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EVALUATION OF THE POPULATION REGENERATION AND INVASION STATUS OF SELECTED TREE ENDEMICS IN THE SHOLA FORESTS OF KERALA

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Abstract

In Kerala State, Southern wet temperate or Shola forests are distributed along the crest of the Western Ghats at elevations beyond 1500 m above msl. The formation is very typical beyond 1800 m altitude and the present study to evaluate the population, regeneration and invasion aspects of endemic shola tree species in the State was conducted at Eravikulam and Silent Valley, where the elevation goes beyond 1900 m above msl. At both the selected locations, six sample plots (33 m x 33 m) each were laid and data gathered on the three aspects of the study.

The arborescent flora of the shola forests sampled at Eravikulam is composed of 36 species of flowering plants. Among them, 30 are those endemic to Peninsular India, representing 83.33 per cent of the total woody angiosperm flora of the sampled area. At Silent Valley, the sampled area contained 37 woody plant species of which 27 were endemic, constituting 72.97 per cent of the total woody flowering plant taxa recorded. The arborescent floras of the two areas also contained the disjunctively distributed species *Rhododendron arboreum* var. *nilagirica*, pointing to the phytogeographic importance of the forest type.

Structurally, the population of arborescent flora of Eravikulam and Silent Valley sholas contains about 60 per cent of woody endemic plants. Regeneration of arborescent endemics with more numbers of seedlings that had crossed the mortality stage is at Eravikulam. This shows the comparatively undisturbed status of the forest type. In both the shola forest areas, woody endemic species invading the grassland were 'also noticed. At Eravikulam, *Rhododendron arboreum* var. *nilagirica* and *Symplocos foliosa* are the best examples of such endemic species and at Silent Valley *Schefflera capitata* and *Symplocos macrophylla* are the potential invaders with *Pavetta blanda* common to both areas. In fact, such species are more suitable for the regeneration of shola forests in any attempt to conserve the forest type and its plant diversity.

1. Introduction

Southern montane wet temperate forests or Tropical montane forests are more commonly designated as the 'shola' forests. The forest type occupies the upper reaches of the Western Ghats of India, typically at elevations above 1800m above msl. A compact patch of tree cover, surrounded by grasslands characterizes the forest type. Shola forests are often developed in sheltered sites like the depressions, valleys or hallows of the Ghat, where from usually rivers originate. Major climatic characteristics, closely associated with the topographic features where the shola forests exist, are frost conditions all around but not inside the tree cover and wind action almost half the year round. Also, low temperature of the shola forest areas results in physiological dryness to the plants growing there, restricting their moisture absorption capability from the topsoil which is also often frozen. Such climatic and physiographical peculiarities that prevail in the shola forest region have resulted in the selective growth and regeneration of plant species, which are also often modified in their growth patterns and morphological features. Tree species characteristic to the forest type are much stunted in habit with spreading, umbrella-shaped canopy, branches and branchlets crooked and twiggy and very often covered with several epiphytic lichens, mosses, ferns and orchids. The physiological, climatic, topographic and vegetational barriers of the shola vegetation have also resulted in very high endemism and also occurrence of certain species whose related taxa are distributed disjunctively at distant places where isoclimatic conditions prevail. According to Srivastava (1994), regeneration and establishment of seedlings is also much restricted in the shola-forests, as the forest type is not having dynamic equilibrium with the climatic conditions, which prevail in those areas.

The technical terminologies used by various authors to designate the vegetation type are the following.

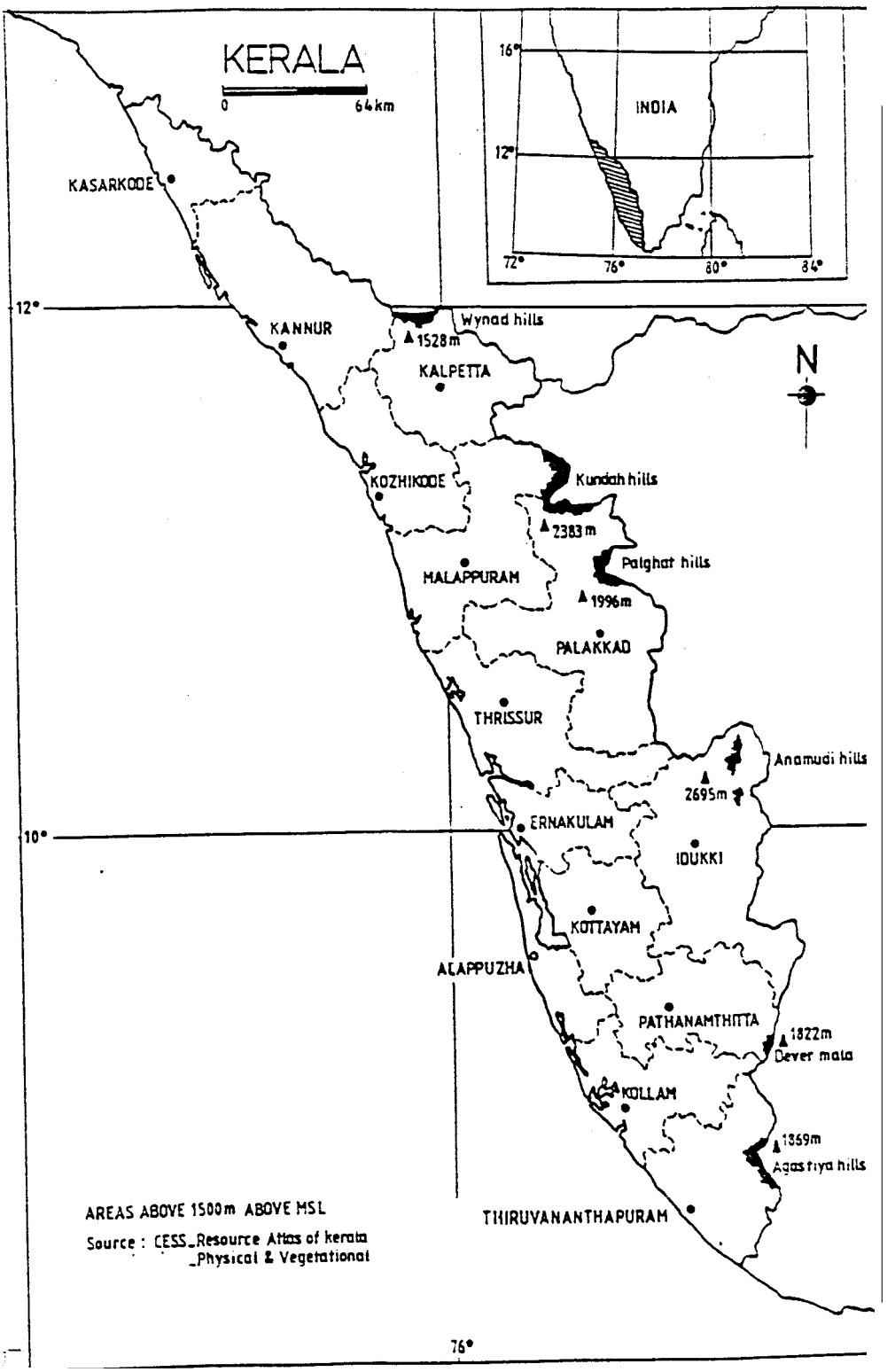
Tropical upper montane rainforests (Brutt-Davy, 1938).
Temperate rainforests in the mountain region (Schimper, 1903).
Montane temperate forests (Champion, 1936).
Montane temperate forests (Chandrashekaran, 1962).
Montane wet temperate forests (Champion and Seth, 1968).
Southern wet temperate forests (Puri, *et al.* 1989).

'Shola' is a term derived from 'Cholai' in the local language Tamil, commonly used in the Nilgiris and Pulneys, where the forest type is also common. The name 'Shola' was incorporated into the forest type terminology by Schimper (1903) for the category 'Tropical rain forests in the mountain region' of the Nilgiris in South India.

In Kerala State, shola forests is represented in Wyanad, Palakkad, Idukki, Patahnamthitta and Triruvananthapuram (Map 1) districts, where the altitude of the Western Ghats exceeds 1500 m above msl. However, typical sholas develop beyond 1800 m of elevation and according to Blasco (1971), 1900 to 2400 m is the ideal range for the forest type to become characteristic (Figs. 1, 2). In fact, the shola forests of Kerala State are virtually extensions of the forest type distributed in the Nilgiris, Pulneys and Anamalai hills of the Western Ghats of Tamil Nadu State and the approximate total area covered by the forest type in the State is between 70-80 km^2 (CESS, 1984).

The tree cover of shola forests in Kerala is roughly divisible into an upper storey, middle storey, shrubaceous layer and herbaceous cover at the ground level. The upper storey trees rarely exceed 15 m in height and is dominated by species of *Syzygium, Cinnamomum, Elaeocarpus, Schefflera* and *Litsea* with occasional occurrence of *Rhododendron arboreum* var. *nilagirica* whose all other allied species are confined to the Himalayan region. The second storey is formed of tree species which are more stunted and twisted in habit and are within a height range of 6-12 m and their branches remain fully covered by epiphytic mosses and lichens. Members of the genera *Ilex, Rapenia, Ternstroemia, Microtropis* and *Symplocos* dominate the cannopy layer. The shrubby layer is mostly dense but partly seasonal and is mainly formed of species of *Strobilanthus*, *Vaccinium, Mahonia, Ardisia, Isonandra, Glochidion,* and so on. In the sholas of Kerala, some of the shrubaceous species like *Strobilanthus*, especially when they are growing along the periferies of the tree cover, die off during summer leaving behind their dried stems which looks like a fence all around the tree patch. The ground flora of shola forests in the State, even though fairly rich in species diversity, is rather sparse in appearance and is dominated by members of the family *Urticaceae* and also ferns, with rarely few species of balsams, orchids and sedges (Figs. 5, 6).

The present study was undertaken to evaluate the population status of Peninsular Indian endemic tree species in the shola forests of Kerala and also to assess their regeneration potential. It was also envisaged in the investigation to assess the level of colonization or spreading of the endemic tree species into the surrounding grasslands as part of the natural regeneration process. As the study progressed, it was understood that large woody shrubs cannot be treated separately from



Map.1. Disribution of shola forests in Kerala State (CESS. 1984).

Fig. General view of the shola forests of Kerala.

Fig.2. Shola forests developed in the valleys and depressions of the Ghat, surrounded by grasslands.

small trees (and some of them are also typical trees in the evergreen forests), and therefore, all the arborescent species of the sampled areas are taken into account for the study.

The specific objectives of the study are the following.

a. To locate and identify the endemic arborescent species of the typical shola forests of Kerala.
b. To assess their regeneration status by sample plots method.
c. To evaluate the invasion capacity of endemic arborescent species into adjoining grasslands.

The study was undertaken in two typical shola forest areas of the State, namely Silent Valley National Park in Palakkad District and Eravikulam National Park in Idukki District. The specific locations of the study were Sispara in Silent Valley and Umaiyamalai in Eravikulam, and at both places, the altitude exceeds 1800 m above msl and the forest type is quite typical.

2. Review of literature

Since the publication of *The Flora of British India* by Hooker and others (1872-96) and *The Flora of Presidency of Madras* by Gamble and Fischer (1915-36), which included all the then known species of shola plants of South India, exhaustive account in the floristics of the forest type is rather scanty, especially for the State of Kerala. The tree flora of Bourdillon (1908) and the floristic account of Rama Rao (1914), both covering the former Travancore State, are also very poor as far as information on shola floristics is concerned. However, more recently, the publication of district or forest floras of some parts of the State like Silent Valley (Manilal, 1988), Palakkad (Vajravelu, 1990) and Nilambur (Sivarajan and Philip Mathew, 1997) had thrown some light on the plant species available in the forest type, as part of the details given for various species occurring in the District or the forest area. In none of the floras mentioned above, there is any attempt to highlight the details of endemic species in the sholas of Kerala, nor there is any information given on their regeneration aspect.

The vascular flora of Anamudi and surrounding hills in the present Idukki District of the State was prepared by Shetty and Vivekananthan (1971) covering many shola patches available in that region. Several new and less known plant taxa, mostly herbaceous in habit, were also reported by Shetty and Vivekananthan (1968, 1970, 1972, 1973) from the higher altitudes of the Western Ghats of Kerala, covering the shola forests. In addition, endemic and endangered plant species of the high ranges of Idukki district were also partly listed by Shetty and Vivekananthan (1991) and

certain details on the endangered flora of the high altitude shola-grassland formation of the State was provided by Kunhikrishnan (1991).

Ecological studies on the shola forests of Kerala is rather very few, eventhough there are several publications dealing with the forest type of the State like those of Champion (1936), Champion and Seth (1968), Ranganathan (1938), Chandrasekharan (1962) and Puri and others (1989). In fact, Aiyar's (1932) account on the sholas of Palakkad actually deals with tropical wet evergreen forests and not the true shola forest type, as evident from the descriptions and species mentioned there.

Recently, Menon (1997) had attempted to map the shola vegetation of Eravikulam National Park using remote sensing techniques and Swarupanandan and others (1998) gathered data on the floristics and community ecology of the shola forests of Eravikulam and Kanthallur, both in Idukki District. Jose and others (1994) had also generated certain amount of data on the floristics and structural composition of the sholas of Eravikulam. Karunakaran (1997), who studied the ecology of grasslands of Eravikulam National Park, gave emphasis on the grass flora of the area, as was intended by the study and Babu and others (1997) had also used remote sensed data to study the shola-grassland ecosystem at Eravikulam.

Endemism of the angiosperm flora India (Chatterjee, 1939; Ahamedulla and Nayar, 1987), Western Ghats (Ramesh and Pascal, 1993) and Kerala (Nair and Basha, 1991) is almost well documented. Also, few references are available on the shola endemic or rare plants of Nilgiris and Pulneys through the works of Balasubramanian (1972). Chandrasekharan (1973) and Shetty and Vivekananthan (1981), Abraham and Mehrotha (1982), Shetty and Vivekananthan (1991) and Vajravelu (1987) had also enumerated the endemic plants of the high altitudes of Idukki and Palakkad districts where shola forests are distributed. However, none of these references contain exhaustive details of the arborescent endemics of the shola forests of any part of the State or other parts of Peninsular India where the forest type is occurring. Recently, a popular article on the classification, functions, environment, regeneration, floristics, plant diversity and threat factors related to the forest type was prepared by Balasubramanian and Kishore Kumar (1999), more useful in getting a general idea on various aspects of the forest type in South India.

With regard to the vegetation dynamics along the shola-grassland edges in the Western Ghats, there is no remarkable contribution. Puri and others (1989) had given a list of plants, which occur

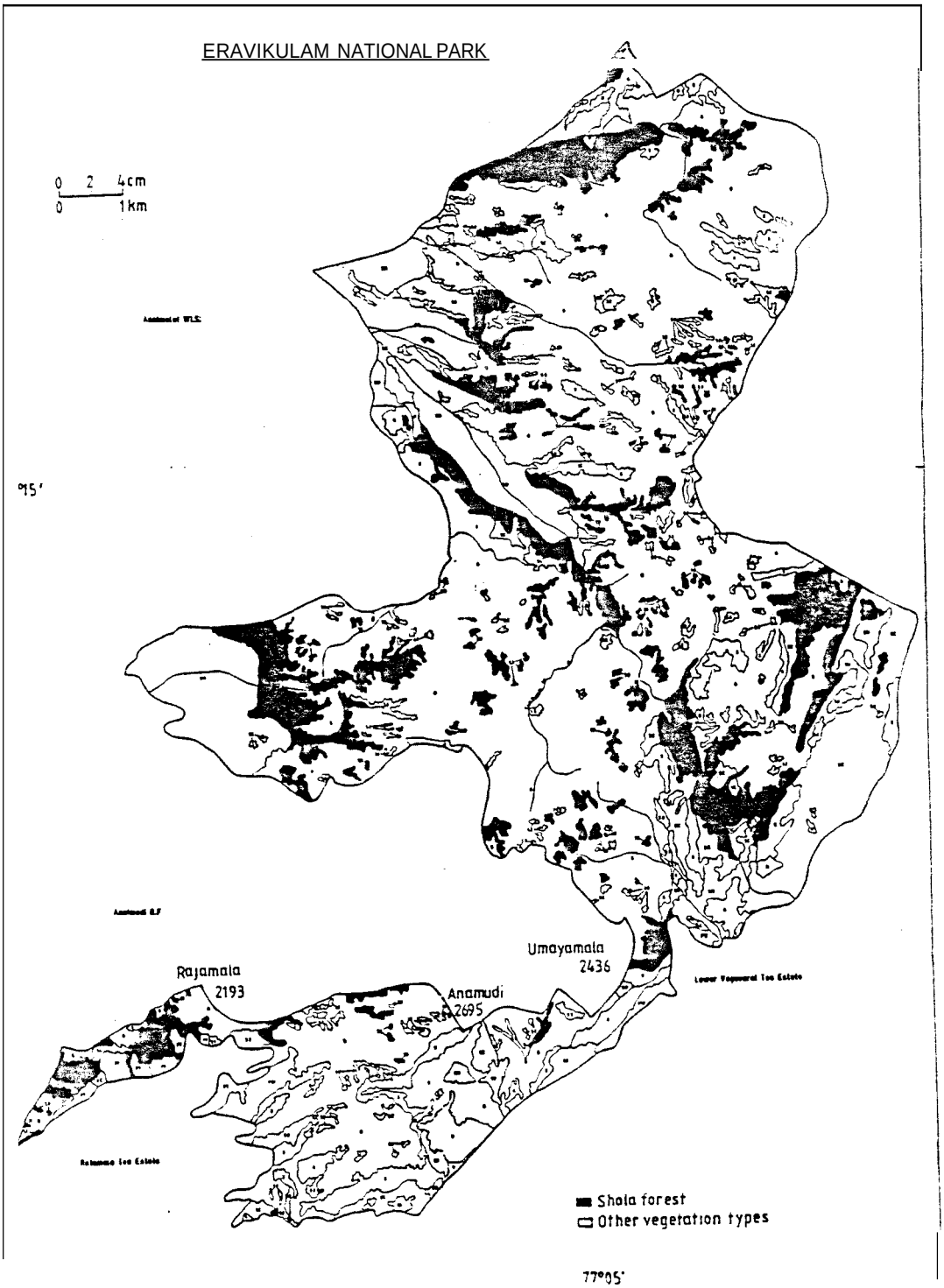
along the edges of the shola tree cover of South India in general. Also, recently, Karunakaran and others (1998) had made certain observations on plant species associations along the shola-grassland edges of Eravikulam National Park with no emphasis on arborescent endemic species, which actually dominates the forest type. However, Billing and Mark (1957) had probed into the factors that led to the persistence of treeless areas in the montane vegetation and Barucha (1958), Blasco (1971), Mehr-Homji (1965) and Nayar (1957) had tried to understand different aspects of the flora, phytogeography and ecology of the grasslands of South Indian hills. It was only Srivastava (1994) who tried to evaluate the spread of shola species into grasslands in different locations at Kodaikanal, triggered through the planting of exotics like Eucalypts and Acacias in the vicinity of the shola tree cover, in an attempt to promote this natural process. In conclusion, it may be noted here that sholas of Tamil Nadu State is better known today for their floristics, ecology and regeneration aspects, as compared to their extensions in the Kerala part of Western Ghats, and there has been no attempt in the past to evaluate the structural composition and regeneration aspects of the predominantly endemic concentrated arborescent flora of the sholas of any of the States in Peninsular India.

3. Materials and methods

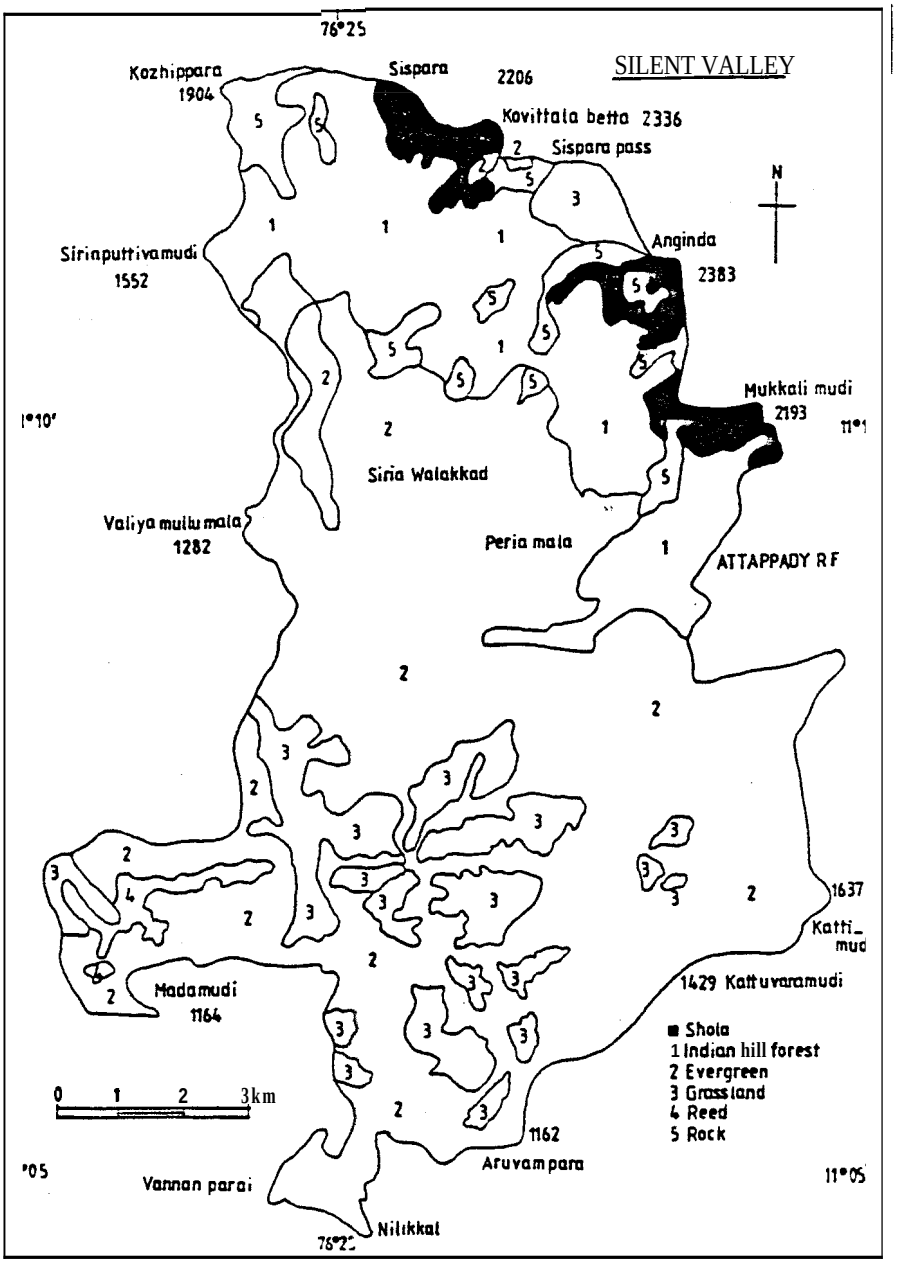
As mentioned earlier, the study was undertaken at 2 locations in the State where typical shola forest areas are available. They are Umaiyamalai sholas of Eravikulam National Park in Idukki district and Sispara sholas of Silent Valley National Park in Palghat District (Map 2,3). Both the locations are situated beyond 1800 m above msl, ie. Umayamalai at 1900-2400 m and Sispara at 2000-2400 m above msl.

To arrive at a synoptic assessment of the sholas of the two locations, false colour composite of IRS1C LISS2 imagery of March 1998 was used. This was visually interpreted and the vegetation distribution map of the two areas were prepared. The sample-plots locations were selected based on the vegetation distribution map prepared and perambulation of the two areas (Maps 2, 3). Census quadrats of 33 m x 33 m were laid in both the study areas for the collection of data on all arborescent elements of the flora in general, and the endemic woody plants in particular.

At each sampling location, three undisturbed shola tree patches and the surrounding grasslands were selected for the study. The plots laid were identified with the help of painted stakes to facilitate repeated data collection. In each shola patch, two sample plots of 33 x 33 m were laid,



Map.2. Distribution of shola forests in Eravikulam National Park.



Map.3. Distribution of shola forests in Silent Valley National Park.

one fully inside the tree cover and the other half inside the tree cover and half extending into the adjoining grassland. This was to assess the regeneration or spreading of any arborescent endemic species growing within the tree cover and regenerating in the grassland area, as part of the natural dispersal process. In total, there were 12 sample plots laid at the two locations with each location having 3 full tree plots and 3 half tree covered and half grassland plots.

3. 1. Floristic studies

The 12 sample plots, each of 33 x 33 m dimension, laid at Eravikulam and Silent Valley sholas (Figs. 3, 4, 5, 6) were intensively surveyed for all the arborescent species represented in each of them. Specimens were collected, either in the flowering or fruiting stage, and herbarium specimens prepared as per the methodology of Fosberg and Sachet (1965). Detailed field notes gathered were recorded in the herbarium specimens prepared later. The specimens were identified with the help of field notes, literature and authentically identified specimens in Herbarium, Kerala Forest Research Institute, Peechi (KFRI) and Herbarium of the Southern Circle, Botanical Survey of India, Coimbatore (MH). For all the species recorded, data on their complete range of distribution were gathered from herbarium specimens and also latest literature. Based on the distribution data, woody species (shrubs and trees) endemic to Peninsular India or any part of it like the southern Western Ghats were seggregated for detailed ecological studies. All the arborescent species in general, including the endemic woody plants, were also enumerated with up-to-date nomenclature, distribution and field notes relevant to the study.

3. 2. Ecological studies

From the sample plots laid fully with in the shola tree cover and partly inside the tree cover and partly in the adjoining grasslands, all the arborescent species were first listed. All stands above 10 cm gbh were considered as tree species and accordingly girth measurements were taken and the number of individuals of each of the species were also recorded. All the species below 10 cm gbh were accounted as saplings or seedlings, for which only height measurements were taken. Also, those seedlings below 50 cm height and those between 50 cm to 1 m height were separately considered during the data collection stage for assessment of the regeneration aspect of various arborescent endemic species. Similar data were also gathered for 50% tree cover and 50% grassland quadrats, to evaluate the invasion trend of the endemic arborescent flora of the two locations studied. In the second stage of data collection, only those woody endemic species

Fig.3. A sampled shola tree cover and adjoining grasslands at Eravikulam.

Fig.4. A shola tree cover and grasslands at Silent Valley sampled for the study.

Fig.5. A view of the interior of the shola forests at Eravikulam showing the plant diversity

Fig.6. Interior of a shola tree patch at Silent Valley showing the plant diversity

identified in the floristic study were considered for data collection. For all the arborescent endemic species in the 12 sample plots analyzed at two locations, number, girth and height data were gathered. These data were used for the analysis on regeneration and invasion aspects of woody endemics.

Primary analysis of the vegetation data gathered was carried out to obtain structural information like vegetation density, frequency, abundance, important value index, etc., as per the methodology given by Misra and Puri (1954), Phillips (1959), Misra (1969), and Muller-Dombois and Ellenberg (1974).

4. Results

The floristic, structural and regeneration data gathered from the sample plots laid in the shola forests of Eravikulam and Silent Valley are presented separately. Towards the end of the report, they are also compared and interpreted in the discussion and conclusion part. Endemic taxa in the species enumeration part are marked with astrix and the distribution of all the taxa enumerated are also given along with the other details provided. In table 1, total number of arborescent and

Table 1. Representation of arborescent and endemic species in the sholas of Eravikulam and Silent Valley.

Area	Endemic tree species	Families	Genera	Total arborescent species
1. Eravikulam	30	19	29	36
2. Silent Valley	27	22	32	37

also endemic species within that group in the sampled shola forests of Eravikulam and Silent Valley are given along with the details of the families and genera represented by those species.

4.1. Eravikulam Shola

4.1.1. Arborescent flora

From the six sample plots laid in the three shola patches of Eravikulam, a total of 36 species of arborescent plants were recorded. They belong to 19 angiosperm families and represent 29 genera. Out of them, 30 taxa are endemic to Peninsular India (marked with astrix), mostly confined to the southern Western Ghats region. The remaining 6 species are either Indo-Sri

Lankan or having more wider distribution range including Malesia or extending to China. Among the endemic trees, members of the family *Lauraceae* are maximum represented with 8 species belonging to 5 genera, followed by *Celastraceae* and *Rubiaceae* with 3 species each, representing a total of 5 genera. Families like *Elaeocarpaceae, Euphorbiaceae, Sapotaceae, Oleaceae, Berberidaceae, Meliosmaceae, Magnoliaceae, Pittosporaceae* and *Ericaceae* are represented by only one endemic tree species in the sholas of Eravikulam. All the arborescent species recorded from the shola are enumerated alphabetically by their up-to-date botanical names, brief diagnostic descriptions, world distribution and also field notes.

1. ***Actinodaphne bourdillonii*** Gamble, Kew Bull. 1925: 129. 1925 & Fl. Presid. Madras 2: 1231. 1925; Ahamed. *et* Nayar, End. Pl. Ind. Reg. 64. 1987 (**Lauraceae**).

Medium sized trees, 6-9 m high; branchlets densely tomentose. Leaves simple, elliptic to oblanceolate, acuminate at apex with very oblique nerves. Male flowers white, 8-10 together in clusters; female flowers 5-10 together in umbellate clusters in leaf scars. Berries ovoid, supported on the enlarged perianth.

Distribution: Endemic to Western Ghats of Peninsular India.

Notes: The tree rarely grows interior in the shola tree cover.

2. ***Ardisia rhomboidea*** Wt., Ic. Pl. Ind. Orient. t. 1213. 1848; Hook.f., Fl. Brit. India 3: 529. 1882; Gamble, Fl. Presid. Madras 2: 755. 1925 (**Myrsinaceae**).

Large shrubs, 1.5-2.5 m high; branchlets pale white. Leaves simple, rhomboid, punctuate with black glands below, acuminate at apex. Flowers pinkish white in axillary umbels. Berries globose or subglobose.

Distribution: Endemic to Western Ghats of Peninsular India.

Notes: Shrubs, fairly common in the shola tree cover, both interior and also along the boundaries.

3. ***Casearia coriacea*** Thw., Enum. Pl. Zeyl. 20. 1858; Hook.f., Fl. Brit. India 2: 592. 1879; Gamble, Fl. Presid. Madras 1: 525. 1921(**Flacourtiaceae**).

Trees, 3-5 m high; bark yellowish-white, smooth. Leaves simple, obovate, entire coriaceous, obtuse or shortly pointed at apex. Flowers greenish-yellow, 3-6 together in axillary fascicles. Capsules greenish, elliptic.

Distribution: India, Sri Lanka.

Notes: Fairly common inside the shola tree cover.

*

4. ***Cinnamomum macrocarpum*** Hook.f., Fl. Brit. India 5: 133. 1886; Gamble, Fl. Presid. Madras 2: 1225. 1925; Ahamed. *et* Nayar, End. Pl. Ind. Reg. 65. 1987 (**Lauraceae**).

C. iners sensu Wt., Ic. Pl. Ind. Orient. t. 122 & 130. 1839 (*non* Rein. *ex* Bl. 1826).

Trees 8-10 m high; branchlets thick, angular. Leaves simple, elliptic-oblong, entire, acuminate at apex. Flowers yellow in lax, grey-pubescent panicles. Berries ovoid-ellipsoid, covered with fleshy perianth lobes.

Distribution: Endemic to Western Ghats of Peninsular India.

Notes: Fairly common, in the interior portions of the shola tree cover.

*

5. ***Cinnamomum perrottetii*** Meisn. in DC., Prodr. 15(1): 22, 504. 1864; Hook.f., Fl. Brit. India 5: 133. 1886; Gamble, Fl. Presid. Madras 2: 1225. 1925; Ahamed. *et* Nayar, End. Pl. Ind. Reg. 65. 1987 (**Lauraceae**).

Trees, 4-6 m high; twigs densely crowded, tomentose. Leaves simple, opposite or alternate, ovate or oblong, pubescent when young, acute at apex. Flowers in 3-4 cm long in densely tomentose panicles. Berries ovoid, seated on enlarged perianth.

Distribution: Endemic to Western Ghats of Peninsular India.

Notes: Common, in the interior and also the perifery of the shola tree patches.

*

6. ***Cinnamomum sulphuratum*** Nees in Wall., Pl. Asiat. Rar. 2: 74. 1831; Hook.f., Fl. Brit. India 5: 132. 1886; Gamble, Fl. Presid. Madras 2: 1225. 1925; Kosterm., Bull. bot. Surv. India 25: 114. 1983; Ahamed. *et* Nayar, End. Pl. Ind. Reg. 65. 1987 (**Lauraceae**).

Trees, 10-15 m high; branchlets slender, angular, yellowish-tomentose. Leaves simple, elliptic to linear-elliptic or elliptic-oblong, yellowish pubescent, acute at apex. Flowers yellowish in short, tomentose panicles. Berries ellipsoid with persistent perianth lobes.

Distribution: Endemic to Western Ghats of Peninsular India.

Notes: Common, in the interior portions and also outer fringes of the shola tree cover.

*

7. ***Cinnamomum wightii*** Meisn. in DC., Prodr. 15(1): 11. 1864; Hook.f., Fl. Brit. India 5: 132. 1886; Gamble, Fl. Presid. Madras 2: 1225. 1925; Kosterm., Bull. bot. Surv. India 25: 114. 1983; Ahamed. *et* Nayar, End. Pl. Ind. Reg. 65. 1987 (**Lauraceae**).

Trees, 12-15 m high; branchlets glabrous. Leaves simple, broadly ovate-elliptic, thickly coriaceous, glaucous beneath, obtuse or acute at apex. Flowers yellow in tomentose panicles. Berries ovate-oblong with truncate perianth.

Distribution: Endemic to Western Ghats of Peninsular India.

Notes: Fairly common trees in the interior portions of the shola tree cover.

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8. ***Eleaocarpus recurvatus*** Corner, Gardn. Bull. Straits Settl. 10: 319, 325. 1939; Ahamed. *et* Nayar, End. Pl. Ind. Reg. 77. 1987 (**Elaeocarpaceae**).

Elaeocarpus ferrugineius (Wt.) Bedd., Fl. Sylvat. South. India t. 112. 1871(*nom. illeg.*); Hook.f., Fl. Brit. India 1: 406. 1874; Gamble, Fl. Presid. Madras 1: 124. 1915.

Monocera ferruginea Wt., Ic. Pl. Ind. Orient. t. 205. 1839. (*non* Jack. 1830).

Trees, 6-8 m high. Leaves simple, narrowly folded back along the margins, coriaceous, densely ferrugineous pubescent beneath, acute at apex. Flowers dull white in axillary or lateral racemes. Drupes elliptic, shiny.

Distribution: Endemic to Western Ghats of Peninsular India.

Notes: Fairly common, both along the outer fringes and also inner portions of the shola tree cover.

*

9. ***Eugenia bracteata*** (Willd.) Roxb. *ex* DC., Prodr. 3: 264. 1828; Hook.f., Fl. Brit. India 2: 502. 1879 (incl. var. *roxburghii*); Gamble, Fl. Presid. Madras 1: 484. 1919 (**Myrtaceae**).

Mytrus bracteata Willd., Sp. Pl. 2: 969. 1799.

Eugenia willdenowii Wt., Ic. Pl. Ind. Orient. t. 545. 1842.

Small trees, 3-4 m high; branchlets stout. Leaves simple, obovate, margins recurved, subcoriaceous obtusely acute at apex. Flowers white axillary, solitary or paired, fascicled, rusty-villous. Berries red, globose, crowned with persistent calyx.

Distribution: Endemic to Western Ghats of Peninsular India.

Notes: Very rare, along the outer fringes of the shola tree cover.

*

10. ***Euonymous crenulatus*** Wall. *ex* Wt. *et* Arn., Prodr. Fl. Penin. Ind. Orient. 161. 1834; Wt., Ic. Pl. Ind. Orient. t. 973. 1845; Hook.f., Fl. Brit. India 1: 608. 1875; Gamble, Fl. Presid. Madras 1: 203. 1915; Ahamed. *et* Nayar, End. Pl. Ind. Reg. 71. 1987 (**Celastraceae**).

Small trees, 5-6 m high. Leaves simple, opposite, crenulate towards apex. Flower reddish in 3-7 flowered cymes with thick pedicles and peduncles. Capsules with valves deeply obcordate.

Distribution: Endemic to Western Ghats of Peninsular India.

Notes: Rare, in the interior portions of the shola tree patch.

*

11. ***Glochidion neilgherrense*** Wt., Ic. Pl. Ind. Orient. 5: t. 29. 1852; Hook.f., Fl. Brit. India 5: 316. 1887; Gamble, Fl. Presid. Madras 2: 1307. 1925; Ahamed. *et* Nayar, End. Pl. Ind. Reg. 176. 1987 (**Euphorbiaceae**).

Small trees, 4-6 m high; branchlets almost glabrous. Leaves elliptic-oblong, oblique at base, acuminate at apex, black on drying. Flowers yellow, in axillary clusters. Capsules globose, 6 valved.

Distribution: Endemic to Western Ghats of Peninsular India.

Notes: Rare, in the interior areas of the tree cover.

*

12. ***Ilex denticulata*** Wall. *ex* Wt., Illustr. Ind. Bot. 2: t. 142. 1850; Hook. f., Fl. Brit. India 1: 600. 1875; Gamble, Fl. Presid. Madras 1: 200. 1915 (**Aquifoliaceae**).

Medium sized trees, 4-6 m high; branchlets glabrous. Leaves simple, elliptic, dentate-serrate, coriaceous, acuminate at apex. Flowers small in fascicles, 2-5 together. Drupes globose, large.

Distribution: Endemic to Western Ghats of Peninsular India.

Notes: Common in the interior portions and also fringes of the tree cover.

*

13. ***Ilex wightiana*** Wall. *ex* Wt., Ic. Pl. Ind. Orient. t. 1216. 1848; Hook. f., Fl. Brit. India 1: 603. 1875; Gamble, Fl. Presid. Madras 1: 200. 1915 (**Aquifoliaceae**).

Trees, 8-12 m high. Leaves simple, alternate, elliptic or elliptic-oblanceolate, coriaceous midrib impressed, acuminate at apex. Flowers white in sub sessile umbels. Berries red, globose.

Distribution: Endemic to Western Ghats of Peninsular India.

Notes: Common trees, habituated to the outer portions of the shola tree cover.

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14. ***Isonandra perrottetiana*** A. DC. in DC., Prodr. 8: 188. 1844; Wt. Ic. Pl. Ind. Orient. t. 1220. 1850; Hook.f., Fl. Brit. India 3: 539. 1882; Gamble, Fl. Presid. Madras 2: 761. 1923 (**Sapotaceae**).

I. candollena Wt., Ic. Pl. Ind. Orient. t. 1220. 1850; Gamble, Fl. Presid. Madras 2: 3: 539. 1882.

Shrubs, up to 3 m high; bark with milky latex. Leaves simple, oblanceolate or elliptic lanceolate, margins recurved, acute at apex. Flowers small in clusters in the axils of fallen leaves. Fruits ellipsoid.

Distribution: Endemic to Western Ghats of Peninsular India.

Notes: Fairly common, mostly confined to the interior areas of the shola tree cover.

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15. ***Lasianthus acuminatus*** Wt., Calcatta J. nat. Hist. 6: 511. 1846; Hook.f., Fl. Brit. India 3: 185. 1880 (*pro parte*); Gamble, Fl. Presid. Madras 2: 647. 1923 (**Rubiaceae**).

Shrubs, 2-3 m high. Leaves simple, elliptic or oblong, glabrous, apiculate at apex. Flowers 1-3 together, sessile. Drupes globose, glabrous.

Distribution: Endemic to Western Ghats of Peninsular India.

Notes: Fairly common, almost throughout the shola tree cover.

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16. ***Ligustrum perrottetii*** A. DC. in DC., Prodr. 8: 294. 1844; Wt., Ic. Pl. Ind. Orient. t. 1244. 1848; Hook.f., Fl. Brit. India: 3: 615. 1882; Gamble, Fl. Presid. Madras 2: 797. 1923 (**Oleaceae**).

Small trees, 4-5 m high. Leaves simple, ovate or elliptic, glabrous, acute at apex. Flowers closely packed. Drupes ellipsoid.

Distribution: Endemic to Western Ghats of Peninsular India.

Notes: Fairly common, in the interior areas of the tree cover.

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17. ***Litsea wightiana*** (Nees) Hook.f. in Benth. & Hook.f., Gen. Pl. 3: 162. 1880; Gamble, Fl. Presid. Madras 3: 1238. 1936 (**Lauraceae**).

Cylicodaphne wightiana Nees in Wall., Pl. Asiat. Rar. 2: 68. 1831; Wt., Ic. Pl. Ind. Orient. t. 1833. 1852.

Trees, 10-15 m high. Leaves simple, alternate, obovate, elliptic or lanceolate, fulvous-pubescent beneath, obtuse or rarely acute at apex. Flowers pale yellow in umbellate clusters. Berries ovoid, seated on perianth cup.

Distribution: Endemic to Western Ghats of Peninsular India.

Notes: Fairly common, distributed throughout the tree cover.

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18. ***Mahonia leschnaultii*** (Wall. *ex* Wt. *et* Arn.) Talceda, Notes Roy. bot. Gard. Edinburgh 6: 223. 1917; Gamble, Fl. Presid. Madras 1: 32. 1915 (**Berberidaceae**).

Berberis leschnaultii Wall. *ex* Wt. *et* Arn., Prodr. Fl. Penin. Ind. Orient. 16. 1834; Wt., Ic. Pl. Ind. Orient. t. 940. 1845.

Berberis nepalensis Spreng. var. *leschnaultii* (Wall. *ex* Wt. *et* Arn.) Hook. f. *et* Thoms. in Hook. f., Fl. Brit. India 1: 109. 1872.

Shrubs or small trees, 2-3.5 m high with stiff, erect, corky barked stems. Leaves compound with leaflets ovate-lanceolate and prickly along the margins. Flowers yellow in long, erect racemes. Berries purple globose, glaucous.

Distribution: Endemic to Western Ghats of Peninsular India.

Notes: Spiny plants with bright green leaves, more common along the outer fringes of the shola tree cover.

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19. ***Meliosma simplicifolia*** (Roxb.) Walp., Rep. 1: 423. 1842; Hook.f., Fl. Brit. India 2: 5. 1876; Gamble, Fl. Presid. Madras 1: 256. 1918; Bensek., Blumea 19: 462. 1971 (**Meliosmaceae**).

Millingtoma simplicifolia Roxb., Pl. Corom. 3: 50. t. 254. 1820.

Small trees, 3-5 m high; branchlets pubescent. Leaves simple, obovate or oblanceolate, acuminate at apex. Flowers very small in terminal brown tomentose panicles. Drupes globose with rugose endocarp.

Distribution: Endemic to Western Ghats of Peninsular India.

Notes: Trees, mostly confined to the interior portions of the shola tree cover.

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20. ***Michelia nilagirica*** Zenk., Pl. Ind. 21. t. 20. 1835; Wt., Ic. Pl. Ind. Orient. 938. 1845; Hook. f., Fl. Brit. India 1: 44. 1872; Gamble, Fl. Presid. Madras 1: 7. 1915 (**Magnoliaceae**).

Trees, 12-15 m high. Leaves simple, ovate-lanceolate, entire, acuminate at apex. Flowers white or yellowish, fragrant, axillary. Follicles white or cream coloured in dense clusters.

Distribution: Endemic to Western Ghats of Peninsular India.

Notes: Very rare, along the outer fringes of the shola tree cover.

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21. ***Microtropis ovalifolia*** Wt., Ic. Pl. Ind. Orient. t. 976. 1845; Hook. f., Fl. Brit. India 1: 614. 1875; Gamble, Fl. Presid. Madras 1: 207. 1918 (**Celastraceae**).

Shrubs or small trees, 3-5 m high. Leaves simple, elliptic, coriaceous, dark above, pale beneath, drying greenish-brown, obtuse at apex. Flowers in axillary or extra-axillary peduncled cymes. Capsules narrowly oblong.

Distribution: Endemic to Western Ghats of Peninsular India.

Notes: Fairly common, almost throughout the shola tree cover.

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22. ***Microtropis ramiflora*** Wt., Ic. Pl. Ind. Orient. t. 977. 1845; Hook. f., Fl. Brit. India 1: 614. 1875; Gamble, Fl. Presid. Madras 1: 207. 1918 (**Celastraceae**).

Stunted trees, 4-6 m high; branchlets purplish black. Leaves simple, broadly elliptic or obovate, coriaceous with distinct nerves, rounded or slightly emarginate at apex. Flowers small, sessile, clustered in axils of fallen or existing leaves. Capsules cylindrical when young, ellipsoid or ovoid and chanelled when mature.

Distribution: Endemic to Western Ghats of Peninsular India.

Notes: Common in the interior portions and outer fringes of the tree patch.

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23. ***Neolitsea scrobiculata*** (Meisn.) Gamble, Fl. Presid. Madras 2: 1240. 1925 (**Lauraceae**).

Litsea scorbiculata Meisn. in DC., Prodr. 15(1): 223. 1864.

L. zeylanica sensu Hook.f., Fl. Brit. India 5: 178. 1886 (*pro parte*, *non* Nees 1823)

Trees, 10-12 m high; Leaves simple, elliptic-ovate or sometimes orbiculate, glabrous above, glaucous beneath, coriaceous, shortly acute at apex. Flowers greenish in subsessile umbels. Berries obovoid to globose with cupular, entire perianth.

Distribution: Endemic to Western Ghats of Peninsular India.

Notes: Fairly common, mostly inside the tree cover but also rarely along the boarders of the tree patch.

24. ***Nothapodytes nimmoniana*** (Grah.) Mabb. in Manilal *et* Sur., Bot. Hist. Hort. Malab. 88. 1980 (**Icacinaceae**).

Premna nimmoniana Grah., Cat. Pl. Bombay 155. 1839.

Mappia foetida (Wt.) Miers, Ann. Mag. Hist. ser. 2, 9: 395. 1852; Hook.f., Fl. Brit. India 1: 589. 1875; Gamble, Fl. Presid. Madras 1: 196. 1915.

Nothapodytes foetida (Wt.) Sleum., Notibl. Bot. Gart. Berlin-Dahlem 15: 247. 1940 & Blumea 17: 232. 1969.

Small trees, 4-6 m high; bark greenish gray. Leaves simple, elliptic-ovate or elliptic, more or less puberulous and pale beneath, subentire, caudate-acuminate at apex. Flowers in terminal panicles. Drupes purple, oblong.

Distribution: India, China, Malesia.

Notes: Rare, interior and boarder trees of the shola tree cover.

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25. ***Pavetta blanda*** Bremek., Fedde Repert. Sp. Nov. Beih. 37: 94. 1934 (**Rubiaceae**).

Pavetta berviflora DC. var. *subcoriacea* Gamble, Fl. Presid. Madras 2: 633. 1921.

Shrubs 1-1.5 m high; bark greyish-white. Leaves simple, elliptic-oblong or oblanceolate, black when dry, obtuse or shortly acuminate at apex. Flowers white in dense corymbs. Berries small, fleshy.

Distribution: Endemic to Western Ghats of Peninsular India.

Notes: Common shrubs, both inside and also along the outer fringes of the shola tree cover.

26. ***Persea macrantha*** (Nees) Kosterm., Reinwardtia 6: 193. 1962 (**Lauraceae**).

Machilus macrantha Nees in Wall., Pl. As. Rar. 2: 70. 1831; Wt., Ic. Pl. Ind. Orient. t. 1824. 1852; Hook.f., Fl. Brit. India 5: 140. 1886; Gamble, Fl. Presid. Madras 2: 1227. 1925.

Trees, 10-15 m high. Leaves simple, elliptic, glaucous beneath, entire, acute at apex. Flowers greenish-white in terminal panicles. Berries globose with persistent perianth lobes.

Distribution: Peninsular India, Sri Lanka.

Notes: Common, almost throughout the shola tree cover.

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27. ***Pittosporum tetraspermum*** Wt. *et* Arn., Prodr. Fl. Penin. Ind. Orient. 154. 1834; Wt., Ic. Pl. Ind. Orient. t. 971. 1845; Hook.f., Fl. Brit. India 1: 198. 1872; Gamble, Fl. Presid. Madras 1: 55. 1915 (**Pittosporaceae**).

Shrubs or small trees, 3-5 m high. Leaves simple, elliptic or oblong, coriaceous, glabrous, acuminate at apex. Flowers white in terminal umbels. Fruits spherical.

Distribution: Endemic to Western Ghats of Peninsular India.

Notes: Rare, mostly inside the shola tree cover.

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28. ***Rapenia thwaitesii*** Mez in Engl., Pflanzenr. 9: 357. 1902; Gamble, Fl. Presid. Madras 2: 751. 1925; Ahamed. *et* Nayar, End. Pl. Ind. Reg. 87. 1987(**Myrsinaceae**).

Trees, 5-9 m high; branchlets thick. Leaves simple, obovate or lanceolate, coriaceous, rounded or emarginate at apex. Flowers violet, pedicellate in umbellate clusters. Berries globose.

Distribution: Endemic to Western Ghats of Peninsular India.

Notes: A dominant tree along the boarders of the shola tree cover.

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29. ***Rhododendron arboreum*** Smith var. ***nilagirica*** (Zenk.) Clarke in Hook. f., Fl. Brit. India 3: 466. 1882 (**Ericaceae**).

Rhododendron nilagiricum Zenk., Ann. Sci. Nat. ser. 2: 6. 1836; Gamble, Fl. Presid. Madras 2: 743. 1921.

Trees, 4-6 m high with reddish brown bark. Leaves often clustered towards branch tips, entire, elliptic or elliptic-oblong, very coriaceous, usually obtuse at both ends, recurred along the margins. Flowers crimson cloured in terminal heads. Capsules hard, woody, loculicidal.

Distribution: Endemic to Western Ghats of Peninsular India.

Notes: Very attractive trees for their flowers; common along the fringes of shola tree patches and also adjoining grasslands but rarely distributed in the interior portions of the tree cover. The tree exhibits the phenomenon of 'false dominance' in the area.

30. ***Rhodomyrtus tomentosa*** (Ait.) Hassk., Flora 25: 35. 1842; Hook.f., Fl. Brit. India 2: 469. 1878; Gamble, Fl. Presid. Madras 1: 471. 1919 (**Myrtaceae**).

Myrtus tomentosa Ait., Hort. Kew (ed.) 2: 159. 1789; Wt., Ic. Pl. Ind. Orient. t. 522. 1842.

Shrubs or small trees, 3-6 m high; bark flaking and branchlets thickly tomentose. Leaves simple, elliptic, lower surface densely velvetty, obtuse or mucronate at apex. Flowers pink in terminal or axillary cymes. Berries dark purple.

Distribution: India, Sri Lanka, Malesia, China.

Notes: Rare, both in the interior and outer fringes of the shola tree patches.

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31. ***Saprosma fragrans*** Bedd., Fl. Sylvat. South. India t. 134. 1871; Hook.f., Fl. Brit. India 3: 193. 1881; Gamble, Fl. Presid. Madras 2: 649. 1921 (**Rubiaceae**).

Serrisa fragrans (Bedd.) Bedd., Ic. Pl. Ind. Orient. t. 14. 1874.

Shrubs or small trees, 1.5-4 m high, often much branched. Leaves simple, elliptic or obovate, glabrous, abruptly acuminate at apex. Flowers white and fragrant in terminal, few flowered cymes. Drupes purple, ellipsoid, single seeded.

Distribution: Endemic to Western Ghats of Peninsular India.

Notes: Common, almost throughout the shola tree cover.

32. ***Symplocos cochinchinensis*** (Lour.) Moore, J. Bot. 52: 148. 1914 subsp. ***laurina*** (Retz.) Nooteb., Leiden Bot. ser. 1: 156. 1975 (**Symplocaceae**).

Drupatris cochinchinenis Lour., Fl. Cochin. 314. 1790.

Symplocos spicata var. *laurina* (Retz.) Wt., Illustr. Ind. Bot. t. 150. 1850; Gamble, Fl. Presid. Madras 2: 782. 1923.

Trees, 5-8 m high. Leaves simple, variable in shape, elliptic or lanceolate, crenate, serrate-acute or acuminate at apex, usually yellowish when dry. Flowers white in axillary, usually 3-6 branched spikes. Drupes ampulliform, globose, ribbed.

Distribution: India, Sri Lanka, Myanmar, Thailand, China, Japan, Malesia.

Notes: Rare, in the interior portions of the shola tree cover.

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33. ***Symplocos foliosa*** Wt., Ic. Pl. Ind. Orient. t. 1234. 1848; Hook.f., Fl. Brit. India 3: 582. 1882; Gamble, Fl. Presid. Madras 2: 783. 1925; Nooteb., Rev. Symploc. Old World 194. 1975 (**Symplocaceae**).

S. nervosa Wt., Ic. Pl. Ind. Orient. t. 1235. 1848 (*non* DC. 1844).

Trees, 10-12 m high; branchlets hairy. Leaves simple, elliptic-oblong, serrate, acuminate at apex. Flowers white, in fulvous-villous spikes. Drupes cylindric, truncate at both ends.

Distribution: Endemic to Western Ghats of Peninsular India.

Notes: Rare, mostly confined to the interior portions of the shola tree cover.

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34. ***Symplocos obtusa*** Wall. *ex* G. Don, Gen. Syst. 4: 3. 1837-38; Wt., Ic. Pl. Ind. Orient. t. 1233. 1848; Hook.f., Fl. Brit. India 3: 583. 1882; Gamble, Fl. Presid. Madras 2: 783. 1925 (**Symplocaceae**).

Trees, 3-5 m high. Leaves obovate, coriaceous, drying yellowish, obtuse at apex. Flowers white in spikes with ovate, caducous bracts. Drupes oblong, crowned by the calyx lobes.

Distribution: Endemic to Western Ghats of Peninsular India.

Notes: Fairly common in the interior portions of the shola tree cover.

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35. ***Syzygium densifolium*** Wall. *ex* Wt. *et* Arn., Prodr. Fl. Penin. Ind. Orient. 329. 1834; Ahamed. *et* Nayar, End. Pl. Ind. Reg. 108. 1987 (**Myrtaceae**).

Syzygium arnottianum Walp., Rep. 2: 180. 1843; Gamble, Fl. Presid. Madras 2: 743. 1921.

Eugenia arnottiana (Walp.) Wt., Ic. Pl. Ind. Orient. t. 999. 1845; Hook.f., Fl. Brit. India 2: 483. 1878.

Trees, 10-15 m high. Leaves simple, ovate-lanceolate or elliptic, pale red when young, acuminate at apex. Flowers creamy or pale yellow in dense cymes of umbellules. Berries dark-purple, oblong.

Distribution: Endemic to Western Ghats of Peninsular India.

Notes: Fairly common trees, mostly confined to the boarders of the shola tree cover.

36. *Turpenia nepalensis* Wall. *ex* Wt. *et* Arn., Prodr. 156. 1834; Wt., Ic. Pl. Ind. Orient. t. 972. 1838; Gamble, Fl. Presid. Madras 1: 241. 1918 (**Staphyleaceae**).

Turpenia pomifera (Roxb.) DC., Prodr. 2: 3. 1825 (*pro parte*); Hook.f., Fl. Brit. India 1: 698. 1875.

Turpenia cochinchinensis (Lour.) Merr., J. Arn. 19: 43. 1938; Perry, J. Arn. Arb. 22: 551. 1941.

Triceros cochinchinensis Lour., Fl. Cochin. 184. 1790.

Trees, 5-10 m high with terete branches. Leaves compound, imparipinnate with leaflets lanceolate and long-acuminate. Flowers dull yellow in terminal and axillary panicles. Drupes globose.

Distribution: India extending to Malesia.

Notes: Rare, distributed almost throughout the shola tree cover.

In terms of endemism of arborescent species in the sholas of Eravikulam, out of the 36 woody species, 30 are those endemic to southern Western Ghats or Peninsular India. In other words, 83.33% of the tree flora of the sampled shola forest area of Eravikulam are those endemic to Peninsular India. Also, *Rhododendron arboreum* Smith var. *nilagirica* (Zenk.) Clarke is a disjunctively distributed tree species in this part of the country and most of the other species belonging to the genus *Rhododendron* are occurring in the Himalayan region. So, the shola forests of Eravikulam is very rich in endemic arborescent species and also phytogeographically a very significant forest type.

4.1.2. Population status of arborescent flora

As enumerated before, the arborescent flora of the sampled shola forest areas at Eravikulam is composed of 37 taxa of flowering plants. Analysis of the data gathered on the number of individuals of each species and their gbh in the three full tree plots showed that the forest type is dominated by species like *Cinnamomum perrottetii, Cinnamomum sulphuratum, Microtropis ramiflora, M. ovalifolia, Ilex wightiana, Ilex denticulata* and *Persea macrantha,* having IVI more than 10 (Table 2). The rare tree species of the sholas of Eravikulam are *Glochidion neilgherrense, Symplocos foliosa* and *Eunonymous crenulatus* with their IVI of less than 4 (Table 2). Species like *Syzygium densifolium, Elaeocarpus recurvatus, Cinnamomum macrocarpum, Litsea floribunda, Casearia coriacea, Ardisia rhomboidea,* etc. are of co-dominant status in the woody vegetation of the area with their IVI values ranging between 4 and 10 (Table 2).

Arborescent species *Cinnamomum perrottetii, Microtropis ramiflora, Microtropis ovalifolia, Ilex denticulata, Persea macrantha, Elaeocarpus recurvatus, Ardisia rhomboidea, Litsea floribunda, Saprosma foetens, Pittosporum tetraspermum* and *Symplocos cochinchinensis* are having high frequency of distribution in the full tree plots at Eravikulam. However, species like *Neolitsea scrobiculata, Actinodaphne bourdillonii, Euonymous crenulatus, Glochidion neilghrrense*, etc. are of poor occurrence in those plots (Table 2) with their frequency values less than 35 per cent.

With regard to density status of various arborescent species in the full tree plots at Eravikulam, *Microtropis ramiflora* has the highest value (9.66) followed by *Microtropis ovalifolia* (8.66), *Ardisia rhomboidea* (6.33) and *Cinnamomum sulphuratum* (6). The endemic trees *Symplocos foliosa* and the non-endemic tree species *Rhodomyrtus tomentosa, Nothapodytes nimmoniana* and *Turpenia nepalensis* are the least dense (0.33) species in the area, followed by *Casearia coriacea, Neolitsea scrobiculata, Ligustrum perrotteti, Glochidion neilghrrense, Isonandra perrottetiana* and *Lasianthus acuminatus* with 0.66 as their density value. Most of the tree species in the sampled area belong to the density class of 1-3.

The tree species *Rhododendron arboreum* var. *nilagirica* with the high IVI value due to its high basal area (18.23) is exhibiting the phenomenon of 'false dominance' in the area (Table 2). This is a notable feature, affecting the regeneration of other shola species because of the microclimatic changes induced by the trees growing along the fringes of the tree cover. A similar phenomenon of 'false dominance' in the moist deciduous forests of Central India and Western India at Bastar in Madhya Pradesh State and Gir Forests of Gujarat State was recorded (Vyas, 1965; Menon, 1980) which affected the moisture regime of vegetation types there. The change in microclimate indirectly promotes regeneration of certain species and this ultimately leads to the improvement of the vegetation both in species content and ecological status. Therefore, autecological studies on such 'false dominance' in edaphic and climatic vegetation type needs more detailed investigations, especially with regard to the regeneration status and germination aspects of the seeds of associated plant species.

With regard to population status of various arborescent species in the three 50% tree-50% grassland plots (Table 3), dominant species with IVI more than 10 are *Ilex wightiana, Rhododendron arboreum* var. *nilagirica, Microtropis ramiflora, Cinnamomum perrotteti, Syzygium densiflorum, Persea macrantha, Cinnamomum sulphuratum, Saprosma fragrans, Ilex denticulata* and *Mahonia leschnaultii*. With regard to frequency, out of the 35 tree species

recorded from the three sample plots, 21 were of frequency more than 35% and the remaining 14 species were of low frequency. Density-wise, species like *Ilex wightiana* was very prominent recording a value of 35 where as all the other 34 species in the three plots recorded a value less than 5.66. *Rhodomyrtus tomentosa, Symplocos foliosa, Turpenia nepalensis, Nothopodytes nimmoniana* and few others recorded low density value of 0.33 in the half-tree plots (Table 3).

4.1.3. Population status of endemic arborescent species

Structural analysis of the endemic arborescent species of Eravikulam shola forests showed that dominant endemics in the area with IVI more than 20 are *Cinnomomum perrottetii* and *Rhododendron arboreum* var. *nilagirica* (Table 4). As mentioned earlier, the endemic tree *Rhododendron arboreum* is exhibiting the property of 'false dominance' as shown by the high basal area values of its population. Other endemic species of common occurrence (IVI between 10-20) are *Microtropis ramiflora, Microtropis ovalifolia, Cinnamomum sulphuratum, Ilex wightiana, Syzygium densifolium, Elaeocarpus recurvatus, Ardisia rhomboidea, Litsea floribunda, Saprosma fragrans, Michelia nilagirica, Ilex denticulata* and *Cinnamomum macrocarpum.* Rare endemic trees in the sampled areas of sholas of Eravikulam with IVI less than 10, are *Glochidion neilghrrense, Symplocos foliosa, Euonymous crenulatus, Actinodaphne bourdillonii, Neolitsea scrobiculata, Symplocos obtusa, Ligustrum perrottetii, Meliosma simplicifolia, Isonandra perrottetii, Lasianthus acuminatus, Pavetta blanda, Eugenia bracteata, Pittosporum tetraspermum, Mahonia leschnaultii* and *Rapenia thwaitesii.* In short, among the total endemic tree flora at Eravikulam, only 7% are dominants, 41% are co-dominants and 52 % of the species are only of rare occurrence.

4.1.4. Regeneration of endemic arborescent species

The status of the seedlings, ie. height less than 50 cm, between 50 cm and 1 m and more than 1m, along with the number of parent trees in the sampled plots were recorded. Table 5 gives the different categories and the number under each category for the full tree and half tree plots.

From the table (Table 5), it is evident that *Ardisia rhomboidea, Microtropis ramiflora, Microtropis ovalifolia, Isonandra perrottetiana, Litsea wightiana, Ligustrum perrottetii* and *Ilex denticulata* show high regeneration potential with representation of all the three seedlings categories in sufficient numbers. In the case of species like *Pavetta blanda, Pittosporum tetraspermum, Symplocos foliosa, Elaeocarpus recurvatus, Rhododendron arboreum* var.

nilagirica, Symplocos obtusa, Michelia nilagirica, Glochidion neilghrrense and *Eugenia bracteata,* regeneration is rather poor as understood from lesser number of seedlings of the different classes as mentioned before. There are also species *of Saprosma, Mahonia, Cinnamomum, Ilex, Syzygium, Lasianthus* and *Actinodaphne* which show medium regeneration potential with the different categories of seedlings represented in fairly good numbers (Table 5). In the full tree plots, the actual percentage of different classes of seedlings recorded are (a) upto 50 cm height 31.27%, (b) 50 cm - 1 m height 22.41% and (c) more than 1 m height 46.32 per cent.

In the case of 50% tree - 50% grassland plots, species like *Ardisia rhomboidea, Lasianthus acuminatus, Mahonia leschnaultii, Syzygium densifolium, Microtropis ramiflora, Pittosporum tetraspermum* and *Cinnamomum macrocarpum* (Table 5) showed high regeneration rate as evidenced by the occurrence of all the three categories of seedlings in sufficient numbers. However, species like *Saprosma fragrans, Neolitsea scrobiculata, Symplocos obtusa, Isonandra perrotteti, Glochidion neilghrrense, Symplocos foliosa* and *Ilex denticulata* recorded very poor regeneration with no representation of all the three categories of seedlings in them. In the case of *Pavetta, Mahonia, Cinnamomum, Microtropis, Actiodaphne* and *Eugenia* all the three categories of seedlings are available but only in limited number (Table 5). The actual percentage of seedlings in half tree plots are (a) below 50 cm height 16.82%, (b) between 50 cm to 1 m 29.15% and (c) more than 1 m hight 54.03 per cent.

4.1.5. Invasion status of arborescent endemic species

Structural analysis of the vegetation of 50% tree and 50% grassland plots laid along the shola boundaries at Eravikulam (Table 6) showed that the marginal tree vegetation slightly vary from the interior full tree plots. In the case of marginal plots, *Ilex wightiana* is the most dominant endemic species, eventhough *Rhododendron arboreum* var. *nilagirica* demonstrates 'false dominance' as in the case of full tree plots. The non-endemic tree *Symplocos cochinchinensis*, recorded from the tree covered area, was also represented in the marginal plots. Similarly, the endemic species *Mahonia leschnaultii*, which is a co-dominant tree in the full tree plot becomes dominant in the tree-grassland combined plot showing its invasion potential. It is also worth mentioning here that *Rhodomyrtus tomentosa* (non-endemic), *Lasianthus acuminatus* (endemic), *Symplocos foliosa* (endemic), *Nothapodytes nimmoniana* (non-endemic) and *Turpenia nepalensis*

(non-endemic) are of rare occurrence in the tree-grassland combined plots with very low density and abundance status (Table 6), demonstrating their low invasion potential.

Among the invading endemics, *Ilex wightiana* with IVI 45.42 in the marginal plots is poorly represented (16.2) in the interior full tree plots. Also some of the co-dominant arborescent endemics like *Microtropis ramiflora* and *Cinnamomum perrottetii* also show the same trend as evidenced by their comparatively high IVI values in the marginal tree-grassland plots. Inversely, woody endemics *Lasianthus acuminatus* and *Isonandra perrottetii* with comparatively high IVI values in the interior full tree plots are poorly represented in the 50% grassland plots. (3.35 & 2.5, respectively). Yet another category of species is represented by *Glochidion nielghrrense*, poorly represented in both marginal and interior areas of the shola tree patch, demonstrating that its population status and regeneration potential are not directly related to the microclimatic conditions, prevailing within the full tree cover or in the open grasslands.

Table 2. Structural details of all arborescent species in the sampled full tree plots at Eravikulam.

No.	Species*	A	D	F	BA	RD	RF	RBA	IVI	Avg. GBH
1.	Rhododendron arboreum	6.00	2.00	33.3	1052.95	1.91	1.35	14.97	18.23	112.9
2.	Cinnamomum perrottetii	5.00	5.00	100	644.90	4.78	4.05	9.17	18.00	85.5
3.	Microtropis ramiflora	9.66	9.66	100	240.84	9.26	4.05	3.42	16.73	53.1
4.	Microtropis ovalifolia	8.66	8.66	100	199.04	8.30	4.05	2.83	15.18	49.5
5.	Ilex wightiana	6.50	4.33	66.6	509.55	4.15	2.70	7.24	14.09	79.1
6.	Ilex denticulata	3.66	3.66	100	447.85	3.52	4.05	6.37	13.94	75.6
7.	Cinnamomum sulphuratum	6.00	6.00	100	256.62	5.75	4.05	3.65	13.45	60.5
8.	Persea macrantha	4.00	4.00	100	390.13	3.83	4.05	5.54	13.42	71.2
9.	Syzygium densifolium	3.66	3.66	100	240.84	3.51	4.05	3.42	10.98	54.7
10.	Elaeocarpus recurvatus	3.33	3.33	100	256.62	3.19	4.05	3.65	10.89	61.8
11.	Cinnamomum macrocarpum	7.00	4.66	66.6	240.84	4.47	2.70	3.42	10.59	55
12.	Ardisia rhomboidea	6.33	6.33	100	17.91	6.07	4.05	0.25	10.37	15
13.	Litsea wightiana	4.00	4.00	100	97.53	3.83	4.05	1.38	9.26	36.6
14.	Saprosma fragrans	4.00	4.00	100	71.66	3.83	4.05	1.01	8.89	30.6
15.	Michelia nilagirica	2.00	1.33	66.6	340.71	1.27	2.70	4.84	8.81	67
16.	Rapenia thwaitesii	3.33	3.33	100	71.66	3.19	4.05	1.01	8.25	31.4
17.	Mahonia leschnaultii	2.66	2.66	100	71.66	2.55	4.05	1.01	7.61	26.3
18.	Pittosporum tetraspermum	2.00	2.00	100	97.53	1.91	4.05	1.38	7.34	34.1
19.	Symplocos cochinchinensis	2.33	2.33	100	71.66	2.23	4.05	1.01	7.29	31.3
20.	Nothapodytes nimmoniana	3.50	2.33	66.6	127.39	2.23	2.70	1.81	6.74	38.1
21.	Casearia coriacea	2.50	1.66	66.6	161.23	1.59	2.70	2.29	6.58	46.3
22.	Eugenia bracteata	7.00	2.33	33.3	199.04	2.23	1.35	2.83	6.41	47.6
23.	Turpenia nepalensis	4.00	1.33	33.3	256.62	1.27	1.35	3.65	6.27	61.2
24.	Pavetta blanda	4.00	2.66	66.6	71.66	2.55	2.70	1.01	6.26	31.7
25.	Lasianthus acuminatus	5.00	3.33	66.6	17.91	3.19	2.70	0.25	6.14	12.4
26.	Isonandra perrottetiana	2.50	1.66	66.6	71.66	1.59	2.70	1.01	5.30	30.3
27.	Meliosma simplicifolia	2.00	1.33	66.6	71.66	1.27	2.70	1.01	4.98	30.9
28.	Ligustrum perrottetii	7.00	2.33	33.3	97.53	2.23	1.35	1.38	4.96	37.6
29.	Symplocos obtusa	1.50	1.00	66.6	71.66	0.95	2.70	1.01	4.66	30
30.	Neolitsea scrobiculata	3.00	1.00	33.3	161.23	0.95	1.35	2.29	4.59	44.2
31.	Actinodaphne bourdillonii	2.00	0.66	33.3	161.23	0.63	1.35	2.29	4.27	43.8
32.	Euonymous crenulatus	5.00	1.66	33.3	71.66	1.59	1.35	1.01	3.95	28.7
33.	Symplocos foliosa	1.00	0.33	33.3	97.53	0.31	1.35	1.38	3.04	37.6
34.	Glochidion neilgherrense	2.00	0.66	33.3	71.66	0.63	1.35	1.01	2.99	27.8

* A= Species abundance; D=Density; F=Frequency; BA=Basal area (in cm);
RD=Relative density; RF=Relative frequency; RBA-Relative basal area (in cm);
IVI=Importance value index; Avg. GBH=Average girth at brest height (in cm).

Table 3. Structural details of all arborescent species in the sampled tree-grassland combined plots at Eravikulam.

No.	Species*	A	D	F	BA	RD	RF	RBA	IVI	Avg. GBH
1.	Ilex wightiana	35.0	35.0	100	509.55	31.25	4.28	7.04	42.57	79.1
2.	Rhododendron arboreum	1.00	0.66	66.6	1052.95	0.59	2.85	14.55	17.99	112.9
3.	Microtropis ramiflora	9.60	9.60	100	240.84	8.63	4.28	3.33	16.24	53.1
4.	Cinnamomum perrottetii	7.00	2.33	66.6	644.90	2.08	2.85	8.91	13.84	85.5
5.	Syzygium densifolium	5.00	5.00	100	240.84	4.46	4.28	3.33	12.47	54.7
6.	Persea macrantha	3.00	3.00	100	390.13	2.67	4.28	5.39	12.34	71.2
7.	Cinnamomum sulphuratum	4.00	4.00	100	256.62	3.57	4.28	3.54	11.39	60.5
8.	Saprosma fragrans	5.66	5.66	100	71.66	5.05	4.28	0.99	10.32	30.6
9.	Ilex denticulata	2.00	1.33	66.6	447.85	1.19	2.85	6.19	10.23	75.6
10.	Mahonia leschnaultii	5.33	5.33	100	71.66	4.76	4.28	0.99	10.03	26.3
11.	Elaeocarpus recurvatus	5.50	3.66	66.6	256.62	3.27	2.85	3.54	9.66	61.8
12.	Michelia nilagirica	3.00	2.00	66.6	340.71	1.78	2.85	4.71	9.34	67
13.	Litsea wightiana	3.33	3.33	100	97.53	2.97	4.28	1.34	8.59	36.6
14.	Cinnamomum macrocarpum	4.00	2.66	66.6	240.84	2.38	2.85	3.33	8.56	55
15.	Rapenia thwaitesii	3.33	3.33	100	71.66	2.97	4.28	0.99	8.24	31.4
16.	Pavetta blanda	3.00	3.00	100	71.66	2.67	4.28	0.99	7.94	31.7
17.	Actinodaphne bourdillonii	4.00	2.66	66.6	161.23	2.38	2.85	2.23	7.46	43.8
18.	Ardisia rhomboidea	3.00	3.00	100	17.91	2.67	4.28	0.24	7.19	15
19.	Microtropis ovalifolia	2.50	2.33	66.6	199.04	1.48	2.85	2.75	7.08	49.5
20.	Symplocos obtusa	7.00	1.00	100	71.66	0.89	4.28	0.99	6.16	30
21.	Euonymous crenulatus	3.50	2.33	66.6	71.66	2.08	2.85	0.99	5.92	28.7
22.	Cinnamomum wightii	3.00	1.00	33.3	256.62	0.89	1.42	3.54	5.85	61.8
23.	Casearia coriacea	1.00	0.66	66.6	161.23	0.59	2.85	2.23	5.67	46.3
24.	Eugenia bracteata	5.00	1.66	33.3	199.04	1.48	1.42	2.75	5.65	47.6
25.	Meliosma simplicifolia	3.00	2.00	66.6	71.66	1.78	2.85	0.99	5.62	30.9
26.	Turpenia nepalensis	1.00	0.33	33.3	256.62	0.29	1.42	3.54	5.25	61.2
27.	Neolitsea scrobiculata	2.00	0.66	33.3	161.23	0.59	1.42	2.23	4.24	44.2
28.	Pittosporum tetraspermum	5.00	2.33	33.3	97.53	1.48	1.42	1.34	4.24	34.1
29.	Nothapodytes nimmoniana	1.00	0.33	33.3	127.39	0.29	1.42	1.76	3.47	38.1
30.	Ligustrum perrottetii	2.00	0.66	33.3	97.53	0.59	1.42	1.34	3.35	37.6
31.	Symplocos foliosa	1.00	0.33	33.3	97.53	0.29	1.42	1.34	3.05	37.6
32.	Glochidion neilgherrense	2.00	0.66	33.3	71.66	0.59	1.42	0.99	3.00	27.8
33.	Isonandra perrottetiana	2.00	0.66	33.3	71.66	0.59	1.42	0.99	3.00	30.3
34.	Lasianthus acuminatus	2.00	0.66	33.3	17.91	0.59	1.42	0.24	2.25	12.4
35.	Rhodomyrtus tomentosa	1.00	0.33	33.3	17.91	0.29	1.42	0.24	1.95	12.8

* A= Species abundance; D=Density; F=Frequency; BA=Basal area (in cm);
RD=Relative density; RF=Relative frequency; RBA-Relative basal area (in cm);
IVI=Importance value index; Avg. GBH=Average girth at brest height (in cm).

Table 4. Structural details of endemic arborescent species in the sampled full tree plots at Eravikulam.

No.	Species*	A	D	F	BA	RD	RF	RBA	IVI
1.	Rhododendron arboreum	6.00	2.00	33.3	1052.95	2.12	1.58	17.48	21.18
2.	Cinnamomum perrottetii	5.00	5.00	100	644.90	5.31	4.76	10.69	20.76
3.	Microtropis ramiflora	9.66	9.66	100	240.84	10.28	4.76	3.99	19.03
4.	Microtropis ovalifolia	8.66	8.66	100	199.04	9.21	4.76	3.30	17.27
5.	Ilex denticulata	3.66	3.66	100	447.85	3.90	4.76	7.43	16.96
6.	Ilex wightiana	6.50	4.33	66.6	509.55	4.60	3.17	8.45	16.22
7.	Cinnamomum sulphuratum	6.00	6.00	100	256.62	6.38	4.76	4.26	15.40
8.	Syzygium densifolium	3.66	3.66	100	240.84	3.90	4.76	3.99	12.65
9.	Elaeocarpus recurvatus	3.33	3.33	100	256.62	3.54	4.76	4.26	12.56
10.	Cinnamomum macrocarpum	7.00	4.66	66.6	240.84	4.96	3.17	3.99	12.12
11.	Ardisia rhomboidea	6.33	6.33	100	17.91	6.73	4.76	0.29	11.78
12.	Litsea floribunda	4.00	4.00	100	97.53	4.25	4.76	1.61	10.62
13.	Michelia nilagirica	2.00	1.33	66.6	340.71	1.41	3.17	5.65	10.23
14.	Saprosma fragrans	4.00	4.00	100	71.66	4.26	4.76	1.19	10.20
15.	Rapenia thwaitesii	3.33	3.33	100	71.66	3.90	4.76	1.19	9.85
16.	Mahonia leschnaultii	2.66	2.66	100	71.66	2.83	4.76	1.19	8.72
17.	Pittosporum tetraspermum	2.00	2.00	100	97.53	2.12	4.76	1.61	8.49
18.	Eugenia bracteata	7.00	2.33	33.3	199.04	2.48	1.58	3.30	7.36
19.	Pavetta blanda	4.00	2.66	66.6	71.66	2.83	3.17	1.19	7.19
20.	Lasianthus acuminatus	5.00	3.33	66.6	17.91	3.54	3.17	0.29	7.00
21.	Isonandra perrottetiana	2.50	1.66	66.6	71.66	1.77	3.17	1.19	6.13
22.	Meliosma simplicifolia	2.00	1.33	66.6	71.66	1.41	3.17	1.19	5.77
23.	Ligustrum perrottetii	7.00	2.33	33.3	97.53	2.48	1.58	1.61	5.67
24.	Symplocos obtusa	1.50	1.00	66.6	71.66	1.06	3.17	1.19	5.42
25.	Neolitsea scrobiculata	3.00	1.00	33.3	161.23	1.06	1.58	2.67	5.31
26.	Actinodaphne bourdillonii	2.00	0.66	33.3	161.23	0.70	1.58	2.67	4.95
27.	Euonymous crenulatus	5.00	1.66	33.3	71.66	1.77	1.58	1.19	4.54
28.	Symplocos foliosa	1.00	0.33	33.3	97.53	0.35	1.58	1.61	3.54
29.	Glochidion neilgherrense	2.00	0.66	33.3	71.66	0.70	1.58	1.19	3.47

* A= Species abundance; D=Density; F=Frequency; BA=Basal area (in cm);
RD=Relative density; RF=Relative frequency; RBA-Relative basal area (in cm);
IVI=Importance value index.

Table 5. Different categories and numbers of seedlings and trees of endemic arborescent species in the full tree and tree-grassland combined plots at Eravikulam.

No.	Species*	Full tree plots				Tree - grassland combined plots			
		< 50 cm	*50 cm – 1m*	*> 1 m*	*Trees*	*< 50 cm*	*50 cm – 1m*	*> 1 m*	*Trees*
1.	Ardisia rhomboidea	105	85	125	19	3	12	23	9
2.	Microtropis ramiflora	21	16	65	29	8	7	21	9
3.	Saprosma fragrans	4	3	6	12	-	-	3	12
4.	Microtropis ovalifolia	19	9	79	26	2	3	10	5
5.	Mahonia leschnaultii	4	3	4	8	10	13	15	8
6.	Isonandra perrottetiana	32	12	20	5	-	-	-	2
7.	Cinnamomum perrottetii	3	7	2	8	-	-	6	4
8.	Rapenia thwaitesii	1	2	6	11	2	4	15	6
9.	Litsea wightiana	40	22	14	11	3	8	22	8
10.	Cinnamomum sulphuratum	3	4	9	14	-	10	1	10
11.	Ilex denticulata	7	7	12	7	2	-	-	4
12.	Pavetta blanda	4	-	7	8	-	6	10	9
13.	Cinnamomum macrocarpum	9	4	11	14	7	14	11	5
14.	Pittosporum tetraspermum	-	-	-	6	10	17	26	5
15.	Symplocos foliosa	-	2	-	1	-	-	2	1
16.	Elaeocarpus recurvatus	7	-	6	8	-	2	-	12
17.	Euonymous crenulatus	13	2	5	5	2	-	1	6
18.	Ilex wightiana	4	6	6	12	-	3	2	2
19.	Syzygium densifolium	7	12	9	8	6	10	14	7
20.	Lasianthus acuminatus	10	8	16	10	3	1	7	2
21.	Actinodapne bourdillonii	5	9	11	2	-	5	12	8
22.	Symplocos obtusa	-	-	-	3	-	2	-	3
23.	Michelia nilagirica	1	2	-	7	2	1	4	6
24.	Glochidion neilgherrense	2	-	-	1	-	-	-	2
25.	Eugenia bracteata	-	-	20	1	4	3	6	5
26.	Ligustrum perrottetii	6	10	15	7	2	3	3	2
27.	Neolitsea scrobiculata	-	-	-	-	-	-	1	3
28.	Cinnamomum wightii	-	-	-	-	1	-	2	3
29.	Rhododendron arboreum	-	-	-	-	2	-	10	-

Table 6. Structural details of the arborescent endemic species in the sampled tree-grassland combined plots at Eravikulam.

No.	Species*	A	D	F	BA	RD	RF	RBA	IVI
1.	Ilex wightiana	35.0	35.0	100	509.55	32.50	4.84	8.08	45.42
2.	Rhododendron arboreum	1.00	0.66	66.6	1052.95	0.61	3.22	16.70	20.53
3.	Microtropis ramiflora	9.60	9.60	100	240.84	8.97	4.84	3.82	17.63
4.	Cinnamomum perrottetii	7.00	2.33	66.6	644.90	2.16	3.22	10.23	15.61
5.	Syzygium densifolium	5.00	5.00	100	240.84	4.64	4.84	3.82	13.30
6.	Cinnamomum sulphuratum	4.00	4.00	100	256.62	3.71	4.84	4.07	12.62
7.	Ilex denticulata	2.00	1.33	66.6	447.85	1.26	3.22	7.10	11.55
8.	Saprosma fragrans	5.66	5.66	100	71.66	5.26	4.84	1.13	11.23
9.	Mahonia leschnaultii	5.33	5.33	100	71.66	4.95	4.84	1.13	10.92
10.	Elaeocarpus recurvatus	5.50	3.66	66.6	256.62	3.40	3.22	4.07	10.69
11.	Michelia nilagirica	3.00	2.00	66.6	340.71	1.85	3.22	5.40	10.47
12.	Cinnamomum macrocarpum	4.00	2.66	66.6	240.84	2.47	3.22	3.82	9.51
13.	Litsea floribunda	3.33	3.33	100	97.53	3.09	4.84	1.54	9.47
14.	Rapenia thwaitesii	3.33	3.33	100	71.66	3.09	4.84	1.13	9.06
15.	Pavetta blanda	3.00	3.00	100	71.66	2.78	4.84	1.13	8.75
16.	Actinodaphne bourdillonii	4.00	2.66	66.6	161.23	2.47	3.22	2.55	8.24
17.	Microtropis ovalifolia	2.50	2.33	66.6	199.04	1.54	3.22	3.15	7.91
18.	Ardisia rhomboidea	3.00	3.00	100	17.91	2.78	4.84	0.28	7.90
19.	Symplocos obtusa	1.00	1.00	100	71.66	0.92	4.84	1.13	6.89
20.	Cinnamomum wightiana	3.00	1.00	33.3	256.62	0.92	1.61	4.07	6.60
21.	Euonymous crenulatus	3.50	2.33	66.6	71.66	2.16	3.22	1.13	6.51
22.	Eugenia bracteata	5.00	1.66	33.3	199.04	1.54	1.61	3.15	6.30
23.	Meliosma simplicifolia	3.00	2.00	66.6	71.66	1.85	3.22	1.13	6.20
24.	Neolitsea scrobiculata	2.00	0.66	33.3	161.23	0.61	1.61	2.55	4.77
25.	Pittosporum tetraspermum	5.00	2.33	33.3	97.53	1.54	1.61	1.54	4.69
26.	Ligustrum perrottetii	2.00	0.66	33.3	97.53	0.61	1.61	1.54	3.76
27.	Symplocos foliosa	1.00	0.33	33.3	97.53	0.30	1.61	1.54	3.45
28.	Glochidion neilgherrense	2.00	0.66	33.3	71.66	0.61	1.61	1.13	3.35
29.	Isonandra perrottetiana	2.00	0.66	33.3	71.66	0.61	1.61	1.13	3.35
30.	Lasianthus acuminatus	2.00	0.66	33.3	17.91	0.61	1.61	0.28	2.50

* A= Species abundance; D=Density; F=Frequency; BA=Basal area (in cm);
RD=Relative density; RF=Relative frequency; RBA-Relative basal area (in cm);
IVI=Importance value index.

4.2.Silent Valley Shola

4.2.1. Arborescent flora

The six sample plots laid in the sholas of Silent Valley at Sispara contained a total of 37 arborescent species of which 27 taxa are endemic to Peninsular India (marked with astrix) and the remaining 10 species are of more wider ranges of distribution in Sri Lanka, Malesia or China. Endemic trees are maximum represented in the family *Lauraceae* with 7 species followed by *Rubiaceae* with 5 species and *Aquifoliaceae* with two taxa of restricted distribution in Peninsular India. Families represented by only one endemic species in the shola are *Elaeocarpaceae, Euphorbiaceae, Icacinaceae, Oleaceae, Melastomataceae, Magnoliaceae, Celastraceae, Ericaceae, Myrtaceae, Symplocaceae, Theaceae, Vaccinaceae* and *Araliaceae*. In total, there are 22 families and 32 genera in which arborescent species are represented in the area. All the species are enumerated alphabetically by their up-to-date botanical names with brief diagnostic descriptions, distribution range and also field notes pertaining to the study.

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1. ***Actinodaphne bourdillonii*** Gamble, Kew Bull. 1925: 129. 1925 & Fl. Presid. Madras 2: 1231. 1925; Ahamed. *et* Nayar, End. Pl. Ind. Reg. 64. 1987 (**Lauraceae**).

Medium sized trees, 5-10 m high; branchlets densely tomentose. Leaves simple, elliptic to oblanceolate, acuminate at apex with very oblique nerves. Male flowers white, 8-10 together in clusters; female flowers 5-10 together in umbellate clusters from leaf scars. Berries ovoid, supported on enlarged perianth.

Distribution: Endemic to Western Ghats of Penisular India.

Notes: Rare trees, habituated to the interior portions of the shola tree cover.

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2. ***Beilschemedia wightii*** (Nees) Benth. *ex* Hook.f., Fl. Brit. India 5: 124. 1886; Gamble, Fl. Presid. Madras 2: 1221. 1925 (**Lauraceae**).

Haasia wightii Nees, Syst. Laurin. 676. 1836; Wt., Ic. Pl. Ind. Orient. t. 1831. 1852.

Trees, 12-15 m high. Leaves simple, usually opposite, elliptic-lanceolate, shiny and glabrous, obtusely acute or acuminate at apex. Flowers in axillary or terminal panicles with slender peduncles and pedicles. Berries purple, ovoid, smooth.

Distribution: Endemic to Western Ghats in Peninsular India.

Notes: Fairly common trees in the interior portions of the shola tree cover.

3. ***Casearia coriacea*** Thw., Enum. Pl. Zeyl. 20. 1858; Hook.f., Fl. Brit. Ind. 2: 592. 1879; Gamble, Fl. Presid. Madras 1: 521. 1921 (**Flacourtiaceae**).

Trees, 4-5 m high; bark yellowish-white, smooth. Leaves simple, obovate, entire coriaceous, obtuse or shortly pointed at apex. Flowers greenish-yellow, 3-6 together, in axillary fascicles. Capsules greenish, elliptic.

Distribution: India, Sri Lanka.

Notes: Fairly common, mostly in the interior areas of the shola tree cover.

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4. ***Cinnamomum perrottetii*** Meisn. in DC., Prodr. 15(1): 22,504. 1864: Hook.f., Fl. Brit. India 5: 133. 1886; Gamble, Fl. Presid. Madras 2: 1225. 1925; Ahamed. *et* Nayar, End. Pl. Ind. Reg. 65. 1987 (**Lauraceae**).

Trees, 4-7 m high; twigs densely branched, tomentose. Leaves simple, opposite or alternate, ovate or oblong, pubescent when young, acute at apex. Flowers in 3-4 cm long, densely tomentose panicles. Berries ovoid, seated on enlarged perianth.

Distribution: Endemic to Western Ghats of Peninsular India.

Notes: Common, towards the interior areas of the shola tree patch.

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5. ***Cinnamomum sulphuratum*** Nees in Wall., Pl. Asiat. Rar. 2: 74. 1831; Hook.f., Fl. Brit. India 5: 132. 1886; Gamble, Fl. Presid. Madras 2: 1225. 1925; Kosterm., Bull. bot. Surv. India 25: 114. 1983; Ahamed *et* Nayar, End. Pl. Ind. Reg. 65. 1987 (**Lauraceae**).

Trees, 10-15 m high; branchlets slender, angular, yellowish-tomentose. Leaves simple, elliptic to linear-elliptic or elliptic-oblong, yellowish pubescent, acute at apex. Flowers yellowish in short, tomentose panicles. Berries ellipsoid with persistent perianth lobes.

Distribution: Endemic to Western Ghats of Peninsular India.

Notes: Fairly common, both inside and along the boundaries of the shola tree cover.

6. ***Daphniphyllum neilgherrense*** (Wt.) K. Rosenth. in Engl., Pflanzenr. 4 (147a): 7. 1919; Gamble, Fl. Presid. Madras 2: 1311. 1925 (**Daphiniphyllaceae**).

Goughia neilgherrensis Wt., Ic. Pl. Ind. Orient. tt. 1878, 1879. 1852.

Daphiniphyllum glaucescens Muell.-Arg. in DC., Prodr. 16(1): 3. 1866 (*non* Bl. 1826-27); Hook.f., Fl. Brit. India 5: 353. 1887.

Trees, 8-10 m high; branches stout. Leaves simple, elliptic or obovate-oblong, entire, usually glaucous beneath, obtuse at apex. Flowers dioecious or sometimes monoecious in axillary racemes, apetalous. Drupes greenish red, ovoid or oblong with woody pericarp.

Distribution: Peninsular India, Sri Lanka, Korea, Java.

Notes: Very common, almost throughout the shola tree cover.

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7. ***Elaeocarpus recurvatus*** Corner, Gardn. Bull. Straits Settl. 10: 319, 325, 1939; Ahamed. *et* Nayar, End. Pl. Ind. Reg. 77. 1987 (**Elaeocarpaceae**).

Elaeocarpus ferrugineius (Wt.) Bedd., Fl. Sylvat. South. India t. 112. 1871(*nom. illeg.*); Hook.f., Fl. Brit. India 1: 406. 1874; Gamble, Fl. Presid. Madras 1: 124. 1915.

Monocera ferruginea Wt., Ic. Pl. Ind. Orient. t. 205. 1839. (*non* Jack. 1830).

Trees, 6-8 m high. Leaves simple, narrowly folded back along the margins, coriaceous, densely ferrugineous pubescent beneath, acute at apex. Flowers dull white in axillary or lateral racemes. Drupes elliptic, shiny.

Distribution: Endemic to Western Ghats of Peninsular India.

Notes: Fairly common along the boarders and aslo interior of the shola tree patch.

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8. ***Glochidion neilgherrense*** Wt., Ic. Pl. Ind. Orient. 5: t. 29. 1852; Hook.f., Fl. Brit. India 5: 316. 1887; Gamble, Fl. Presid. Madras 2: 1307. 1925; Ahamed. *et* Nayar, End. Pl. Ind. Reg. 176. 1987 (**Euphorbiaceae**).

Small trees, 4-6 m high; branchlets almost glabrous. Leaves elliptic-oblong , oblique at base, acuminate at apex, black on drying. Flowers yellow, in axillary clusters. Capsules globose, 6 valved.

Distribution: Endemic to Western Ghats of Peninsular India.

Notes: Fairly common, mostly confined to the inner portions of the shola tree cover.

9. ***Gnidia glauca*** (Fresen.) Gilg., Bot. Jahrb. Syst. 19: 265. 1894 (**Thymeleaceae**).

Lasiosplem glaucus Fresen., Flora 21: 603. 1838.

L. eriocephalus (Meissn.) Decne in Jacq., Voy. Ind. 4. Bot. 148. 1844; Gamble, Fl. Presid. Madras 2: 1244. 1925.

G. sisparensis Gardn., Calcutta J. nat. Hist. 7: 456-1847; Wt., Ic. Pl. Ind. Orient. t. 1860. 1852.

Shrubs or small trees, 2-4 m high. Leaves clustered towards the tip of the branchlets, subsessile, obovate-oblong, obtuse at apex. Flowers yellow in dense, terminal, white-silky heads. Capsules dry, included in the base of the perianth.

Distribution: South-West India, Sri Lanka, Africa.

Notes: Fairly common almost throughout the shola tree cover.

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10. ***Gomphandra coriacea*** Wt., Illustr. Ind. Bot. 1: 103. 1840; Gamble, Fl. Presid. Madras 1: 194. 1918; Sleum., Blumea 17: 206. 1969 (**Icacinaceae**).

G. polymaorpha Wt., Illustr. Ind. Bot. 1: 103. 1840 (*pro parte*); Wt. Ic. Pl. Ind. Orient. t. 9538. 954. 1845; Hook.f., Fl. Brit. India 1: 586. 1875 (*pro parte*).

Trees, 4-6 m high. Leaves elliptic or oblanceolate, coriaceous acute or acuminate at apex. Flowers yellowish green or dull white in leaf-opposed racemes. Drupes oblong, smooth.

Distribution: Endemic to Western Ghats of Peninsular India.

Notes: Fairly common, in the interior areas of the shola tree patch.

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11. ***Hedyotis leschnaultiana*** DC., Prodr. 4: 422. 1830; Deb *et* Dutta, Taxon 34: 296. 1985 (**Rubiaceae**).

Hedyotis stylosa R. Br. *ex* Wt. *et* Arn., Prodr. 407. 1834; Wt., Ic. Pl. Ind. Orient. t. 1027. 1845; Hook.f., Fl. Brit. India 3: 51. 1880.

Oldenlandia stylosa (R. Br. *ex* Wt. *et* Arn.) Kuntz, Rev. Gen. Pl. 1: 293. 1891; Gamble, Fl. Presid. Madras 2: 598. 1921.

O. sisparensis (Gage) Gamble, Fl. Presid. Madras 2: 599. 1921.

Branched shrubs, 1.5-2 m high. Leaves simple, ovate or elliptic-lanceolate, glabrous, recurred along the margins, acuminate at apex. Flowers bluish purple or lilac tinged and white, in terminal and subterminal panicles. Capsules ovoid, glabrous, dehiscent.

Distribution: Endemic to Western Ghats of Peninsular India.

Notes: Rare, in the interior areas of the shola tree cover.

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12. ***Ilex gardneriana*** Wt., Ic. Pl. Ind. Orient. t. 1217. 1848; Hook.f., Fl. Brit. India 1: 603. 1875; Gamble, Fl. Presid. Madras 1: 200. 1918 (**Aquifoliaceae**).

Shrubs, 1.5-2 m high. Leaves simple, alterante, ovate-lanceolate, midrib imposed, coriaceous long acuminate at apex. Flowers small, with about 1 cm long pedicels. Drupes globose with thick pericarp.

Distribution: Endemic to Western Ghats of Peninsular India.

Notes: Fairly common, almost throughout the shola tree growing area.

13. ***Ilex wightiana*** Wall. *ex* Wt., Ic. Pl. Ind. Orient. t. 1216. 1848; Hook. f., Fl. Brit. India 1: 603. 1875; Gamble, Fl. Presid. Madras 1: 200. 1918 (**Aquifoliaceae**).

Trees, 8-12 m high. Leaves simple, alternate, elliptic or elliptic-oblanceolate, coriaceous, midrib impressed, acuminate at apex. Flowers white in subsessile umbels. Berries red, globose.

Distribution: Endemic to Western Ghats of Peninsular India.

Notes: A dominant tree along the interior and also outer fringes of the shola tree cover.

14. ***Ixora notoniana*** Wall. *ex* G. Don, Gen. Syst. 3: 571. 1834; Hook.f., Fl. Brit. India 3: 139. 1880; Gamble, Fl. Presid. Madras 1: 630. 1921 (**Rubiaceae**).

Trees, 4-6 m high. Leaves simple, opposite, coriaceous, entire, elliptic-obovate, obtusely acute at apex. Flowers red in long, peduncled corymbs. Fruits globose.

Distribution: Endemic to Peninsular India.

Notes: Rare, mostly towards the interior areas of the shola tree cover.

15. ***Lasianthus ciliatus*** Wt., Calcatta J. nat. Hist. 6: 506. 1846; Hook.f., Fl. Brit. India 3: 184. 1880; Gamble, Fl. Prseid, Madras 2: 647. 1921 (**Rubiaceae**).

Shrubs, 1-2 m high; branchlets hirsute with spreading hairs. Leaves simple, distichous, elliptic-oblong, hirsute beneath, ciliate along the margins, acute or acuminate at apex. Flowers in axillary, sessile cymes. Drupes with triquetrous pyrenes.

Distribution: Endemic to Peninsular India.

Notes: Rare, in the innner portions of the shola tree patches.

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16. ***Ligustrum perrottetii*** A. DC., Prodr. 8: 294. 1844; Wt., Ic. Pl. Ind. Orient. t. 1244. 1848; Hook.f., Fl. Brit. India 41: 3: 615. 1882; Gamble, Fl. Presid. Madras 2 797. 1923 (**Oleaceae**).

Trees, 4-5 m high; branchlets lenticellate. Leaves simple, opposite, ovate or elliptic, glabrous, acute at apex. Flowers white in stout, short, dense panicles. Drupes ellipsoid.

Distribution: Endemic to Western Ghats of Peninsular India.

Notes: Fairly common in the interior areas of the shola tree cover.

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17. ***Litsea floribunda*** (Bl.) Gamble, Fl. Presid. Madras 2: 1238. 1925 (**Lauraceae**).

Cyclicodaphne floribunda Bl., Mus. Bot. 1: 387. 1857.

Litsea wightiana sensu Hook.f., Fl. Brit. India 5: 177. 1886 (*pro parte*).

Trees, 10-15 m high; branchlets fulvous tomentose. Leaves simple, elliptic-oblong, densely brown tomentose, coriaceous, abruptly acuminate at apex. Flowers pale yellow in umbellate clusters. Berries oblong, seated on perianth lobes.

Distribution: Endemic to Western Ghats of Peninsular India.

Notes: Fairly common, mostly confined to the interior portions of the tree patches.

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18. ***Litsea wightiana*** (Nees) Hook.f. in Benth. *et* Hook.f., Gen. Pl. 3: 162. 1880; Gamble, Fl. Presid. Madras 3: 1238. 1936 (**Lauraceae**).

Cylicodaphne wightiana Nees in Wall., Pl. Asiat. Rar. 2: 68. 1831; Wt., Ic. Pl. Ind. Orient. t. 1833. 1852.

Trees, 10-15 m high. Leaves simple, alternate, obovate, elliptic or lanceolate, fulvous-pubescent beneath, obtuse or rarely acute at apex. Flowers pale yellow in umbellate clusters. Berries ovoid, seated on perianth cup.

Distribution: Endemic to Western Ghats of Peninsular India.

Notes: Rare, occurring almost throughout the tree cover in the shola forests.

19. ***Meliosma simplicifolia*** (Roxb.) Walp., Rep. 1: 423. 1842; Hook.f., Fl. Brit. India 2: 5. 1876; Gamble, Fl. Presid. Madras 1: 256. 1918; Beusek., Blumea 19: 462. 1971 (**Meliosmaceae**).

Millingtonia simplicifolia Roxb., Pl. Corom. 3: 50., t. 254. 1820.

Small trees, 3-5 m high; branchlets pubescent. Leaves simple, obovate or oblanceolate, acuminate at apex. Flowers very small in terminal, brown-tomentose panicles. Drupes globose with rugose endocarp.

Distribution: India, China, Malesia.

Notes: A tree characteristic to the interior areas of the tree cover but also growing rarely along the boundaries of the shola tree patches.

20. * ***Memecylon flavescens*** Gamble, Bull. Misc. Inform. Kew 1919: 226. 1919 & Fl. Presid. Madras 1: 503. 1919 (**Melastomataceae**).

Woody shrubs, 1-2 m high; branchlets slender, noduled; Leaves simple, obovate or elliptic, coriaceous, drying yellowish, obtuse or acute at apex; Flowers pale blue in axillary, few flowered fascicles. Berries globose, greyish.

Distribution: Endemic to Western Ghats of Peninsular India.

Notes: A common shrub along the outer fringes of the shola tree cover.

21. * ***Michelia nilagirica*** Zenk., Pl. Ind. 21., t. 20. 1835; Wt., Ic. Pl. Ind. Orient. 938. 1845; Hook. f., Fl. Brit. India 1: 44. 1872; Gamble, Fl. Presid. Madras 1: 7. 1915 (**Magnoliaceae**).

Trees, 12-15 m high; Leaves simple, ovate-lanceolate, entire, acuminate at apex. Flowers white or yellowish, fragrant, axillary. Follicles in dense clusters.

Distribution: Endemic to Peninsular India.

Notes: Common trees along the boarders of the tree patch and rarely growing in the interior areas.

22. * ***Microtropis ramiflora*** Wt., Ic. Pl. Ind. Orient. t. 977. 1845; Hook.f., Fl. Brit. India 1: 614. 1875; Gamble, Fl. Presid. Madras 1: 207. 1919 (**Celastraceae**).

Small trees, 4-6 m high; branchlets purplish black. Leaves simple, broadly elliptic or obovate, coriaceous with distinct nerves, rounded or slightly emarginate at apex. Flowers small, sessile, clustered in the axils of fallen or existing leaves. Capsules cylindrical when young, ellipsoid or ovoid, chanelled when mature.

Distribution: Endemic to Western Ghats of Peninsular India.

Notes: Fairly common, almost throughout the shola tree patch.

23. * ***Neolitsea scrobiculata*** (Meissn.) Gamble, Fl. Presid. Madras 2: 1240. 1925 (**Lauraceae**).

Litsea scrobiculata Meissn. in DC., Prodr. 15(1): 223. 1864.

L. zeylanica sensu Hook.f., Fl. Brit. India 5: 178. 1886 (*pro parte*, *non* Nees 1823)

Trees, 10-12 m high; Leaves simple, elliptic-ovate or sometimes orbiculate, glabrous above, glaucous beneath, coriaceous, shortly acute at apex. Flowers greenish in subsessile umbels. Berries obovoid to globose with cupular, entire perianth.

Distribution: Endemic to Western Ghats of Peninsular India.

Notes: Fairly common throughout the tree growing area of the shola forests.

24. ***Nothapodytes nimmoniana*** (Grah.) Mabb. in Manilal *et* Sur., Bot. Hist. Hort. Malab. 88. 1980 (**Icacinaceae**).

Mappia foetida (Wt.) Meirs, Ann. Mag. Hist. ser. 2. 9: 395. 1852; Hook.f., Fl. Brit. India 1: 589. 1872; Gamble, Fl. Presid. Madras 1: 196. 1915.

Premna nimmoniana Grah., Cat. Pl. Bombay 155. 1839.

Nothapodytes foetida (Wt.) Sleum., Notibl. Bot. Gart. Berlin-Dahlem 15: 247. 1940 & Blumea 17: 232. 1969.

Small trees, 3-5 m high; bark greenish grey. Leaves simple, elliptic-ovate or elliptic, more or less puberulous and pale beneath, subentire, caudate-acuminate at apex. Flowers in terminal panicles. Drupes purple, oblong.

Distribution: India, Indo-China, Malesia.

Notes: Rare, almost throughout the shola tree patch.

25. * ***Pavetta blanda*** Bremek., Fedde Repert. Sp. Nov. Beih. 37: 94. 1934 (**Rubiaceae**).

Pavetta berviflora DC. var. *subcoriacea* Gamble, Fl. Presid. Madras 2: 633. 1921.

Shrubs, 1-1.5 m high; bark greyish-white. Leaves simple, elliptic-oblong or oblanceolate, black when dry, acuminate at apex. Flowers white in dense corymbs. Berries small, fleshy.

Distribution: Endemic to Western Ghats of Peninsular India.

Notes: Common along the boarders and rarely in the interior areas of the shola tree cover.

26. ***Photinia integrifolia*** Lindl. var. ***sublanceolata*** Miq., Fl. Ind. Bot. 1(1): 387. 1857 (**Rosaceae**).

Photinia notoniana Wt. *et* Arn., Prodr. Fl. Penin. Ind. Orient. 302. 1834; Wt., Ic. Pl. Ind. Orient. t. 991. 1845; Hook.f., Fl. Brit. India 2: 380. 1878; Gamble, Fl. Presid. Madras 1: 445. 1919.

Trees, 4-5 m high; Leaves crowded at branch tips, ovate to oblong, entire, coriaceous, acute or acuminate at apex; Flowers brown or white, small, in corymbose, terminal panicles. Drupes red, globose.

Distribution: Eastern and Peninsular India, Sri Lanka.

Notes: Fairly common throughout the shola tree cover.

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27. ***Rhododendron arboreum*** Smith var. ***nilagirica*** (Zenk.) Clarke in Hook. f., Fl. Brit. India 3: 466. 1882 (**Ericaceae**).

Rhododendron nilagiricum Zenk., Ann. Sci. Nat. ser. 2: 6. 1836; Gamble, Fl. Presid. Madras 2: 743. 1921.

Trees, 4-6 m high with reddish brown bark. Leaves often clustered towards branch tips, entire, elliptic or elliptic-oblong, very coriaceous, usually obtuse at both ends, recurved along the margins. Flowers crimson cloured in terminal heads. Capsules long, hard, woody.

Distribution: Endemic to Western Ghats of Peninsular India.

Notes: Dominant trees, common along the boarders and adjoining grasslands and also interior areas of the tree cover.

28. ***Rhodomytrus tomentosa*** (Ait.) Hassk., Flora 25: 35. 1842; Hook.f., Fl. Brit. India 2: 469. 1878; Gamble, Fl. Presid. Madras 1: 471. 1919 (**Myrtaceae**).

Myrtus tomentosa Ait., Hort. Kew (ed.) 2: 159. 1789; Wt., Ic. Pl. Ind. Orient. t. 522. 1842.

Small trees, 3-6 m high; bark flaking and branchlets thickly tomentose. Leaves simple, elliptic, lower surface densely velvetty, obtuse or mucronate at apex. Flowers pink in terminal or axillary cymes. Berries dark purple.

Distribution: India, Sri Lanka, China, Malesia.

Notes: Rare, with in the shola tree cover, distributed almost throughout the patches.

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29. ***Saprosma fragrans*** Bedd., Fl. Sylvat. South. Ind. t. 134. 1871; Hook.f., Fl. Brit. India 3: 193. 1881; Gamble, Fl. Presid. Madras 2: 649. 1921 (**Rubiaceae**).

Serrisa fragrans (Bedd.) Bedd., Ic. t. 14. 1874.

Shrubs or small trees, 2-4.5 m high, often much branched. Leaves simple, elliptic or obovate, glabrous, abruptly acuminate at apex. Flowers white, fragrant in terminal, few flowered cymes. Drupes purple, ellipsoid, single seeded.

Distribution: Endemic to Peninsular India.

Notes: Fairly common almost throughout the shola tree cover.

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30. ***Schefflera capitata*** (Wt. *et* Arn.) Harms in Engler & Prantl., Pflanzenfam 3(8): 36. 1894; Gamble, Fl. Presid. Madras 2: 571. 1919 (**Araliaceae**).

Paratropix capitata Wt. *et* Arn., Prodr. Fl. Penin. Ind. Orient. 378. 1834.

Brassia capitata (Wt. *et* Arn.) Clarke in Hook.f., Fl. Brit. India 2: 732. 1879.

Stunted trees, 3-4 m high; Leaves digitate with 6-8 leaflets, each oblong, coriaceous acute or acuminate at apex. Flowers sessile in panicles of racemes with stout branches. Drupes subglobose, angled.

Distribution: Endemic to Western Ghats of Peninsular India.

Notes: Fairly common, mostly distributed towards the boarders of the shola tree cover.

31. ***Symplocos cochinchinensis*** (Lour.) Moore, J. Bot. 52: 148. 1914 subsp. ***laurinia*** (Retz.) Nooteb., Leiden Bot. ser. 1: 156. 1975 (**Symplocaceae**).

Drupatris cochinchinenis Lour., Fl. Cochin. 314. 1790.

Symplocos spicata var. *laurina* (Retz.) Wt., Illustr. Ind. Bot. t. 150. 1850; Gamble, Fl. Presid. Madras 2: 782. 1923.

Trees, 5-8 m high. Leaves simple, variable in shape, elliptic or lanceolate, crenate or serrate, acute or acuminate at apex, usually yellowish when dry. Flowers white in axillary, usually 3-6 branched spikes. Drupes ampulliform, globose, ribbed.

Distribution: India, Sri Lanka, Myanmar, Thailand, China, Japan, Malesia.

Notes: Fairly common, confined to the interior areas of the shola tree cover.

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32. ***Symplocos macrophylla*** Wall. *ex* A. DC. in DC., Prodr. 8: 257. 1844; Hook.f., Fl. Brit. India 3: 578. 1882; Gamble, Fl. Presid. Madras 2: 784. 1925; Nooteb., Symplocac. Old World 229. 1975 (**Symplocaceae**).

Trees, 6-8 m high; branchlets tomentose. Leaves simple, elliptic-ovate, glandular, acuminate at apex; Flowers white in densely hairy racemes. Drupes white, glabrous, ovoid-oblong.

Distribution: Endemic to Western Ghats of Peninsular India.

Notes: Rare, along the boarders of the shola tree cover.

33. ***Symplocos obtusa*** Wall. *ex* G. Don, Gen. Syst. 4: 3. 1837-38; Wt., Ic. Pl. Ind. Orient. t. 1233. 1848; Hook.f., Fl. Brit. India 3: 583. 1882; Gamble, Fl. Presid. Madras 2: 783. 1925 (**Symplocaceae**).

Trees, 3-5 m high. Leaves obovate, coriaceous, drying yellowish, obtuse at apex. Flowers white in spikes with ovate, caducous bracts. Drupes oblong, crowned by calyx lobes.

Distribution: India, Sri Lanka.

Notes: Rare, almost confined to the interior portions of the shola tree cover.

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34. ***Syzygium densiflorum*** Wall. *ex* Wt. *et* Arn., Prodr. Fl. Penin. Ind. Orient. 329. 1834; Ahamed. *et* Nayar, End. Pl. Ind. Reg. 108. 1987 (**Myrtaceae**).

Syzygium arnottianum Walp., Rep. 2: 180. 1843; Gamble, Fl. Presid. Madras 2: 743. 1921.

Eugenia arnottiana (Walp.) Wt., Ic. Pl. Ind. Orient. t. 999. 1845; Hook.f., Fl. Brit. India 2: 483. 1878.

Trees, 10-15 m high. Leaves simple, ovate-lanceolate or elliptic, pale red when young, acuminate at apex. Flowers creamy or pale yellow in dense cymes of umbellules. Berries dark purple, oblong.

Distribution: Endemic to Western Ghats of Peninsular India.

Notes: Very common trees, almost throughout the shola tree cover.

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35. ***Ternstroemia japonica*** (Thumb.) Thumb., Trans. Linn. Soc. London 2: 335. 1794; Hook.f., Fl. Brit. India 1: 280. 1874; Gamble, Fl. Presid. Madras 1: 78. 1915 (**Theaceae**).

Cleyera japonica Thumb., Fl. Jap. 224. 1784.

Trees, 4-6 m high; Leaves simple, obovate, entire, coriaceous, obtuse at apex; Flowers pale yellow, usually dioecious, solitary or fascicled in the axils of leaves. Berries reddish with thick rind, apiculate.

Distribution: Endemic to Peninsular India.

Notes: Fairly common trees, confined to the interior portions of the shola tree patch.

36. ***Turpinia nepalensis*** Wall. *ex* Wt. *et* Arn., Prodr. Fl. Penin. Ind. Orient. 156. 1834; Wt., Ic. Pl. Ind. Orient. t. 972. 1838; Gamble, Fl. Presid. Madras 1: 241. 1918 (**Staphyleaceae**).

Turpinia cochinchinensis (Lour.) Merr., J. Arn. Arbor. 19: 43. 1938; Perry, J. Arn. Arb. 22: 551. 1941.

Triceros cochinchinensis Lour., Fl. Cochin. 184. 1790.

Trees, 5-10 m high with terete branches. Leaves compound, imparipinnate with leaflets lanceolate and long-acuminate. Flowers dull yellow in terminal and axillary panicles. Drupes globose.

Distribution: India extending to Malesia.

Notes: Common trees, growing along the boarders of the shola tree patch.

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37. ***Vaccinium leschnaultii*** Wt., Ic. Pl. Ind. Orient. t. 1188. 1848; Bedd., Fl. Sylvat. South. Ind. t. 272. 1872; Hook.f., Fl. Brit. India 3: 455. 1882; Gamble, Fl. Presid. Madras 2: 742. 1921 (**Vacciniaceae**).

Shrubs or small trees, 2-4 m high. Leaves simple, ovate, ovate-lanceolate or orbicular, minutely serrate, acute or obtuse at apex; Flowers pinkish-white in lax racemes. Berries globose, 5 loculed.

Distribution: Endemic to Western Ghats of Peninsular India.

Notes: Fairly common, along the boarders and also interior areas of the shola tree patch.

The representation of endemic woody plants in the sholas of Silent Valley is 72.97% and as compared to the forest type at Eravikulam (83.33%), this is a low representation. The shola forests of Silent Valley also contains the tree species *Photinia integrifolia* Lindl. var. *sublanceolata* Miq. of curious distribution in Eastern and Peninsular India and also Sri Lanka, in addition to *Rhododendron arboreum* Smith var. *nilagirica* (Zenk.) Clarke of disjunctive

distribution in the Himalayas. In fact, the occurrence of the genus *Rhododendron* in Peninsular India is strictly restricted to the shola forests and the adjoining grasslands along the crest of the Western Ghats.

4.2.2. Population status of arborescent flora

At Silent Valley, the sampled shola plots contain 37 taxa of woody plants of which 27 are endemics. Structurally, the flora is much similar to that of Eravikulam. The shola vegetation in the full tree plots of Silent Valley is dominated by arborescent species like *Ilex wightiana* and *Cinnamomum perrottetii* with maximum IVI (24.05 and 23.58, respectively). The other dominant species having IVI more than 10 are *Syzygium densiflorum, Daphiniphyllum neilgherrense, Litsea floribunda, Turpenia nepalensis, Beilschmedia wightii, Michelia nilagirica, Microtropis ramiflora, Elaeocarpus recurvatus, Cinnamomum sulphuratum* and *Rhododendron arboreum* var. *nilagirica* (Table 7).

Examples of co-dominant species within the tree patches of Silent Valley with their IVI values ranging between 4-10 are *Vaccinium leschnaultii, Photinia integrifolia, Rhodomyrtus tomentosa, Neolitsea scrobiculata, Glochidion neilghrrense, Ternstroemia japonica, Gomphandra coriacea, Ilex gardneriana,* and so on. Rare species with their IVI values less than 4 are represented in the Silent Valley sholas by both endemic and non-endemic species like *Actinodaphne bourdilloni, Symplocos obtusa, Ixora notoniana, Nothapodytes nimmoniana, Meliosma simplicifolia, Lasianthus ciliatus* and *Hedyotis leschnaultiana*.

With regard to frequency of occurrence of various arborescent species in the sholas of Silent Valley, 12 taxa are distributed at a frequency of 33.33 per cent. Species like *Ixora notoniana, Meliosma simplicifolia* and *Actinodaphne bourdillonii* belong to this category. Five species, namely *Beilschemedia wightii, Neolitsea scrobiculata, Glochidion neilghrrense, Gomphandra coriacea* and *Ilex gardneriana* are having a frequency of 66.66% and the remaining species belong to the category of 100% frequency (Table 7).

A comparison of the dominant arborescent species of the sholas of Eravikulam and Silent Valley showed that species like *Ardisia rhomboidea, Cinnamomum macrocarpum, Persea macrantha, Ilex denticulata* and *Microtopis ovalifolia* which are dominant at Eravikulam are not even represented in the sampled shola patches of Silent Valley. Similarly, dominant arborescent

species of Silent Valley sholas, namely *Daphiniphyllum neilgherrense* and *Beilschmedia wightii* are not occurring in the sampled shola patches at Eravikulam. Also, species of *Turpenia* and *Michelia,* dominant in the sholas of Silent Valley, are found to be co-dominants in their population status at Eravikulam.

Analysis of the density of the arborescent shola species at Silent Valley showed that 8 species are in the density class of 0.33 to 0.66 as exemplified by *Hedyotis leschnaultiana, Lasianthus ciliatus, Meliosma simplicifolia* and *Actinodaphne bourdillonii*. Maximum density is enjoyed by *Syzygium densiflorum* (9), followed by *Litsea floribunda* (8.66) and *Ilex wightiana* (8.33), all endemic to Southern Peninsular India (Table 7). There are about 20 species in the density class of 1 to 8 and species-wise, and this set of trees is represented maximum in the shola.

Population status of woody species in the tree-grassland plots was also considered (Table 8). Here, there were 13 species with IVI more than 10 and *Syzygium densiflorum* and *Ilex gardneriana* recorded the maximum value. Co-dominant species with IVI 4-10 were represented by 11 species and five species were rare with their IVI values less than 4 (Table 8). Frequency-wise, 12 species recorded 100%, 10 taxa 66.6% and the remaining 7 taxa were in the range of 33.3 per cent. *Syzygium densifolium* with a value of 8.66 was the most dense species in the marginal plots followed by Ilex wightiana. Species like *Ternstroemia japonica*, *Nothapodytes nimmoniana* and *Gnidia glauca* recoreded the least density value of 0.33.

4.2.3. Population status of endemic arborescent species

In the sampled shola patches of Silent Valley, there were 20 endemic arborescent species. Phytosociological analysis of the woody endemics of Silent Valley sholas showed that *Ilex wightiana, Cinnamomum perrotteti, Syzygium densiflorum* and *Blischemedia wighiti* are the dominant endemic trees in the area with IVI more than 20 (Table 9). Other co-dominant endemics with the IVI ranging between 10-20 are *Michelia nilagirica, Microtropis ramiflora, Rhododendron arboreum* var. *nilagirica, Litsea floribunda, Elaeocarpus recurvatus, Cinnamomum sulphuratum, Vaccinium leschnaultii* and *Litsea wightiana.* Rare, woody endemics with IVI less than 10 in the area are *Ixora notoniana, Actinodaphne bourdillonii, Saprosma fragrans, Symplocos macrophylla, Ligustrum perrottetii, Ilex gardneriana, Memecylon flavescens, Lasianthus ciliatus, Hedyotis leschnaultiana, Gomphandra coriacea, Ternstroemia japonica, Glochidion neilghrrense* and *Neolitsea scorbiculata* (Table 9). In short, out of the total

woody endemics recorded from Silent Valley sholas, 13% of the species are dominants, 39% are co-dominants and 48% of them are of rare occurrence in the 3 sample plots laid fully inside the tree cover.

At Silent Valley, *Rhododendron arboreum* var. *nilagirica,* which is present both in full tree plots and also half tree and half grassland plots, do not exhibit the property of 'false dominance' as in the case of Eravikulam. This is because, at Silent Valley, the species is dominant not only by basal area but also by its population size and are also common almost throughout the shola tree patches spreading into the adjoining grasslands where the sample plots were laid.

4.2.4. Regeneration of endemic arborescent species

As in the case of Eravikulam, the seedlings and saplings of woody endemics were enumerated and classified. (Table 10) gives the different categories of them for the full tree and half tree plots laid in the area. In the full-tree plots, species with sufficient numbers of seedlings and saplings were found to be *Cinnamomum perrottetii, Cinnamomum sulphuratum, Microtropis ramiflora, Syzygium densifolium, Ilex wightiana* and *Litsea floribunda*. Only few numbers of seedlings and saplings were recorded for the species *Ilex gardneriana, Lasianthus ciliatus, Ligustrum perrotteti, Glochidion neilghrrense* and *Bleischemedia wightii* in the full tree plot. Medium regeneration, expressed by the occurrence of all categories of seedlings in fairly goood numbers, were recorded for the woody endemics like *Elaeocarpus recurvatus, Gomphandra coriacea, Litsea wightiana, Memecylon flavescens, Michelia nilagirica* and *Rhododendron arboreum* var. *nilagirica* (Table 10). In the full tree plots, the percentage of different classes of seedlings recorded are a) upto 50 cm height 56.04%, b) 50 cm - 1 m hieht 27.18% and c) more than 1 m height 16.78 per cent.

In the case of tree-grassland plots, species like *Cinnamomum perrottetii, Cinnamomum sulphuratum, Microtropis ramiflora, Syzygium densiflorum* and *Saprosma fragrans* showed high regeneration potential as evident from the occurrence of all the three categories of seedlings in sufficient numbers (Table 10). Poor regeneration was observed for species like *Pavetta blanda, Bleischemedia wightii, Symplocos macrophylla, Glochidion neilgherrense* and *Hedyotis leschnaultiana* with no representation of all the three categories of seedlings. Species like *Gomphandra coriacea, Ilex wightiana, Lasianthus ciliatus, Litsea wightiana, Memecylon flavescens, Vaccinium leschnaultii, Litsea floribunda* and *Michelia nilagirica* showed medium range of regeneration with limited availability of all the three categories of seedlings (Table 10).

Percentage-wise, the different categories of seedlings are a) upto 50 cm height 52.49%, b) 50 cm - 1 m hieht 27.24% and c) more than 1 m height 20.27 per cent.

4.2.5. Invasion status of arborescent endemic species

The structural analysis of the arborescent endemics in the 50% tree - 50% grassland plots laid in the sholas of Silent Valley, there is not much of a difference noted in the occurrence of dominant species as compared with the full tree plots laid there. In the tree-grassland plots, species like *Syzygium densifolium, Ilex wightiana* and *Cinnamomum perrotteti* are the dominant ones with their IVI values more than 25 (Table 11). In fact, 83% of the endemic species are common to both full tree and half tree plots and it is only 17% of the endemic arborescent species that are confined to full tree plots laid towards the interior areas of the shola tree patch. Examples of such woody endemics restricted to the interior areas of the tree patch at Silent Valley are *Litsea wightiana, Ligustrum perrotteti, Actinodapne bourdillonii* and *Ixora notoniana*.

A comparison between the co-dominant (IVI between 4-10) endemic trees of Eravikulam and Silent Valley shola sites showed that there are 6 species not represented at Silent Valley but available at Eravikulam and 3 species that are confined to Silent Valley and not recorded from Eravikulam. The status of the endemics was also compared between the two sites. It was observed that the dominant species (IVI more than 10) are represented by 7% and 13% of the total population of tree endemic species at Eravikulam and Silent Valley, respectively. Similarly, rare endemics (IVI less than 4) are represented by 52% and 48% and common endemics (IVI between 4-10) are available at the rate of 41% and 39% respectively, at Eravikulam and Silent Valley.

Table 7. Structural details of all arborescent species in the sampled full tree plots at Silent Valley.

No.	Species*	A	D	F	BA	RD	RF	RBA	IVI	Avg. GBH
1.	Ilex wightiana	8.33	8.33	100	390.13	10.01	4.31	9.73	24.05	68.5
2.	Cinnamomum perrottetii	2.66	2.66	100	644.90	3.18	4.31	16.09	23.58	91.4
3.	Syzygium densifolium	9.00	9.00	100	161.23	10.75	4.31	4.02	19.08	46.9
4.	Daphiniphyllum neilgherrense	8.66	8.66	100	161.23	10.49	4.31	4.02	18.82	44.1
5.	Litsea floribunda	7.00	7.00	100	97.53	8.45	4.31	2.43	15.19	35.0
6.	Turpenia nepalensis	5.33	5.33	100	161.23	6.45	4.31	4.02	14.78	43.2
7.	Beilschemedia wightii	2.00	1.33	66.6	390.13	1.60	2.84	9.73	14.17	71.7
8.	Michelia nilagirica	3.33	3.33	100	199.04	4.02	4.31	4.96	13.29	48.4
9.	Microtropis ramiflora	3.66	3.66	100	161.23	4.43	4.31	4.02	12.76	42.3
10.	Elaeocarpus recurvatus	3.33	3.33	100	161.23	4.02	4.31	4.02	12.35	45.6
11.	Cinnamomum sulphuratum	1.66	1.66	100	240.83	2.00	4.31	6.00	12.31	54.6
12.	Rhododendron arboreum	5.00	5.00	100	71.66	6.05	4.31	1.78	12.14	47.4
13.	Vaccinium leschnaultii	2.66	2.66	100	97.53	3.21	4.31	2.43	9.95	32.2
14.	Photinia integrifolia	2.00	0.66	100	161.23	0.80	4.31	4.02	9.13	43.8
15.	Rhodomyrtus tomentosa	3.00	3.00	100	25.70	3.62	4.31	0.64	8.57	17.4
16.	Gnidia glauca	2.33	2.33	100	38.50	2.81	4.31	0.96	8.08	21.5
17.	Neolitsea scrobiculata	2.50	1.66	66.6	97.53	2.00	2.84	2.43	7.27	35.9
18.	Glochidion nilgherrense	1.50	1.00	66.6	127.39	1.21	2.84	3.17	7.22	39.0
19.	Ternstroemia japonica	1.33	1.33	100	25.70	1.60	4.31	0.64	6.55	18.0
20.	Gomphandra coriacea	2.50	1.66	66.6	49.76	2.00	2.84	1.24	6.08	24.9
21.	Ilex gardenariana	2.00	1.33	66.6	38.50	1.60	2.84	0.96	5.40	19.2
22.	Casearia coriacea	2.00	0.66	33.3	97.53	0.80	1.39	2.44	4.63	35.0
23.	Ligustrum perrottetii	2.00	0.66	33.3	97.53	0.80	1.39	2.43	4.62	37.0
24.	Symplocos macrophylla	2.00	0.66	33.3	97.53	0.80	1.39	2.43	4.62	36.8
25.	Saprosma fragrans	4.00	1.33	33.3	49.76	1.60	1.39	1.24	4.23	24.0
26.	Memecylon flavescens	2.50	1.66	33.3	25.70	2.00	1.39	0.64	4.03	18.0
27.	Actinodaphne bourdillonii	1.00	0.33	33.3	53.82	0.40	1.39	1.34	3.13	26.0
28.	Symplocos obtusa	3.00	1.00	33.3	13.45	1.20	1.39	0.33	2.92	35.0
29.	Nothapodytes nimmoniana	1.00	0.33	33.3	38.50	0.40	1.39	0.96	2.75	21.7
30.	Ixora notoniana	2.00	0.66	33.3	13.45	0.80	1.39	0.33	2.52	13.5
31.	Meliosma simplicifolia	1.00	0.33	33.3	17.90	0.40	1.39	0.44	2.23	15.0
32.	Lasianthus ciliatus	1.00	0.33	33.3	17.90	0.40	1.39	0.44	2.23	15.0
33.	Hedyotis leschnaultiana	1.00	0.33	33.3	13.45	0.40	1.39	0.33	2.12	11.5

Individual average of single plot = 82 Nos / 33 m^2 (0.1 ha)

* A= Species abundance; D=Density; F=Frequency; BA=Basal area (in cm);
RD=Relative density; RF=Relative frequency; RBA-Relative basal area (in cm);
IVI=Importance value index; Avg. GBH=Average girth at brest height (in cm).

Table 8. Structural details of all arborescent species in the sampled tree-grassland combined plots at Silent Valley.

No.	Species*	A	D	F	BA	RD	RF	RBA	IVI	Avg. GBH
1.	Syzygium densifolium	8.66	8.66	100	161.23	15.66	4.76	4.06	24.48	46.9
2.	Ilex wightiana	4.33	4.33	100	390.13	7.83	4.76	9.84	22.43	68.5
3.	Cinnamomum perrottetii	1.50	1.00	66.6	644.90	1.80	3.17	16.27	21.24	91.4
4.	Daphiniphyllum neilgherrense	5.00	5.00	100	161.23	9.03	4.76	4.06	17.85	44.1
5.	Beilschemedia wightii	1.33	1.33	100	390.13	2.40	4.76	9.84	17.00	71.7
6.	Cinnamomum sulphuratum	2.00	2.00	100	240.83	3.61	4.76	6.07	14.44	54.6
7.	Litsea floribunda	3.66	3.66	100	97.53	6.62	4.76	2.46	13.84	25.8
8.	Photinia integrifolia	2.66	2.66	100	161.23	4.80	4.76	4.06	13.62	43.8
9.	Vaccinium leschnaultii	3.00	3.00	100	97.53	5.40	4.76	2.46	12.62	32.2
10.	Turpenia nepalensis	3.50	2.66	66.6	161.23	4.80	3.17	4.06	12.03	43.2
11.	Rhododendron arboreum	3.00	3.00	100	71.66	5.40	4.76	1.80	11.96	47.4
12.	Microtropis ramiflora	3.00	2.00	66.6	161.23	3.61	3.17	4.06	10.84	42.3
13.	Neolitsea scrobiculata	1.66	1.66	100	97.53	3.00	4.76	2.46	10.22	35.9
14.	Michelia nilagirica	1.50	1.00	66.6	199.04	1.80	3.17	5.02	9.99	48.4
15.	Saprosma fragrans	2.00	2.00	100	49.76	3.60	4.76	1.25	9.61	24.0
16.	Rhodomyrtus tomentosa	2.33	2.33	100	25.70	4.20	4.76	0.64	9.60	17.4
17.	Elaeocarpus recurvatus	1.50	1.00	66.6	161.23	1.80	3.17	4.06	9.03	45.6
18.	Casearia coriacea	2.00	1.33	66.6	97.53	2.40	3.17	2.46	8.03	35.0
19.	Symplocos macrophylla	1.00	0.66	66.6	97.53	1.20	3.17	2.46	6.83	36.8
20.	Gomphandra coriacea	1.50	1.00	66.6	49.76	1.80	3.17	1.25	6.22	24.9
21.	Schfflera capitata	1.00	0.66	66.6	42.11	1.20	3.17	1.06	5.43	23.0
22.	Glochidion neilgherrense	1.00	0.33	33.3	127.39	0.60	1.58	3.21	5.39	39.0
23.	Ilex gardeneriana	1.00	0.66	66.6	38.50	1.20	3.17	0.97	5.34	19.2
24.	Symplocos cochinchinensis	2.00	0.66	33.3	97.53	1.20	1.58	2.46	5.24	35.0
25.	Gnidia glauca	2.00	0.66	33.3	38.50	1.24	1.58	0.97	3.79	21.5
26.	Memecylon flavescens	2.00	0.66	33.3	25.70	1.20	1.58	0.64	3.42	18.0
27.	Nothapodytes nimmoniana	1.00	0.33	33.3	38.50	0.60	1.58	0.97	3.15	21.7
28.	Pavetta blanda	2.00	0.66	33.3	11.46	1.20	1.58	0.28	3.06	12.6
29.	Ternstroemia japonica	1.00	0.33	33.3	25.70	0.60	1.58	0.64	2.82	18.0

* A= Species abundance; D=Density; F=Frequency; BA=Basal area (in cm);
RD=Relative density; RF=Relative frequency; RBA-Relative basal area (in cm);
IVI=Importance value index; Avg. GBH=Average girth at brest height (in cm).

Table 9. Structural details of endemic arborescent species in the sampled full tree plots at Silent Valley.

No.	Species*	A	D	F	BA	RD	RF	RBA	IVI
1.	Ilex wightiana	8.33	8.33	100	390.13	13.81	5.62	11.28	30.71
2.	Cinnamomum perrottetii	2.66	2.66	100	644.90	4.41	5.62	18.68	28.71
3.	Syzygium densifolium	9.00	9.00	100	161.23	14.9	5.62	4.68	25.20
4.	Beilschemedia wightii	2.00	1.33	66.6	390.13	2.12	3.70	11.28	17.10
5.	Michelia nilagirica	3.33	3.33	100	199.04	5.52	5.62	5.78	16.92
6.	Microtropis ramiflora	3.66	3.66	100	161.23	6.07	5.62	4.68	16.37
7.	Rhododendron arboreum	5.00	5.00	100	71.66	8.28	5.62	2.10	16.00
8.	Litsea floribunda	5.33	5.33	100	52.99	8.83	5.62	1.53	15.98
9.	Elaeocarpus recurvatus	3.33	3.33	100	161.23	5.52	5.62	4.68	15.82
10.	Cinnamomum sulphuratum	1.66	1.66	100	240.83	2.76	5.62	6.98	15.36
11.	Vaccinium leschnaultii	2.66	2.66	100	97.53	4.41	5.62	2.88	12.91
12.	Litsea wightiana	2.50	1.66	66.6	148.50	2.76	3.70	4.28	10.74
13.	Neolitsea scrobiculata	2.50	1.66	66.6	97.53	2.76	3.70	2.88	9.34
14.	Glochidion neilgherrense	1.50	1.00	66.6	127.39	1.65	3.70	3.68	9.03
15.	Ternstroemia japonica	1.33	1.33	100	25.70	2.12	5.62	0.72	8.46
16.	Gomphandra coriacea	2.50	1.66	66.6	49.76	2.76	3.70	1.42	7.88
17.	Memecylon flavescens	2.50	1.66	33.3	25.70	2.76	3.70	1.42	7.88
18.	Ilex gardeneriana	2.00	1.33	66.6	38.50	2.12	3.70	1.11	6.93
19.	Ligustrum perrottetii	2.00	0.66	33.3	97.53	1.06	1.81	2.88	5.75
20.	Symplocos macrophylla	2.00	0.66	33.3	97.53	1.06	1.81	2.88	5.75
21.	Saprosma fragrans	4.00	1.33	33.3	49.76	2.12	1.81	1.42	5.35
22.	Actinodaphne bourdillonii	1.00	0.33	33.3	53.82	0.53	1.81	1.58	3.92
23.	Ixora notoniana	2.00	0.66	33.3	13.45	1.06	1.81	0.39	3.26
24.	Lasianthus ciliatus	1.00	0.33	33.3	17.9	0.53	1.81	0.50	2.84
25.	Hedyotis leschnaultiana	1.00	0.33	33.3	13.45	0.53	1.81	0.39	2.73

* A= Species abundance; D=Density; F=Frequency; BA=Basal area (in cm);
RD=Relative density; RF=Relative frequency; RBA-Relative basal area (in cm);
IVI=Importance value index.

Table 10. Different categories and numbers of seedlings and trees of endemic arborescent species in the full tree and tree-grassland combined plots in Silent Valley.

No.	Species	Full tree plots				Tree - grassland combined plots			
		< 50 cm	*50 – 1 m*	*> 1 m*	*Trees*	*< 50 cm*	*50 – 1 m*	*> 1 m*	*Trees*
1.	Beilschemedia wightii	-	2	1	4	-	2	-	4
2.	Cinnamomum perrottetii	23	7	3	8	20	8	6	3
3.	Cinnamomum sulphuratum	13	7	5	5	16	8	3	6
4.	Elaeocarpus recurvatus	8	6	1	10	-	5	6	3
5.	Glochidion neilgherrense	1	3	-	3	2	-	1	1
6.	Gomphandra coriacea	5	2	1	5	-	-	-	-
7.	Ilex wightiana	8	6	4	25	13	1	6	13
8.	Litsea floribunda	11	8	6	16	8	5	2	6
9.	Litsea wightiana	10	6	5	5	12	2	4	5
10.	Ligustrum perrottetii	2	3	-	2	-	-	-	-
11.	Memecylon flavescens	4	3	-	5	8	4	2	2
12.	Michelia nilagirica	5	2	3	10	4	7	3	3
13.	Microtropis ramiflora	15	5	9	11	4	7	8	6
14.	Neolitsea scrobiculata	6	1	1	5	2	3	2	5
15.	Rhododendron arboreum	8	2	2	15	4	-	3	9
16.	Saprosma fragrans	4	2	2	4	13	5	3	6
17.	Syzygium densifolium	25	10	5	27	19	7	6	26
18.	Vaccinium leschnaultii	7	1	1	8	3	4	-	9
19.	Ilex gardneriana	2	1	-	4	2	3	1	2
20.	Lasianthus ciliatus	2	1	-	-	9	6	-	-
21.	Hedyotis leschnaultiana	6	3	-	-	3	1	-	-
22.	Schefflera capitata	-	-	-	-	5	2	3	2
23.	Symplocos macrophylla	-	-	-	2	2	-	1	2
24.	Pavetta blanda	-	-	-	-	2	1	-	2

Table 11. Structural details of the arborescent endemic species in the tree-grassland combined plots at Silent Valley.

No.	Species*	A	D	F	BA	RD	RF	RBA	IVI
1.	Syzygium densifolium	8.66	8.66	100	161.23	22.0	6.25	4.90	33.15
2.	Ilex wightiana	4.33	4.33	100	390.13	11.01	6.25	11.80	29.06
3.	Cinnamomum perrottetii	1.50	1.00	66.6	644.90	2.54	4.16	19.50	26.2
4.	Beilschemedia wightii	1.33	1.33	100	390.13	3.38	6.25	11.80	21.43
5.	Cinnamomum sulphuratum	2.00	2.00	100	240.83	5.08	6.25	7.30	18.63
6.	Vaccinium leschnaultii	3.00	3.00	100	97.53	7.62	6.25	3.10	16.97
7.	Rhododendron arboreum	3.00	3.00	100	71.66	7.62	6.25	2.26	16.13
8.	Litsea wightiana	1.66	1.66	100	143.58	4.23	6.25	4.39	14.87
9.	Microtropis ramiflora	3.00	2.00	66.6	161.23	5.08	4.16	4.90	14.14
10.	Neolitsea scrobiculata	1.66	1.66	100	97.53	4.23	6.25	3.10	13.58
11.	Michelia nilagirica	1.50	1.00	66.6	199.04	2.54	4.16	6.02	12.72
12.	Elaeocarpus recurvatus	1.50	1.00	66.6	161.23	2.54	4.16	4.90	11.6
13.	Litsea floribunda	3.00	2.00	66.6	52.99	5.08	4.16	1.60	10.84
14.	Saprosma fragrans	2.00	2.00	100	49.76	4.23	4.16	1.40	9.79
15.	Symplocos macrophylla	1.00	0.66	66.6	97.53	1.69	4.16	3.10	8.95
16.	Gomphandra coriacea	1.50	1.00	66.6	49.76	2.54	4.16	1.50	8.2
17.	Schefflera capitata	1.00	0.66	66.6	42.11	1.69	4.16	1.30	7.15
18.	Ilex gardneriana	1.00	0.66	66.6	38.50	1.69	4.16	1.26	7.11
19.	Glochidion neilgherrense	1.00	0.33	33.3	127.39	0.84	2.08	3.80	6.72
20.	Memecylon flavescens	2.00	0.66	33.3	25.70	1.69	2.08	0.80	4.57
21.	Pavetta blanda	2.00	0.66	33.3	11.46	1.69	2.08	0.34	4.11
22.	Ternstroemia japonica	1.00	0.33	33.3	25.70	0.84	2.08	0.80	3.72

* A= Species abundance; D=Density; F=Frequency; BA=Basal area (in cm);
RD=Relative density; RF=Relative frequency; RBA-Relative basal area (in cm);
IVI=Importance value index.

5. Discussion and conclusions

The study on endemism, population, regeneration and invasion potentials of the arborescent angiosperms of the typical shola forests at Eravikulam and Silent Valley revealed that the tree floras of the two areas are very rich in woody endemic species, most of which are found only in similar habitats within the southern Western Ghats. Also, with regard to endemic tree angiosperms, Eravikulam sholas is more rich than that of Silent Valley. Out of the 36 woody angiosperms recorded from 6 sample plots at Eravikulam, 30 are endemic to Peninsular India, and most of them are limited to narrow ranges of geographical distribution in the southern Western Ghats. The endemic fraction of the tree flora of Eravikulam is 83.33% of the total arborescent species recorded. As compared to Silent Valley sholas, where the woody endemics are represented by 72.97% of the total 37 tree taxa, Eravikulam shola is more rich. It is also notable that the tree flora of the sholas, apart from their high endemism, is also the abode of a much diverse assemblage of orchids, balsams, ferns, lichens and bryophytes, either as epiphytes or growing in the shaded microclimate created by the tree cover (Figs. 7, 8). Therefore, total protection of the tree patches confined to the valleys and depressions of grasslands, characteristic to the shola vegetation type, is very essential both for the survival of endemic tree species and also the associated flora.

Another important observation made with regard to the tree flora of the shola forests of Kerala is the occurrence of phytogeographically significant plant species. A very notable species in this regard is *Rhododendron arboreum* Smith var. *nilagirica* (Zenk.) Clarke, occurring in the sholas of both Eravikulam and Silent Valley (Fig. 9). In fact, all other members of the genus *Rhododendron* in India are confined to the Himalayan region. Yet another woody plant species of disjunctive distribution, recorded from the sholas of Silent Valley is *Photinia integrifolia* Lindl. var. *sublanceolata* Miq., which is distributed only in the eastern and southern parts of India, apart from Sri Lanka. Of course, other than Peninsular Indian endemic tree species, the sholas of Kerala is more represented by species of Sri Lankan distribution, showing the affinity of the flora of South India to that of Sri Lanka, where also shola forests are available. A general feature of endemic tree species of shola forests is that they are mostly found only in the shola forests, either within the country or outside, adding to the significance of the forest type from a conservation point of view.

Fig.7. Trunk of a shola tree covered with fungi, lichens and other epiphytes

Fig.8. Orchids growing on the shola tree trunks.

Fig.9. The endemic tree *Rhododendron arboreum* var. *nilagirica* and its regeneration in the surrounding grasslands.

Fig.10. Spreading of arborescent species from the tree cover into the grasslands (Eravikulam)

As mentioned earlier, Eravikulam sholas is more rich in woody endemic species content than Silent Valley sholas. However, in both areas representation of endemic trees in the total tree population is about 60 per cent. Regeneration-wise, the comparatively species rich endemic tree flora of Eravikulam is also rich in the percentage of seedlings which had crossed the mortality stage (ie. more than 1 m height). This shows that the shola forests of Eravikulam is regnerating better than that of Silent Valley.

At Eravikulam, species like *Rhododendron arboreum* var. *nilgirica*, *Symplocos foliosa* and *Pavetta blanda* with mature trees inside the tree cover are fairly well reperesented in the adjoining grasslands as established seedlings showing their invasion potential (Fig. 10). Similar endemic woody invaders at Silent Valley are *Schefflera capitata*, *Symplocos macrophylla* and *Pavetta blanda*. Promoting the regeneration of such species can help in the expansion of the shola tree cover, which will help to preserve the forest type and also conserve the endemic plant species and the associated biodiversity

6. References

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