarica Roxb., *Leg./Caes.*
Belosynapsis kewensis Hassk., *Commel.*
B. vivipara C.E.C. Fischer
Bhidea burnsiana Bor, *Gram.*
Bidens biternata (Lour.) Merr. & Sherff, *Comp.*
Bischofia javanica Bl., *Euph.*
Blumea membranacea DC., *Comp.*
Boehmeria scabrella (Roxb.) Gaud., *Urtic.*
Bombax ceiba L., *Bombac.*
Brachiaria semiundulata (Hochst. ex A. Rich.) Stapf, *Gram.*
Bridelia squamosa Gehrm., *Euph.*
Butea parviflora Roxb., *Leg./Pap.*

Calamus sp., *Palm.*
Calophyllum apetalum Willd., *Gutt.*
C. elatum Bedd.
Calycopteris floribunda (Roxb.) Lam., *Combret.*
Canarium strictum Roxb., *Burs.*
Capparis baducca L., *Capp.*
C. longispina Hook. f. & Thoms.
C. zeylanica L.
Carallia brachiata (Lour.) Merr., *Rhizoph.*
Cardamine trichocarpa [Hochst. ex] Rich., *Cruc.*
Carissa congesta Wt., *Apoc.*
Carvia callosa (Nees) Brem., *Acanth.*
Casearia graveolens Dalz., *Flac.*
Cassia fistula L., *Leg./Caes.*
Cassine glauca (Rottb.) O. Ktze., *Celast.*
Cassytha capillaris Meissn., *Laur.*
Cayratia sp., *Vit.*
Celastrus paniculata Willd., *Celast.*
Celtis cinnamomea Lindl., *Ulm.*
Ceropegia rollae Hemadri, *Asclep.*
Chlorophytum bharuchae Ansari, Raghavan & Hemadri, *Lil.*
C. glaucum Dalz.
Chrysophyllum roxburghii G. Don, *Sapot.*
Cinnamomum zeylanicum Bl., *Laur.*
Cissus woodrowii (Stapf ex Cooke) Santapau, *Vit.*
Colebrookea oppositifolia Smith, *Lab.*
Combretum ovalifolium Roxb., *Combret.*
Connarus wightii Hook. f., *Connar.*
Conyza leucantha (D. Don) Ludlow & Raven, *Comp.*
Corchorus acutangulus Lam., *Til.*
Costus speciosus (Koenig) Smith, *Zing.*
Crotalaria albida [Heyne ex] Roth, *Leg./Pap.*
C. nana Burm.
Curcuma sp., *Zing.*
Cyanotis concanensis Hassk., *Commel.*
C. obtusa Trimen
Cyperus malabaricus (C.B.Cl.) Cooke, *Cyper.*

Dalbergia lanceolaria L.f., *Leg. /Pap.*
D. latifolia Roxb.
Decaschistia triloba Wt., *Malv.*
Delphinium dasycaulon Fres., *Ran.*
Dendrobium sp., *Orch.*
Dendrolobium triangulare (Retz.) Schindler, *Leg./Pap.*
Desmodium gangeticum (L.) DC., *Leg./Pap.*
Dichanthium armatum (Hook. f.) Blatt. & McC., *Gram.*
D. maccanii Blatt.
D. panchganiense Blatt. & McC.
Dillenia pentagyna Roxb., *Dill.*
Diospyros candolleana Wt., *Eben.*
D. montana Roxb.
Diploclisia glaucescens (Bl.) Diels, *Meni.*
Dipterocarpus indicus Bedd., *Dipter.*
D. turbinatus Gaertn.
Dysophylla stellata Benth., *Lab.*
Drymaria quercifolia (L.) J. Sm., *Caryoph.*
Dysoxylum binectariferum [Hook. f. ex] Bedd., *Meli.*
D. malabaricum Bedd.

Elaeagnus conferta Roxb., *Elaeag.*
Elaeocarpus oblongus Gaertn., *Elaeoc.*
E. tuberculatus Roxb.
Elephantopus scaber L., *Comp.*
Elettaria cardamomum Maton, *Zing.*
Embelia ribes Burm., *Myrsin.*
E. tsjariamcottam A. DC.
Entada pursaetha DC., *Leg./Mim.*
Eranthemum roseum (Vahl) R. Br., *Acanth.*

Eria reticosa Wt., *Orch.*
Eriocaulon sp., *Erio.*
Euphorbia erythroclada Boiss., *Euph.*
E. fimbriata [Heyne ex] Roth
E. neriifolia L.
Euphoria longana (Lour.) Steud., *Sapind.*
Exacum bicolor Roxb., *Gent.*
E. lawii C.B.Cl.

Ficus racemosa L., *Mor.*
F. rumphii Bl.
F. virens Ait.
Fimbristylis lawiana (Boeck.) Kern., *Cyper.*
F. woodrowii C.B.Cl.
Firmiana colorata R.Br., *Sterc.*
Flacourtia indica (Burm. f.) Merr., *Flac.*
F. montana Graham
Flemingia congesta Roxb., *Leg./Pap.*
F. strobilifera R. Br.
Fleurya interrupta (L.) Gaud., *Urtic.*
Frerea indica Dalz., *Asclep.*

Garcinia indica (Du Petit-Thou.) Choiss., *Gutt.*
G. talbotii [Raiz ex] Sant.
Gardneria ovata Wall., *Logan.*
Garnotia arboreum [Stapf ex] Woodrow, *Gram.*
Garuga pinnata Roxb., *Burs.*
Gastrochilus albo-lutea Baker, *Orch.*
Gmelina arborea Roxb., *Verb.*
Grewia ritchiei Mart., *Til.*
G. serrulata DC.
Gymnosporia rothiana (Wt. & Arn.) Laws., *Celast.*
Gynura cusimbua Moore, *Comp.*

Habenaria grandifloriformis Blatt. & McC., *Orch.*
H. rariflora A. Rich.
Hedyotis auricularia L, *Rub.*
H. maheshwarii (Sant. & Merch.) Rolla Rao & Hemadri
H. stocksii (Hook. f. & Thoms.) Rolla Rao & Hemadri
Helicteres isora L., *Sterc.*
Heracleum concanense Dalz., *Umbel.*
Heterophragma quadriloculare (Roxb.) K. Schum., *Bign.*
Hiptage benghalensis (L.) Kurz., *Malpig.*
Holarrhena antidysenterica (Roth) A.DC. *Apoc.*
Holigarna arnottiana Hook. f., *Anacard.*
Holoptelea integrifolia (Roxb.) Planch., *Ulm.*
Hopea parviflora Bedd., *Dipter.*
H. wightiana Wt. & Arn.
Hugonia bellii Sedg., *Lin.*
Humboldtia brunonis Wall., *Leg./Caes.*
Hydnocarpus laurifolia (Dennst.) Sleumer, *Flac.*
H. wightiana Bl.
Hymenodictyon excelsum (Roxb.) Wall., *Rub.*
Hypoxis aurea Lour., *Hypox.*

Impatiens kleinii Wt. & Arn., *Balsam.*
Indochloa clarkei (Hackel) Bor, *Gram.*
Iphigenia stellata Blatt., *Lil.*
Isachne borii Hemadri, *Gram.*
I. clarkei Hook. f.
I. mysorensis S. Raghavan
Ischaemum raizadae Hemadri & Billore, *Gram.*
Ixora bracteata Roxb., *Rub.*
I. coccinea L.

Jansenella griffithiana (Muell.) Bor, *Gram.*
Jasminum malabaricum Wt., *Ole.*

Kedrostis rostrata (Rottl.) Cogn., *Cucurb.*
Knema attenuata (Wall.) Warb., *Myrist.*
Knoxia wightiana Wall., *Rub.*

Lagerstroemia parviflora Roxb., *Lythr.*
Lannea coromandelica (Houtt.) Merr., *Anacard.*
Lansium anamallayanum Bedd., *Meli.*
Lasiosiphon eriocephalus Decne, *Thymel.*
Leea edgeworthii Santapau, *Vit.*
L. indica (Burm.) Merr.
Lepidagathis cuspidata Nees, *Acanth.*
Lepisanthes tetraphylla (Vahl) Radlk., *Sapind.*
Leucas ciliata Benth., *Lab.*
L. deodikarii Billore & Hemadri
Ligustrum perrottetii A.DC., *Ole.*
Linociera malabarica [Wall. ex] Don, *Ole.*
Litsea sp., *Laur.*
Lophopetalum wightianum Arn., *Celast.*
Lygodium flexuosum (L). SW., *Schizae.*

Maba nigrescens Dalz., *Eben.*
Mackenziea integrifolia (Dalz.) Brem., *Acanth.*
Madhuca longifolia (Koen.) McBride, *Sapot.*
Mammea suriga (Buch.-Ham. ex Roxb.) Kosterm., *Gutt.*
Manisuris forficulata Fisch., *Gram.*
Melanthesa retusa (Dennst.) Kostel, *Euph.*
Memecylon angustifolium Wt., *Melast.*
M. talbotianum Brandis
M. umbellatum Burm.
Mesua ferrea L., *Gutt.*
Meyna laxiflora Robyns, *Rub.*
Michelia champaca L., *Mag.*
Microcos paniculata L., *Til.*
Miliusa tomentosa (Roxb.) Sinclair, *Annon.*
Mimosa hamata Willd., *Leg./Mim.*
Mimusops elengi L., *Sapot.*
Miquelia dentata Bedd., *Icac.*

Mitragyna parvifolia (Roxb.) Korth., *Rub.*
Monsonia senegalensis Grill. & Perr. *Geran.*
Mucuna prurita Hook., *Leg./Pap.*
Murraya paniculata (L.) Jack., *Rut.*
Mycetia acuminata O. Ktze., *Rub.*
Myristica magnifica Bedd., *Myrist.*

Nanothamnus sericeus Thoms., *Comp.*
Naregamia alata Wt. & Arn., *Meli.*
Neurocalyx wightii Arn., *Rub.*
Nilgirianthus heyneana (Nees) Brem., *Acanth.*
N. lupulinus (Walt.) Brem.
N. reticulatus (Stapf) Brem.
Nothapodytes foetida (Wt.) Sleumer, *Icac.*
Nothopegia dalzellii Gamble, *Anacard.*

Oberonia sp., *Orch.*
Ochlandra travancorica Gamble, *Gram.*
Ochna squarrosa L., *Ochn.*
Olea dioica Roxb., *Ole.*
Osmunda regalis L., *Osmund.*
Osyris wightiana [Wall. ex] Wt., *Santal.*
Oxytenanthera nigrociliata Munro, *Gram.*

Palaquium ellipticum Engl., *Sapot.*
Pancratium sanctae-mariae Blatt. & Hallb., *Amaryll.*
Pandanus tectorius Sol., *Pand.*
Paramignya monophylla Wt., *Rut.*
Pavetta crassicaulis Brem., *Rub.*
Persea macrantha (Nees) Kosterm., *Laur.*
Peucedanum grande C.B.Cl., *Umbel.*
Phoenix humilis Royle, *Palm.*
Pimpinella adscendens Dalz., *Umbel.*
P. multiradiata Santapau
Pinanga dicksonii Bl., *Palm.*
Pittosporum floribundum Wt. & Arn., *Pittosp.*
Pleopeltis membranacea Moore, *Polypod.*
Poeciloneuron indicum Bedd. *Gutt.*
Pogostemon purpurescens Dalz., *Lab.*
Polyalthia coffeoides Hook. f., *Annon.*
Polycarpaea spicata Wt. & Arn., *Caryoph.*
Pongamia pinnata (L.) Pierre, *Leg./Pap.*
Pouzolzia zeylanica (L.) Benn., *Urtic.*
Pseudodichanthium serrafalcoides (Cooke & Stapf) Bor, *Gram.*
Psychotria dalzellii Hook. f., *Rub.*
Pteridium aquilinum (L.) Kuhn., *Pterid.*
Pteris vittata L., *Pterid.*

Rauvolfia densiflora [Benth. ex] Hook. f. *Apoc.*

Sageraea laurifolia (Graham) Blatt., *Annon.*
Salacia chinensis L., *Celast.*
S. oblonga Wall.
Salomonia ciliata DC., *Lil.*
Schleichera oleosa (Lour.) Oken, *Sapind.*
Scutia circumscissa (L.f.) Druce, *Rhamn.*
Securinega virosa (Roxb. ex Willd.) Pax & Hoffm., *Euph.*
Senecio grahami Hook. f., *Comp.*
S. hewrensis (Dalz.) Hook. f.
Seshagiria sahyadrica Ansari & Hemadri, *Asclep.*
Sida acuta Burm., *Malv.*
S. rhombifolia L.
Smithia agharkari Hemadri, *Leg./Pap.*
S. bigemina Dalz.
S. hirsuta Dalz.
S. setulosa Dalz.
Sopubia delphinifolia G. Don, *Scroph.*
Sterculia guttata Roxb., *Sterc.*
S. urens Roxb.
Stereospermum personatum (Hassk.) Chatterjee, *Bign.*
Strobilanthes sp., *Acanth.*
Strychnos nuxvomica L., *Logan.*
Symplocos beddomei C.B.Cl., *Symploc.*
Syzygium caryophyllatum Alston, *Myrt.*
S. cumini Skeels
S. hemisphericum (Walp.) Alston
S. phillyraeoides (Trimen) Santapau

Tarenna agumbensis S. Raghavan, *Rub.*
Tectona grandis L. f., *Verb.*
Teramnus labialis (L.f.) Spr., *Leg./Pap.*
Terminalia chebula Retz., *Combret.*
T. crenulata Roth
T. paniculata Roth
Tetrameles nudiflora R. Br., *Tetramel.*
Thelepaepale ixiocephala (Benth.) Brem., *Acanth.*
Thelypteris setigera (Bl.) Ching, *Thelypt.*
Toona ciliata M. Roem, *Meli.*
Torenia thouarsii (Chaub. & Sch.) O. Ktze., *Scroph.*
Trema orientalis (L.) Bl., *Ulm.*
Triumfetta annua L., *Til.*
Turraea villosa Benn., *Meli.*
Tylophora dalzellii Hook. f., *Asclep.*

Unona pannosa Dalz., *Annon.*
Urena lobata L., *Malv.*
Utricularia arcuata Wt., *Lentib.*
Uvaria narum [Wall. ex] Bl., *Annon.*

Vateria indica L., *Dipter.*
Ventilago bombaiensis Dalz., *Rhamn.*
V. madraspatana Gaertn.
Vepris bilocularis Engl., *Rut.*
Vernonia divergens (Roxb.) Edg., *Comp.*
V. ornata Talb.
Vitex trifolia L. f., *Verb.*

Wagatea spicata Dalz., *Leg./Caes.*
Waltheria indica L., *Sterc.*
Webera corymbosa Willd., *Rub.*
Wendlandia thyrsoidea (R. & S.) Steud., *Rub.*
Woodfordia fruticosa (L.) Kurz, *Asclep.*
Wrightia tinctoria R.Br., *Apoc.*
Xanthophyllum flavescens Roxb., *Xanthop.*
Xantolis tomentosa Rafin., *Sapot.*
Xeromphis spinosa (Thunb.) Keay, *Rub.*

Zizyphus mauritiana Lam., *Rhamn.*
Z. oenoplia Mill.
Z. rugosa Lam.