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Diversity of woody vegetation in the buffer zone of silent valley national park, Kerala

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Abstract

The Buffer zone (Latitude 11°2'-11°14' N and Longitude 76°21'-76°32' E) surrounding Silent Valley National Park is an ecologically important region located within the Nilgiri Biosphere Reserve in Palakkad district, Kerala. The area functions as a protective barrier that minimizes human interference and helps maintain the ecological integrity of the core rainforest ecosystem. The present study evaluated the diversity and composition of woody species in five different forest types of the buffer zone using the quadrat sampling method. The investigated forest types include West Coast Tropical Evergreen Forest, West Coast Semi-evergreen Forest, Southern Moist Mixed Deciduous Forest, Southern Dry Mixed Deciduous Forest, and Southern Montane Wet Temperate Forest. Among these, the West Coast Tropical Evergreen Forest exhibited the highest species richness with 141 woody species, along with a Shannon-Wiener diversity index of 2.767, Simpson diversity index of 0.900, and stand density of 1035 stems ha⁻¹. The West Coast Semi-evergreen Forest recorded 83 species with Shannon-Wiener and Simpson indices of 2.496 and 0.895, respectively, and a stand density of 699 stems ha⁻¹. The South Indian Moist Deciduous Forest contained 77 woody species with diversity indices of 2.253 and 0.877, and a stand density of 415 stems ha⁻¹. The South Indian Dry Deciduous Forest showed 52 woody species with Shannon-Wiener and Simpson indices of 2.318 and 0.888, respectively, and a stand density of 488 stems ha⁻¹. The Southern Montane Wet Temperate Forest supported 63 woody species with a Shannon-Wiener index of 2.527, Simpson index of 0.897, and stand density of 1032 stems ha⁻¹. The study demonstrates significant variation in woody species diversity and stand structure among the forest types, highlighting the ecological significance of the Silent Valley buffer zone in biodiversity conservation and sustainable forest management.

Keywords: Buffer zone, diversity indices, forest types, phytosociology, silent valley

Introduction

Silent Valley National Park represents one of the best-preserved Tropical Evergreen forest ecosystems in the Western Ghats and forms an ecologically important part of the Nilgiri Biosphere Reserve. The region is well known for its rich biodiversity, high level of endemism, and significant ecological value (Pascal, 1988; Nair, 1991) [45, 41]. The establishment of buffer zones around protected areas is considered an important conservation approach for reducing habitat degradation, regulating human activities, and maintaining ecological connectivity (Nair, 1991) [41]. The buffer zone surrounding Silent Valley National Park acts as a transitional landscape that safeguards the core rainforest ecosystem from anthropogenic disturbances while supporting long-term ecological stability and sustainable resource management. Woody species diversity is considered a key ecological attribute because it reflects vegetation composition, community structure, regeneration status, and overall ecosystem functioning (Odum, 1971) [42]. Therefore, phytosociological investigations are essential for understanding forest dynamics and for developing effective biodiversity conservation and forest management strategies.

Quantitative ecological methods such as quadrat sampling are widely used to analyze vegetation composition, species distribution, and stand structure in forest ecosystems (Misra, 1968) [39]. Diversity indices, including the Shannon-Wiener and Simpson indices, are commonly applied to evaluate species richness, dominance, and community diversity. Earlier studies conducted in the Western Ghats have reported considerable variation in woody species diversity among different forest types. Studies from the Nilgiri Biosphere Reserve and Periyar Tiger Reserve revealed higher species diversity in evergreen and semi-evergreen

forests compared to deciduous forests, mainly due to climatic and anthropogenic influences (Sundarapandian and Swamy, 2000; Parthasarathy, 1999) ^[53, 43]. Similar observations were reported from Kalakad-Mundanthurai Tiger Reserve, where evergreen forests exhibited greater structural complexity and biodiversity significance (Ganesh *et al.*, 1996) ^[27].

Kunhikannan *et al.*, (2011) ^[37] conducted a phytosociological assessment in the Medicinal Plant Conservation Area (MPCA) located in the core zone of Silent Valley National Park and documented high woody species richness and ecological stability in the evergreen forests. Their findings highlighted the importance of the Silent Valley forests in conserving endemic, rare, and medicinal plant species of the Western Ghats. However, detailed studies on woody species diversity and stand structure in the buffer zone forests of Silent Valley remain limited. In this context, the present study aims to evaluate woody species diversity, stand density, and phytosociological characteristics across five major forest types of the Silent Valley buffer zone. The study provides baseline ecological information that can support biodiversity conservation and sustainable forest management in the region.

Materials and Methods

Study Area

The study was conducted in the buffer zone of Silent Valley National Park, located in the southern Western Ghats of Kerala, India. The buffer zone lies between Latitude 11°2'-11°14' N and Longitude 76°21'-76°32' E and forms part of the Nilgiri Biosphere Reserve. The total extent of the buffer zone is approximately 14,800 ha, which was designated to strengthen the protection of the core rainforest ecosystem and maintain ecological connectivity within the landscape (Kerala Forest Department, 2007) ^[36].

The study area is characterized by rugged topography, undulating hills, valleys, and heterogeneous vegetation. The altitude ranges from 110 m to over 2050 m above mean sea level, resulting in marked variation in climate and forest composition. The region experiences a tropical humid climate with heavy rainfall received mainly from the southwest and northeast monsoons. The buffer zone comprises several forest types with varying spatial distribution. Evergreen Forest occupies the largest area (6,096 ha), followed by Semi-evergreen Forest (3,970 ha), Dry Deciduous Forest (2,190 ha), and Moist Deciduous Forest (1,740 ha), while Shola Forest occupies the smallest extent (210 ha) (Satish and Reddy, 2016) ^[52]. These diverse forest formations support rich woody species diversity and provide habitat for numerous endemic and threatened species of the Western Ghats (Pascal, 1988) ^[45]. The buffer zone also plays a vital ecological role in reducing anthropogenic pressure on the core forest, while contributing to biodiversity conservation, watershed protection, and ecosystem stability in the Silent Valley landscape (Nair, 1991) ^[41].

Methods

A phytosociological assessment was carried out during 2019-2024 using 25 × 25 m quadrats for woody species, 3 × 3 m quadrats for shrubs, and 1 × 1 m quadrats for seedlings and herbs (Curtis & Cottam, 1956) ^[14] to evaluate the composition, distribution, and status of vegetation in the

buffer zone of Silent Valley National Park. A total of 84 quadrats were laid across different forest types within the buffer zone. Among these, 20 quadrats were established in West Coast Tropical Evergreen Forest, 16 quadrats in West Coast Semi-evergreen Forest, 24 quadrats in South Indian Moist Deciduous Forest, 16 quadrats in South Indian Dry Deciduous Forest, and 8 quadrats in Southern Montane Wet Temperate Forest. The quadrats were distributed throughout the study area to assess woody species diversity and vegetation structure across the different forest types (Table 6).

Data from each quadrat were collected and recorded individually, and all plant specimens within the sampling plots were documented. Trees and lianas with a girth at breast height (GBH) greater than 10 cm were identified, and girth measurements were taken at 1.37 m above ground level (Parthasarathy and Karthikeyan, 1997) ^[44]. Species identification was carried out using standard floristic literature and regional taxonomic manuals, including Flora of the Presidency of Madras (Gamble and Fischer, 1915-1936) ^[25], A Field Key to the Trees and Lianas of the Evergreen Forests of the Western Ghats (Pascal and Ramesh, 1987) ^[46], Flora of Silent Valley (Manilal, 1988) ^[38], Flora of Palghat District (Vajravelu, 1990) ^[54], and Flowering Plants of Kerala (Sasidharan, 2013) ^[51]. The nomenclature and taxonomic status of the recorded plant species were verified using Plants of the World Online (POWO) and International Plant Names Index (IPNI) to confirm accepted scientific names, author citations, and synonymy (POWO, 2024; IPNI, 2024) ^[47, 31]. The Red-listed species recorded according to IUCN reports(2024) ^[35].

Phytosociological analysis of woody species was carried out following standard ecological methods described by Curtis and McIntosh (1950) ^[15], Curtis and Cottam (1956) ^[14], and Misra (1968) ^[39]. Quantitative ecological parameters such as density, frequency, abundance, abundance to frequency ratio (A/F), relative density (RD), relative frequency (RF), relative dominance (RDO), Importance Value Index (IVI), and total basal area were calculated to evaluate vegetation structure and species dominance in different forest types of the buffer zone of Silent Valley National Park. Density was calculated as the total number of individuals of a species divided by the total number of quadrats studied. Frequency was determined based on the percentage occurrence of species in the sampling quadrats, while abundance was estimated from the number of individuals present in quadrats where the species occurred. The abundance to frequency ratio (A/F) was used to determine the distribution pattern of species. Basal area was calculated from girth at breast height (GBH) measurements, and total basal area was obtained by summing the basal area of all individuals of a species. The 15 major species based on Density (D) values were selected for regeneration and population structure analysis. Population structure and regeneration status were assessed based on the distribution of individuals among different girth, seedling, and sapling classes to evaluate population stability and regeneration potential of the species. Relative density, relative frequency, and relative dominance were computed to determine the ecological significance of species, and the Importance Value Index (IVI) was derived by summing RD, RF, and RDO values. Family Importance Value Index (FIVI) was calculated as the sum of Relative Density, Relative Diversity, and Relative Dominance of each family (Mori *et al.*, 1983) ^[40]. The

diversity indices, including the Shannon-Wiener index and Simpson index, were calculated using PAST version 5.3 statistical software (Hammer *et al.*, 2001) [29].

Result and Discussion

Five major forest types were selected for the present study. Each forest type exhibited distinct ecological characteristics, species composition, and vegetation growth patterns. The details of these forest types are described below.

West Coast Tropical Evergreen Forest (1A/C4)

A total of 141 woody species were recorded from the study area, comprising 116 trees and 25 lianas. These species belonged to 115 genera distributed among 56 families. The Family Importance Value Index (FIVI) revealed that Phyllanthaceae was the most ecologically dominant family with the highest FIVI value of 19.71, followed by Putranjivaceae (17.46) and Myristicaceae (15.52). In contrast, families such as Olacaceae, Combretaceae, Staphyleaceae, and Erythroxylaceae exhibited the lowest FIVI values (0.31), indicating comparatively lower ecological representation and dominance within the forest.

The total stand density was 1035 stems ha^{-1} . Among the woody species, *Cullenia exarillata* (Figure 1A) exhibited the highest density (61.6 stems ha^{-1}), followed by *Garcinia cambogioides* var. *cambogioides* (52.0 stems ha^{-1}), *Palaquium ellipticum* (48.0 stems ha^{-1}) (Figure 1E), *Drypetes oblongifolia* (45.6 stems ha^{-1}), and *Dimocarpus longan* (44.0 stems ha^{-1}) (Figure 1B). Other dominant species included *Reinwardtiadendron anamalaiense* (41.6 stems ha^{-1}), *Drypetes venusta* (37.6 stems ha^{-1}), *Myristica beddomei* (36.0 stems ha^{-1}), *Actinodaphne bourdillonii* (35.2 stems ha^{-1}), and *Mesua ferrea* (32.8 stems ha^{-1}). Several species showed very low densities of 0.8 stems ha^{-1} , including *Diospyros sylvatica*, *Holigarna nigra*, and *Monoon coffeoides* indicating poor representation in the forest stand.

The abundance-to-frequency (A/F) ratio revealed that the majority of species exhibited a contiguous (clumped) distribution pattern in the study area. Out of the 140 recorded species, 129 species (92.14%) showed contiguous distribution with A/F values greater than 0.05, while 9 species (6.43%) exhibited random distribution with A/F values ranging between 0.025 and 0.05. Only 2 species (1.43%) showed a regular distribution pattern with A/F values less than 0.025, indicating a highly aggregated distribution of species within the forest stand. In this forest type, 2 species were categorized as Data Deficient (DD), 3 species as Endangered (EN), 7 species as Near Threatened (NT), and 10 species as Vulnerable (VU) according to the International Union for Conservation of Nature (IUCN) Red List criteria (Table 7).

The analysis revealed active natural regeneration within the forest, as most species were predominantly represented by seedlings, saplings, and lower girth classes. Among the upper canopy species, *Knema attenuata* (97.66%), *Palaquium ellipticum* (95.94%) (Figure 1E), *Canarium strictum* (95.64%), and *Dimocarpus longan* (95.32%) (Figure 1B) exhibited high seedling representation, indicating successful regeneration status. In the lower canopy, *Gomphandra tetrandra* recorded the highest seedling percentage (98.48%), followed by *Garcinia cambogioides* var. *cambogioides* (83.85%). Species such as *Agrostistachys borneensis* and *Paracroton pendulus* subsp. *zeylanicus* were mainly concentrated in lower girth classes, reflecting a developing population structure with comparatively fewer mature individuals.

The dominance of species within the stand was reflected by their total basal area contribution. Among the recorded species, *Cullenia exarillata* (Figure 1A) exhibited the highest basal area (101,025 $\text{cm}^2 \text{ha}^{-1}$), contributing approximately 19.37% of the total stand basal area. This was followed by *Bischofia javanica* (13.79%), *Palaquium ellipticum* (8.65%) (Figure 1E), *Lagerstroemia microcarpa* (8.28%), and *Homalium ceylanicum* (6.84%). Collectively, these five species accounted for about 56.93% of the total stand basal area, indicating their strong ecological dominance in the evergreen forest stand. In contrast, the remaining species together contributed 43.07% of the total basal area, reflecting a comparatively lower individual contribution but substantial cumulative representation of species diversity within the community.

The ecological dominance of species within the forest was assessed using the Importance Value Index (IVI). Among the recorded species, *Cullenia exarillata* (Figure 1A) exhibited the highest IVI value (27.63), followed by *Palaquium ellipticum* (15.37), *Dimocarpus longan* (11.63) (Figure 1B), *Drypetes venusta* (10.40), and *Mesua ferrea* (8.54). Other ecologically important species included *Drypetes oblongifolia* (7.73), *Canarium strictum* (7.31), *Myristica beddomei* (6.72), *Antidesma montanum* var. *montanum* (6.49), and *Reinwardtiadendron anamalaiense* (6.37). The higher IVI values of these species indicate their greater ecological significance and dominance within the forest stand. In contrast, several species exhibited very low IVI values (<0.50), reflecting their poor representation and lower ecological influence within the community structure. Overall, the IVI distribution suggests that a few dominant species contribute substantially to stand structure, while a large number of species occur with relatively low ecological importance, highlighting the diverse nature of the tropical evergreen forest community.

Table 1: Phyto-sociological parameters of trees and lianas in the West Coast Tropical Evergreen Forest of the Silent Valley buffer zone with details on density (D), frequency (F), abundance (A), relative density (RD), relative frequency (RF), relative dominance (RDO), Importance Value Index (IVI), and abundance-to-frequency (A/F) ratio

Species name	D	F	A	RD	RF	RDO	IVI	A/F
<i>Acrocarpus fraxinifolius</i>	1.60	10.00	1.00	0.15	0.46	1.16	1.77	0.10
<i>Acronychia pedunculata</i>	13.60	35.00	2.43	1.31	1.62	0.42	3.35	0.07
<i>Actinodaphne bourdillonii</i>	8.80	40.00	1.38	0.85	1.85	0.40	3.10	0.03
<i>Actinodaphne tadulingamii</i>	0.80	5.00	1.00	0.08	0.23	0.01	0.31	0.20
<i>Aglaia lawii</i>	1.60	10.00	1.00	0.15	0.46	0.37	0.99	0.10
<i>Agrostistachys borneensis</i>	70.40	15.00	29.33	6.80	0.69	0.84	8.34	1.96
<i>Ampelocissus birii</i> *	0.80	5.00	1.00	0.08	0.23	0.00	0.31	0.20
<i>Anamirta cocculus</i> *	2.40	10.00	1.50	0.23	0.46	0.01	0.71	0.15

<i>Ancistrocladus heyneanus</i> *	3.20	15.00	1.33	0.31	0.69	0.01	1.02	0.09
<i>Antidesma montanum</i> var. <i>montanum</i>	36.00	65.00	3.46	3.48	3.00	0.01	6.49	0.05
<i>Aphanamixis polystachya</i>	4.00	15.00	1.67	0.39	0.69	0.03	1.11	0.11
<i>Apodytes dimidiata</i>	3.20	10.00	2.00	0.31	0.46	0.04	0.81	0.20
<i>Apollonias arnottii</i>	1.60	5.00	2.00	0.15	0.23	0.58	0.97	0.40
<i>Archidendron bigeminum</i>	0.80	5.00	1.00	0.08	0.23	0.02	0.33	0.20
<i>Artabotrys zeylanicus</i> *	4.00	10.00	2.50	0.39	0.46	0.04	0.89	0.25
<i>Artocarpus heterophyllus</i>	7.20	35.00	1.29	0.70	1.62	1.72	4.04	0.04
<i>Artocarpus hirsutus</i>	2.40	15.00	1.00	0.23	0.69	1.51	2.44	0.07
<i>Atalantia monophylla</i>	1.60	5.00	2.00	0.15	0.23	0.03	0.41	0.40
<i>Atalantia racemosa</i>	0.80	5.00	1.00	0.08	0.23	0.11	0.42	0.20
<i>Baccaurea courtallensis</i>	12.00	25.00	3.00	1.16	1.15	0.07	2.39	0.12
<i>Barleria involucrata</i> var. <i>elata</i>	8.80	10.00	5.50	0.85	0.46	0.02	1.33	0.55
<i>Bischofia javanica</i>	4.00	15.00	1.67	0.39	0.69	0.37	1.45	0.11
<i>Calamus pseudotenius</i>	7.20	10.00	4.50	0.70	0.46	0.02	1.18	0.45
<i>Calophyllum polyanthum</i>	9.60	20.00	3.00	0.93	0.92	1.37	3.22	0.15
<i>Canarium strictum</i>	12.80	55.00	1.45	1.24	2.54	3.54	7.31	0.03
<i>Carissa carandas</i>	0.80	5.00	1.00	0.08	0.23	0.01	0.32	0.20
<i>Caryota urens</i>	0.80	5.00	1.00	0.08	0.23	0.01	0.32	0.20
<i>Casearia wynadensis</i>	8.00	15.00	3.33	0.77	0.69	0.03	1.49	0.22
<i>Casearia zeylanica</i>	0.80	5.00	1.00	0.08	0.23	0.05	0.36	0.20
<i>Cassia fistula</i>	0.80	5.00	1.00	0.08	0.23	0.03	0.34	0.20
<i>Cayratia pedata</i> *	0.80	5.00	1.00	0.08	0.23	0.00	0.31	0.20
<i>Celtis tetrandra</i>	0.80	5.00	1.00	0.08	0.23	0.01	0.32	0.20
<i>Celtis timorensis</i>	6.40	40.00	1.00	0.62	1.85	1.04	3.51	0.03
<i>Chionanthus mala-elengi</i>	0.80	5.00	1.00	0.08	0.23	0.00	0.31	0.20
<i>Chionanthus ramiflorus</i>	0.80	5.00	1.00	0.08	0.23	0.16	0.47	0.20
<i>Chukrasia tabularis</i>	0.80	5.00	1.00	0.08	0.23	0.00	0.31	0.20
<i>Cinnamomum malabattrum</i>	11.20	25.00	2.80	1.08	1.15	0.23	2.47	0.11
<i>Clerodendrum infortunatum</i>	2.40	5.00	3.00	0.23	0.23	0.07	0.53	0.60
<i>Combretum malabaricum</i> *	0.80	5.00	1.00	0.08	0.23	0.00	0.31	0.20
<i>Connarus wightii</i> *	2.40	15.00	1.00	0.23	0.69	0.01	0.94	0.07
<i>Cordia dichotoma</i>	1.60	10.00	1.00	0.15	0.46	1.33	1.94	0.10
<i>Croton aromaticus</i>	0.80	5.00	1.00	0.08	0.23	0.18	0.49	0.20
<i>Croton malabaricus</i>	3.20	15.00	1.33	0.31	0.69	0.09	1.10	0.09
<i>Cryptocarya wightiana</i>	5.60	25.00	1.40	0.54	1.15	0.27	1.96	0.06
<i>Cryptolepis buehneri</i> *	0.80	5.00	1.00	0.08	0.23	0.01	0.31	0.20
<i>Cullenia exarillata</i>	61.60	50.00	7.70	5.95	2.31	19.37	27.63	0.15
<i>Dalbergia volubilis</i>	0.80	5.00	1.00	0.08	0.23	0.01	0.32	0.20
<i>Dendrocnide sinuate</i>	1.60	10.00	1.00	0.15	0.46	0.00	0.62	0.10
<i>Dichapetalum gelonioides</i>	0.80	5.00	1.00	0.08	0.23	0.04	0.35	0.20
<i>Dillenia pentagyna</i>	0.80	5.00	1.00	0.08	0.23	0.11	0.42	0.20
<i>Dimocarpus longan</i>	44.00	70.00	3.93	4.25	3.23	4.15	11.63	0.06
<i>Diospyros buxifolia</i>	0.80	5.00	1.00	0.08	0.23	0.00	0.31	0.20
<i>Diospyros saldanhae</i>	0.80	5.00	1.00	0.08	0.23	0.00	0.31	0.20
<i>Diospyros sylvatica</i>	0.80	5.00	1.00	0.08	0.23	0.48	0.79	0.20
<i>Discospermum apiocarpum</i>	0.80	5.00	1.00	0.08	0.23	0.00	0.31	0.20
<i>Discospermum sphaerocarpum</i>	1.60	10.00	1.00	0.15	0.46	1.34	1.96	0.10
<i>Drypetes oblongifolia</i>	45.60	30.00	9.50	4.40	1.39	1.94	7.73	0.32
<i>Drypetes venusta</i>	37.60	60.00	3.92	3.63	2.77	3.99	10.40	0.07
<i>Dysoxylum malabaricum</i>	0.80	5.00	1.00	0.08	0.23	0.00	0.31	0.20
<i>Elaeagnus indica</i> *	1.60	5.00	2.00	0.15	0.23	0.02	0.40	0.40
<i>Elaeocarpus munronii</i>	1.60	10.00	1.00	0.15	0.46	1.03	1.65	0.10
<i>Elaeocarpus tuberculatus</i>	3.20	15.00	1.33	0.31	0.69	3.17	4.17	0.09
<i>Embelia tsjeriam-cottam</i>	2.40	5.00	3.00	0.23	0.23	0.03	0.49	0.60
<i>Erythralium scandens</i> *	2.40	10.00	1.50	0.23	0.46	0.01	0.70	0.15
<i>Erythroxylum moonii</i>	0.80	5.00	1.00	0.08	0.23	0.00	0.31	0.20
<i>Euonymus acutangulus</i>	2.40	10.00	1.50	0.23	0.46	0.01	0.70	0.15
<i>Ficus hispida</i>	2.40	10.00	1.50	0.23	0.46	0.07	0.76	0.15
<i>Ficus nervosa</i>	2.40	10.00	1.50	0.23	0.46	0.06	0.76	0.15
<i>Flacourtia indica</i>	3.20	15.00	1.33	0.31	0.69	0.68	1.68	0.09
<i>Garcinia cambogioides</i> var. <i>cambogioides</i>	52.00	40.00	8.13	5.02	1.85	0.39	7.26	0.20
<i>Gomphandra tetrandra</i>	23.20	40.00	3.63	2.24	1.85	0.25	4.34	0.09
<i>Grewia laevigata</i>	0.80	5.00	1.00	0.08	0.23	0.02	0.33	0.20
<i>Grewia tiliifolia</i>	0.80	5.00	1.00	0.08	0.23	0.03	0.34	0.20
<i>Heritiera papilio</i>	0.80	5.00	1.00	0.08	0.23	0.10	0.41	0.20
<i>Heynea trijuga</i>	3.20	20.00	1.00	0.31	0.92	0.42	1.65	0.05
<i>Holigarna nigra</i>	0.80	5.00	1.00	0.08	0.23	0.04	0.34	0.20

<i>Homalium ceylanicum</i>	5.60	15.00	2.33	0.54	0.69	6.83	8.07	0.16
<i>Hydnocarpus alpinus</i>	14.40	35.00	2.57	1.39	1.62	0.87	3.88	0.07
<i>Ichnocarpus frutescens</i> *	2.40	10.00	1.50	0.23	0.46	0.03	0.72	0.15
<i>Isonandra lanceolata</i>	0.80	5.00	1.00	0.08	0.23	0.00	0.31	0.20
<i>Ixora nigricans</i>	0.80	5.00	1.00	0.08	0.23	0.00	0.31	0.20
<i>Knema attenuate</i>	24.00	20.00	7.50	2.32	0.92	2.05	5.29	0.38
<i>Kunstleria keralensis</i> *	2.40	10.00	1.50	0.23	0.46	0.01	0.70	0.15
<i>Lagerstroemia microcarpa</i>	8.80	20.00	2.75	0.85	0.92	8.28	10.05	0.14
<i>Leea indica</i>	1.60	5.00	2.00	0.15	0.23	0.01	0.39	0.40
<i>Litsea ghatica</i>	2.40	5.00	3.00	0.23	0.23	0.24	0.70	0.60
<i>Litsea oleoides</i>	1.60	10.00	1.00	0.15	0.46	0.64	1.26	0.10
<i>Litsea stocksii</i>	0.80	5.00	1.00	0.08	0.23	0.00	0.31	0.20
<i>Macaranga peltata</i>	0.80	5.00	1.00	0.08	0.23	0.06	0.37	0.20
<i>Machilus macranthus</i>	2.40	15.00	1.00	0.23	0.69	0.50	1.43	0.07
<i>Madhuca longifolia</i>	0.80	5.00	1.00	0.08	0.23	0.07	0.38	0.20
<i>Mallotus philippensis</i>	6.40	25.00	1.60	0.62	1.15	0.32	2.10	0.06
<i>Mallotus resinous</i>	9.60	10.00	6.00	0.93	0.46	0.04	1.43	0.60
<i>Mastixia arborea</i>	5.60	15.00	2.33	0.54	0.69	0.06	1.29	0.16
<i>Melicope lunu-ankenda</i>	0.80	5.00	1.00	0.08	0.23	0.02	0.33	0.20
<i>Meliosma pinnata</i>	4.00	15.00	1.67	0.39	0.69	1.75	2.83	0.11
<i>Memecylon angustifolium</i>	0.80	5.00	1.00	0.08	0.23	0.02	0.33	0.20
<i>Memecylon heyneanum</i>	2.40	15.00	1.00	0.23	0.69	0.02	0.94	0.07
<i>Mesua ferrea</i>	32.80	50.00	4.10	3.17	2.31	3.06	8.54	0.08
<i>Mezoneuron cucullatum</i> *	8.80	25.00	2.20	0.85	1.15	0.04	2.04	0.09
<i>Monoon coffeoides</i>	0.80	5.00	1.00	0.08	0.23	0.00	0.31	0.20
<i>Monoon fragrans</i>	8.00	20.00	2.50	0.77	0.92	1.38	3.08	0.13
<i>Murraya paniculata</i>	8.00	15.00	3.33	0.77	0.69	0.05	1.52	0.22
<i>Myristica malabarica</i>	22.40	25.00	5.60	2.16	1.15	0.64	3.95	0.22
<i>Myristica beddomei</i>	36.00	45.00	5.00	3.48	2.08	1.17	6.72	0.11
<i>Nothopegia heyneana</i>	0.80	5.00	1.00	0.08	0.23	0.08	0.39	0.20
<i>Olax imbricata</i> *	0.80	5.00	1.00	0.08	0.23	0.00	0.31	0.20
<i>Olea paniculata</i>	2.40	10.00	1.50	0.23	0.46	0.36	1.05	0.15
<i>Oreocnide integrifolia</i>	8.80	20.00	2.75	0.85	0.92	0.25	2.02	0.14
<i>Oxyceros rugulosus</i> *	5.60	25.00	1.40	0.54	1.15	0.04	1.74	0.06
<i>Palaquium ellipticum</i>	48.00	45.00	6.67	4.64	2.08	8.65	15.37	0.15
<i>Paracroton pendulus</i> subsp. <i>Zeylanicus</i>	13.60	20.00	4.25	1.31	0.92	0.25	2.49	0.21
<i>Paramignya monophylla</i> *	0.80	5.00	1.00	0.08	0.23	0.00	0.31	0.20
<i>Phyllanthus assamicus</i>	4.00	10.00	2.50	0.39	0.46	0.06	0.91	0.25
<i>Phyllanthus candolleanus</i>	0.80	5.00	1.00	0.08	0.23	0.02	0.33	0.20
<i>Prunus ceylanica</i>	1.60	5.00	2.00	0.15	0.23	0.13	0.51	0.40
<i>Psychotria nigra</i>	2.40	15.00	1.00	0.23	0.69	0.01	0.93	0.07
<i>Pterocarpus marsupium</i>	0.80	5.00	1.00	0.08	0.23	0.23	0.54	0.20
<i>Reinwardtiodendron anaimalaiense</i>	41.60	35.00	7.43	4.02	1.62	0.74	6.37	0.21
<i>Salacia oblonga</i>	15.20	20.00	4.75	1.47	0.92	0.32	2.71	0.24
<i>Sapindus trifoliatus</i>	0.80	5.00	1.00	0.08	0.23	0.45	0.75	0.20
<i>Scolopia crenata</i>	8.80	40.00	1.38	0.85	1.85	0.68	3.38	0.03
<i>Senegalia pennata</i> *	1.60	10.00	1.00	0.15	0.46	0.03	0.65	0.10
<i>Senegalia rugata</i> *	1.60	10.00	1.00	0.15	0.46	0.01	0.63	0.10
<i>Spondias pinnata</i>	2.40	10.00	1.50	0.23	0.46	1.55	2.24	0.15
<i>Stereospermum colais</i>	5.60	15.00	2.33	0.54	0.69	1.47	2.71	0.16
<i>Strobocalyx arborea</i>	6.40	10.00	4.00	0.62	0.46	0.03	1.11	0.40
<i>Strychnos wallichiana</i> *	2.40	5.00	3.00	0.23	0.23	0.02	0.48	0.60
<i>Syzygium gardneri</i>	9.60	35.00	1.71	0.93	1.62	1.31	3.85	0.05
<i>Syzygium laetum</i>	20.80	50.00	2.60	2.01	2.31	0.13	4.45	0.05
<i>Syzygium lanceolatum</i>	0.80	5.00	1.00	0.08	0.23	0.02	0.33	0.20
<i>Syzygium mundagam</i>	1.60	5.00	2.00	0.15	0.23	0.10	0.49	0.40
<i>Syzygium munronii</i>	0.80	5.00	1.00	0.08	0.23	0.00	0.31	0.20
<i>Tetrapilus dioicus</i>	2.40	10.00	1.50	0.23	0.46	0.22	0.91	0.15
<i>Toona ciliate</i>	1.60	10.00	1.00	0.15	0.46	0.39	1.01	0.10
<i>Turpinia malabarica</i>	0.80	5.00	1.00	0.08	0.23	0.00	0.31	0.20
<i>Uvaria narum</i> *	9.60	30.00	2.00	0.93	1.39	0.10	2.41	0.07
<i>Ventilago madraspatana</i> *	7.20	30.00	1.50	0.70	1.39	0.04	2.12	0.05
<i>Wendlandia thyrsoides</i>	0.80	5.00	1.00	0.08	0.23	0.00	0.31	0.20
<i>Xanthophyllum flavescens</i>	9.60	20.00	3.00	0.93	0.92	0.05	1.90	0.15
<i>Zanthoxylum asiaticum</i> *	4.80	30.00	1.00	0.46	1.39	0.03	1.88	0.03

*Liana

West Coast Semi- Evergreen Forest (2A/C2)

A total of 83 woody species were recorded from the study area, comprising 68 trees and 15 lianas. These species belonged to 68 genera distributed among 40 families. The Family Importance Value Index (FIVI) revealed that Myrtaceae exhibited the highest FIVI value (24.27), followed by Lauraceae (23.64), Phyllanthaceae (21.73), Myristicaceae (19.63), and Putranjivaceae (17.50). These families showed greater ecological dominance and wider representation within the forest community. Moderate FIVI values were recorded for Rutaceae (15.30), Calophyllaceae (13.90), Meliaceae (13.59), Sapindaceae (12.14), and Polygalaceae (12.03). In contrast, families such as Acanthaceae (0.86), Icacinaceae (0.63), and Achariaceae (0.57) exhibited very low FIVI values, indicating comparatively poor ecological representation in the forest stand.

The total stand density represented by 83 woody species with density values ranging from 1 to 52 stems ha^{-1} . *Myristica beddomei* (Figure 1D) exhibited the highest density (52 stems ha^{-1}), followed by *Xanthophyllum flavescens* (50 stems ha^{-1}), *Antidesma montanum* var. *montanum* (30 stems ha^{-1}), *Dimocarpus longan* (Figure 1B) and *Syzygium laetum* (25 stems ha^{-1} each). Moderate density values were recorded for *Drypetes oblongifolia* and *Atalantia monophylla* (21 stems ha^{-1} each), *Drypetes venusta* (20 stems ha^{-1}), *Mesua ferrea* (18 stems ha^{-1}), *Kunstleria keralensis* and *Paramignya monophylla* (17 stems ha^{-1} each). Several species, such as *Aglaia lawii*, *Albizia chinensis*, *Artocarpus lacucha*, *Cassia fistula*, and *Hydnocarpus alpinus*, showed very low density values with only 1 stem ha^{-1} , indicating poor representation within the forest stand.

Analysis of the abundance to frequency (A/F) ratio showed that the majority of species exhibited contiguous (clumped) distribution patterns in this forest. Out of the total recorded species, 77 species (95.06%) showed contiguous distribution with A/F values greater than 0.05, while 4 species (4.94%) exhibited random distribution with A/F values between 0.025 and 0.05. No species showed regular distribution (<0.025). The predominance of contiguous distribution indicates heterogeneous habitat conditions and patchy regeneration patterns within the forest ecosystem. This forest type contained 1 Data Deficient (DD) species, 2 Endangered (EN) species, 4 Near Threatened (NT) species,

and 6 Vulnerable (VU) species, indicating the conservation significance of the forest and the presence of several threatened woody taxa (Table 7).

The regeneration and population structure analysis indicated active natural regeneration, as most species were dominated by seedlings, saplings, and lower girth classes. Among the upper canopy species, *Mesua ferrea* (98.58%), *Dimocarpus longan* (97.00%) (Figure 1B), and *Drypetes oblongifolia* (96.75%) showed high seedling representation, while *Myristica malabarica* (91.44%) and *Drypetes venusta* (77.64%) were mainly represented by saplings. In the lower canopy, *Xanthophyllum flavescens* recorded the highest seedling percentage (87.89%), followed by *Syzygium laetum* (79.23%) and *Garcinia gummi-gutta* (63.44%). Species such as *Celtis timorensis*, *Heynea trijuga*, and *Prunus ceylanica* were mainly confined to intermediate girth classes, indicating fewer regenerating individuals.

The dominance of species was reflected by their basal area contribution. *Syzygium gardneri* showed the highest basal area contribution (8.56%), followed by *Lagerstroemia microcarpa* (7.65%), *Antidesma montanum* var. *montanum* (7.62%), *Mesua ferrea* (5.18%), and *Myristica beddomei* (5.07%) (Figure 1D). Moderate basal area contribution was recorded for *Drypetes oblongifolia* (4.08%), *Machilus macranthus* (4.23%), *Heynea trijuga* (4.03%), and *Dimocarpus longan* (3.08%) (Figure 1B). In contrast, several species exhibited very low basal area contribution, indicating poor representation within the stand structure.

The Importance Value Index (IVI) analysis revealed that *Antidesma montanum* var. *montanum* exhibited the highest IVI value (16.13), followed by *Myristica beddomei* (15.88) (Figure 1D), *Xanthophyllum flavescens* (12.03), *Syzygium gardneri* (11.96), *Dimocarpus longan* (10.88) (Figure 1B), and *Drypetes oblongifolia* (10.04). Moderate IVI values were recorded for *Mesua ferrea* (9.86), *Lagerstroemia microcarpa* (9.77), and *Syzygium laetum* (9.56), indicating their ecological importance within the forest community. In contrast, several species such as *Aglaia lawii* (0.57), *Paracroton pendulus* subsp. *zeylanicus* (0.57), and *Tetrastigma leucostaphyllum* (0.57) showed very low IVI values, reflecting poor ecological representation in the forest stand (Table 2). The Shannon-Wiener diversity index (2.496) and Simpson diversity index (0.895) indicated high woody species diversity and ecological stability within the semi-evergreen forest.

Table 2: Phyto-sociological parameters of trees and lianas in the West Coast Semi-Evergreen Forest of the Silent Valley buffer zone with details on density (D), frequency (F), abundance (A), relative density (RD), relative frequency (RF), relative dominance (RDO), Importance Value Index (IVI), and abundance-to-frequency (A/F) ratio.

Species name	D	F	A	RD	RF	RDO	IVI	A/F
<i>Acrocarpus fraxinifolius</i>	4.00	12.50	2.00	0.57	0.84	0.08	1.49	0.16
<i>Acronychia pedunculata</i>	9.00	25.00	2.25	1.29	1.69	0.86	3.84	0.09
<i>Actinodaphne bourdillonii</i>	12.00	31.25	2.40	1.72	2.11	0.56	4.39	0.08
<i>Aglaia elaeagnoidea</i>	8.00	6.25	8.00	1.14	0.42	1.90	3.47	1.28
<i>Aglaia lawii</i>	1.00	6.25	1.00	0.14	0.42	0.00	0.57	0.16
<i>Albizia chinensis</i>	1.00	6.25	1.00	0.14	0.42	0.01	0.57	0.16
<i>Anamirta cocculus</i> *	12.00	25.00	3.00	1.72	1.69	0.12	3.52	0.12
<i>Ancistrocladus heyneanus</i> *	2.00	12.50	1.00	0.29	0.84	0.07	1.20	0.08
<i>Antidesma montanum</i> var. <i>montanum</i>	30.00	62.50	3.00	4.29	4.22	7.62	16.13	0.05
<i>Artabotrys hexapetalus</i> *	2.00	6.25	2.00	0.29	0.42	0.01	0.72	0.32
<i>Artabotrys zeylanicus</i> *	4.00	12.50	2.00	0.57	0.84	0.03	1.44	0.16
<i>Artocarpus heterophyllus</i>	3.00	12.50	1.50	0.43	0.84	0.01	1.29	0.12
<i>Artocarpus lacucha</i>	1.00	6.25	1.00	0.14	0.42	0.01	0.57	0.16
<i>Atalantia monophylla</i>	21.00	25.00	5.25	3.00	1.69	0.42	5.11	0.21
<i>Baccaurea courtallensis</i>	7.00	25.00	1.75	1.00	1.69	0.09	2.78	0.07
<i>Barleria involucreta</i> var. <i>elata</i>	3.00	6.25	3.00	0.43	0.42	0.01	0.86	0.48

<i>Callicarpa tomentosa</i>	4.00	18.75	1.33	0.57	1.27	0.10	1.94	0.07
<i>Calophyllum polyanthum</i>	5.00	18.75	1.67	0.72	1.27	2.06	4.04	0.09
<i>Canarium strictum</i>	5.00	31.25	1.00	0.72	2.11	1.74	4.56	0.03
<i>Carissa spinarum</i>	1.00	6.25	1.00	0.14	0.42	0.00	0.57	0.16
<i>Cassia fistula</i>	1.00	6.25	1.00	0.14	0.42	0.06	0.63	0.16
<i>Cayratia pedata</i> *	1.00	6.25	1.00	0.14	0.42	0.02	0.59	0.16
<i>Celtis timorensis</i>	13.00	18.75	4.33	1.86	1.27	4.07	7.19	0.23
<i>Chionanthus mala-elengi</i>	8.00	12.50	4.00	1.14	0.84	0.21	2.20	0.32
<i>Chionanthus ramiflorus</i>	5.00	12.50	2.50	0.72	0.84	0.51	2.07	0.20
<i>Cinnamomum malabattrum</i>	16.00	62.50	1.60	2.29	4.22	2.25	8.76	0.03
<i>Clerodendrum infortunatum</i>	11.00	31.25	2.20	1.57	2.11	0.11	3.79	0.07
<i>Croton malabaricus</i>	1.00	6.25	1.00	0.14	0.42	0.14	0.70	0.16
<i>Cryptocarya wightiana</i>	8.00	12.50	4.00	1.14	0.84	0.44	2.43	0.32
<i>Cullenia exarillata</i>	14.00	25.00	3.50	2.00	1.69	2.26	5.95	0.14
<i>Dimocarpus longan</i>	25.00	62.50	2.50	3.58	4.22	3.08	10.88	0.04
<i>Diospyros saldanhae</i>	2.00	12.50	1.00	0.29	0.84	0.05	1.18	0.08
<i>Diospyros sylvatica</i>	1.00	6.25	1.00	0.14	0.42	0.55	1.11	0.16
<i>Discospermum apiocarpum</i>	5.00	18.75	1.67	0.72	1.27	2.78	4.76	0.09
<i>Drypetes oblongifolia</i>	21.00	43.75	3.00	3.00	2.95	4.08	10.04	0.07
<i>Drypetes venusta</i>	20.00	12.50	10.00	2.86	0.84	3.75	7.46	0.80
<i>Elaeocarpus serratus</i>	4.00	18.75	1.33	0.57	1.27	0.19	2.02	0.07
<i>Elaeocarpus tuberculatus</i>	2.00	12.50	1.00	0.29	0.84	0.38	1.51	0.08
<i>Ficus callosa</i>	1.00	6.25	1.00	0.14	0.42	0.10	0.67	0.16
<i>Ficus hispida</i>	3.00	12.50	1.50	0.43	0.84	0.15	1.42	0.12
<i>Flacourtia indica</i>	2.00	6.25	2.00	0.29	0.42	0.57	1.27	0.32
<i>Garcinia gummi-gutta</i>	13.00	25.00	3.25	1.86	1.69	0.17	3.71	0.13
<i>Garuga pinnata</i>	11.00	12.50	5.50	1.57	0.84	1.45	3.87	0.44
<i>Gnetum edule</i> *	14.00	25.00	3.50	2.00	1.69	0.46	4.15	0.14
<i>Heynea trijuga</i>	13.00	25.00	3.25	1.86	1.69	4.03	7.58	0.13
<i>Hydnocarpus alpinus</i>	1.00	6.25	1.00	0.14	0.42	0.01	0.57	0.16
<i>Ichnocarpus frutescens</i> *	2.00	12.50	1.00	0.29	0.84	0.05	1.18	0.08
<i>Kunstleria keralensis</i> *	17.00	18.75	5.67	2.43	1.27	0.12	3.82	0.30
<i>Lagerstroemia microcarpa</i>	6.00	18.75	2.00	0.86	1.27	7.65	9.77	0.11
<i>Macaranga peltata</i>	4.00	18.75	1.33	0.57	1.27	0.38	2.21	0.07
<i>Machilus macranthus</i>	12.00	31.25	2.40	1.72	2.11	4.23	8.06	0.08
<i>Mallotus philippensis</i>	5.00	12.50	2.50	0.72	0.84	1.91	3.47	0.20
<i>Mallotus tetracoccus</i>	11.00	12.50	5.50	1.57	0.84	0.30	2.72	0.44
<i>Mappia nimmoniana</i>	1.00	6.25	1.00	0.14	0.42	0.06	0.63	0.16
<i>Meiogyne pannosa</i>	1.00	6.25	1.00	0.14	0.42	0.00	0.57	0.16
<i>Mesua ferrea</i>	18.00	31.25	3.60	2.58	2.11	5.18	9.86	0.12
<i>Murraya paniculata</i>	3.00	12.50	1.50	0.43	0.84	0.09	1.36	0.12
<i>Myristica beddomei</i>	52.00	50.00	6.50	7.44	3.38	5.07	15.88	0.13
<i>Myristica malabarica</i>	9.00	12.50	4.50	1.29	0.84	1.62	3.75	0.36
<i>Nothopegia heyneana</i>	1.00	6.25	1.00	0.14	0.42	0.03	0.59	0.16
<i>Opilia amentacea</i> *	3.00	12.50	1.50	0.43	0.84	0.08	1.36	0.12
<i>Oxyceros rugulosus</i> *	3.00	12.50	1.50	0.43	0.84	0.05	1.32	0.12
<i>Palaequium ellipticum</i>	13.00	31.25	2.60	1.86	2.11	2.00	5.97	0.08
<i>Paracroton pendulus</i> subsp. <i>Zeylanicus</i>	1.00	6.25	1.00	0.14	0.42	0.00	0.57	0.16
<i>Paramignya monophylla</i> *	16.00	12.50	8.00	2.29	0.84	0.38	3.51	0.64
<i>Phyllanthus candolleanus</i>	2.00	12.50	1.00	0.29	0.84	0.37	1.50	0.08
<i>Phyllanthus vitis-idaea</i>	6.00	6.25	6.00	0.86	0.42	0.04	1.32	0.96
<i>Prunus ceylanica</i>	13.00	12.50	6.50	1.86	0.84	0.85	3.55	0.52
<i>Reinwardtiadendron anamalaiense</i>	6.00	12.50	3.00	0.86	0.84	0.27	1.97	0.24
<i>Schleichera oleosa</i>	1.00	6.25	1.00	0.14	0.42	0.69	1.26	0.16
<i>Scolopia crenata</i>	13.00	18.75	4.33	1.86	1.27	4.08	7.20	0.23
<i>Senegalia caesia</i> *	1.00	6.25	1.00	0.14	0.42	0.03	0.60	0.16
<i>Senegalia pennata</i> *	7.00	25.00	1.75	1.00	1.69	0.05	2.74	0.07
<i>Spondias pinnata</i>	4.00	12.50	2.00	0.57	0.84	1.00	2.42	0.16
<i>Stereospermum colais</i>	6.00	18.75	2.00	0.86	1.27	1.42	3.55	0.11
<i>Strobocalyx arborea</i>	2.00	12.50	1.00	0.29	0.84	0.27	1.40	0.08
<i>Syzygium gardneri</i>	12.00	25.00	3.00	1.72	1.69	8.56	11.96	0.12
<i>Syzygium laetum</i>	25.00	37.50	4.17	3.58	2.53	3.45	9.56	0.11
<i>Syzygium munronii</i>	10.00	18.75	3.33	1.43	1.27	0.05	2.74	0.18
<i>Tetrastigma leucostaphylum</i> *	1.00	6.25	1.00	0.14	0.42	0.00	0.57	0.16
<i>Ventilago madraspatana</i> *	7.00	12.50	3.50	1.00	0.84	0.10	1.94	0.28
<i>Xanthophyllum flavescens</i>	50.00	43.75	7.14	7.15	2.95	1.92	12.03	0.16
<i>Zanthoxylum asiaticum</i> *	4.00	12.50	2.00	0.57	0.84	0.06	1.48	0.16

*Liana

Southern Moist Mixed Deciduous Forest (3B/C2)

A total of 77 woody species, comprising 66 trees and 11 lianas, belonging to 64 genera and 33 families, were recorded from the forest. The Family Importance Value Index (FIVI) revealed that Fabaceae was the most ecologically dominant family with the highest FIVI value (93.05), followed by Combretaceae (49.93), Malvaceae (22.60), and Apocynaceae (21.50). Moderate FIVI values were observed for Euphorbiaceae (17.43), Sapindaceae (14.25), Lauraceae (10.48), and Phyllanthaceae (9.44). In contrast, families such as Dilleniaceae (0.59), Simaroubaceae (0.59), and Connaraceae (0.56) exhibited very low FIVI values, indicating comparatively lower ecological representation within the forest.

The total stand density was 415 stems ha^{-1} . Species density values ranged from 0.67 to 64.67 stems ha^{-1} . Among the recorded species, *Xylia xylocarpa* exhibited the highest density (64.67 stems ha^{-1}), followed by *Wrightia tinctoria* (30 stems ha^{-1}), *Terminalia paniculata* (20.67 stems ha^{-1}), *Dalbergia lanceolaria* and *Grewia tiliifolia* (20 stems ha^{-1} each), and *Drypetes venusta* (18.67 stems ha^{-1}). Moderate density values were recorded for *Terminalia bellirica* (17.33 stems ha^{-1}), *Tetrapilus dioicus* (13.33 stems ha^{-1}), *Holarrhena pubescens* (12.67 stems ha^{-1}), *Macaranga peltata*, and *Mallotus philippensis* (12 stems ha^{-1} each). Several species, such as *Ailanthus triphyssa*, *Pterygota alata*, *Strychnos nux-vomica*, and *Tabernaemontana alternifolia*, showed very low density values with only 0.67 stems ha^{-1} , indicating poor representation within the forest stand.

Analysis of the abundance to frequency (A/F) ratio revealed that the majority of species exhibited contiguous (clumped) distribution patterns. Out of the total recorded species, 64 species (94.12%) showed contiguous distribution with A/F values greater than 0.05, while 4 species (5.88%) exhibited random distribution with A/F values between 0.025 and 0.05. No species showed regular distribution (<0.025). According to the IUCN Red List categories, this forest type contained 3 Data Deficient (DD) species, 4 Near Threatened (NT) species, and 1 Vulnerable (VU) species, indicating the presence of several conservation-priority woody taxa within the forest ecosystem (Table 7).

The regeneration and population structure analysis indicated active regeneration in most species. Among the upper

canopy species, *Schleichera oleosa* (93.95%), *Drypetes venusta* (93.70%), *Albizia odoratissima* (90.82%), and *Mallotus philippensis* (85.36%) showed high seedling representation, while *Grewia tiliifolia* (95.42%) and *Litsea ghatica* (80.33%) were mainly represented by saplings. Species such as *Terminalia paniculata*, *Dalbergia lanceolaria*, and *Dimocarpus longan* (Figure 1B) were mainly confined to intermediate girth classes. In the lower canopy, *Holarrhena pubescens* (94.55%) showed the highest sapling representation, whereas *Chionanthus ramiflorus* (88.32%) and *Tetrapilus dioicus* (73.24%) exhibited high seedling percentages, indicating continuous recruitment and stable regeneration dynamics.

The *Xylia xylocarpa* showed the highest basal area contribution (19.36%), followed by *Terminalia paniculata* (12.83%), *Terminalia bellirica* (10.43%), *Dalbergia lanceolaria* (8.16%), and *Grewia tiliifolia* (7.66%). Moderate basal area contribution was recorded for *Mallotus philippensis* (3.26%), *Pterocarpus marsupium* (3.20%), and *Schleichera oleosa* (3.41%). Together, the major dominant species contributed a substantial proportion of the total stand basal area, indicating their ecological importance within the forest structure. In contrast, several species exhibited very low basal area contribution, reflecting poor representation in the forest stand.

Among the recorded species, *Xylia xylocarpa* exhibited the highest IVI value (41.20), indicating its strong dominance within the forest stand. This was followed by *Terminalia paniculata* (22.52), *Terminalia bellirica* (20.09), *Grewia tiliifolia* (17.97), *Dalbergia lanceolaria* (16.11), and *Wrightia tinctoria* (15.03). Moderate IVI values were recorded for *Mallotus philippensis* (10.07), *Terminalia anogeissiana* (5.82), *Holarrhena pubescens* (5.91), and *Albizia odoratissima* (5.67). In contrast, several species such as *Pterygota alata* (0.55), *Ziziphus oenopolia* (0.55), and *Connarus wightii* (0.56) showed very low IVI values, reflecting comparatively poor ecological representation and lower dominance within the forest (Table 3). The Shannon-Wiener diversity index (2.253) and Simpson diversity index (0.877) indicated moderate to high woody species diversity and ecological stability within the South Indian Moist Deciduous Forest.

Table 3: Phyto-sociological parameters of trees and lianas in the Southern Moist Mixed Deciduous Forest of the Silent Valley buffer zone with details on density (D), frequency (F), abundance (A), relative density (RD), relative frequency (RF), relative dominance (RDO), Importance Value Index (IVI), and abundance-to-frequency (A/F) ratio.

Species name	D	F	A	RD	RF	RDO	IVI	A/F
<i>Acronychia pedunculata</i>	1.33	8.33	1.00	0.32	0.78	0.19	1.30	0.12
<i>Aglaia lawii</i>	4.00	12.50	2.00	0.96	1.18	1.42	3.56	0.16
<i>Ailanthus triphyssa</i>	0.67	4.17	1.00	0.16	0.39	0.04	0.59	0.24
<i>Albizia odoratissima</i>	4.67	29.17	1.00	1.12	2.75	1.80	5.67	0.03
<i>Allophylus cobbe</i>	2.67	8.33	2.00	0.64	0.78	0.01	1.44	0.24
<i>Antidesma montanum</i> var. <i>montanum</i>	3.33	8.33	2.50	0.80	0.78	0.26	1.84	0.30
<i>Artabotrys hexapetalus</i> *	1.33	4.17	2.00	0.32	0.39	0.01	0.72	0.48
<i>Artocarpus heterophyllus</i>	0.67	4.17	1.00	0.16	0.39	0.52	1.07	0.24
<i>Baccaurea courtallensis</i>	1.33	8.33	1.00	0.32	0.78	0.01	1.12	0.12
<i>Bauhinia racemosa</i>	2.00	8.33	1.50	0.48	0.78	0.36	1.63	0.18
<i>Caryota urens</i>	2.67	12.50	1.33	0.64	1.18	0.70	2.51	0.11
<i>Cassia fistula</i>	1.33	4.17	2.00	0.32	0.39	0.24	0.95	0.48
<i>Cayratia pedata</i> *	1.33	8.33	1.00	0.32	0.78	0.01	1.11	0.12
<i>Celtis timorensis</i>	1.33	8.33	1.00	0.32	0.78	0.48	1.59	0.12
<i>Chionanthus mala-elengi</i>	6.00	16.67	2.25	1.44	1.57	0.20	3.22	0.14
<i>Chionanthus ramiflorus</i>	6.67	20.83	2.00	1.61	1.96	0.37	3.93	0.10
<i>Chukrasia tabularis</i>	3.33	4.17	5.00	0.80	0.39	1.96	3.16	1.20

<i>Cinnamomum malabathricum</i>	2.00	4.17	3.00	0.48	0.39	0.58	1.46	0.72
<i>Connarus wightii</i> *	0.67	4.17	1.00	0.16	0.39	0.00	0.56	0.24
<i>Anamirta cocculus</i> *	1.33	4.17	2.00	0.32	0.39	0.01	0.72	0.48
<i>Cycas circinalis</i>	1.33	4.17	2.00	0.32	0.39	0.18	0.89	0.48
<i>Dalbergia horrida</i> *	2.67	8.33	2.00	0.64	0.78	0.04	1.46	0.24
<i>Dalbergia lanceolaria</i>	20.00	33.33	3.75	4.82	3.14	8.16	16.11	0.11
<i>Dalbergia sissooides</i>	8.00	25.00	2.00	1.93	2.35	2.64	6.92	0.08
<i>Dalbergia volubilis</i>	1.33	4.17	2.00	0.32	0.39	0.01	0.72	0.48
<i>Dillenia pentagyna</i>	0.67	4.17	1.00	0.16	0.39	0.04	0.59	0.24
<i>Dimocarpus longan</i>	4.67	8.33	3.50	1.12	0.78	0.81	2.72	0.42
<i>Diploclisia glaucescens</i> *	0.67	4.17	1.00	0.16	0.39	0.03	0.59	0.24
<i>Drypetes venusta</i>	18.67	25.00	4.67	4.49	2.35	0.25	7.10	0.19
<i>Erythrina variegata</i>	6.67	16.67	2.50	1.61	1.57	1.53	4.70	0.15
<i>Flacourtia indica</i>	2.00	8.33	1.50	0.48	0.78	0.36	1.63	0.18
<i>Grewia tiliifolia</i>	20.00	58.33	2.14	4.82	5.49	7.66	17.97	0.04
<i>Helicteres isora</i>	2.67	8.33	2.00	0.64	0.78	0.03	1.45	0.24
<i>Heynea trijuga</i>	1.33	8.33	1.00	0.32	0.78	0.87	1.97	0.12
<i>Hiptage benghalensis</i> *	0.67	4.17	1.00	0.16	0.39	0.10	0.65	0.24
<i>Holarrhena pubescens</i>	12.67	25.00	3.17	3.05	2.35	0.51	5.91	0.13
<i>Ixora brachiata</i>	4.00	8.33	3.00	0.96	0.78	0.01	1.76	0.36
<i>Lagerstroemia microcarpa</i>	1.33	8.33	1.00	0.32	0.78	0.15	1.26	0.12
<i>Leea indica</i>	3.33	8.33	2.50	0.80	0.78	0.02	1.60	0.30
<i>Litsea coriacea</i>	0.67	4.17	1.00	0.16	0.39	0.01	0.56	0.24
<i>Litsea ghatica</i>	11.33	12.50	5.67	2.73	1.18	0.76	4.66	0.45
<i>Litsea glutinosa</i>	4.00	8.33	3.00	0.96	0.78	0.04	1.79	0.36
<i>Macaranga peltata</i>	12.00	33.33	2.25	2.89	3.14	1.34	7.37	0.07
<i>Machilus macranthus</i>	2.00	8.33	1.50	0.48	0.78	0.74	2.01	0.18
<i>Mallotus philippensis</i>	12.00	41.67	1.80	2.89	3.92	3.26	10.07	0.04
<i>Mangifera indica</i>	0.67	4.17	1.00	0.16	0.39	0.42	0.97	0.24
<i>Mappia nimmoniana</i>	1.33	4.17	2.00	0.32	0.39	0.03	0.74	0.48
<i>Monoon coffeoides</i>	1.33	4.17	2.00	0.32	0.39	0.11	0.83	0.48
<i>Nothopegia castaneifolia</i>	3.33	8.33	2.50	0.80	0.78	0.32	1.91	0.30
<i>Phanera vahlii</i> *	0.67	4.17	1.00	0.16	0.39	0.01	0.56	0.24
<i>Phyllanthus candolleanus</i>	2.67	8.33	2.00	0.64	0.78	0.85	2.27	0.24
<i>Phyllanthus emblica</i>	2.67	16.67	1.00	0.64	1.57	0.52	2.74	0.06
<i>Phyllanthus retusus</i>	2.67	8.33	2.00	0.64	0.78	0.04	1.47	0.24
<i>Pongamia pinnata</i>	0.67	4.17	1.00	0.16	0.39	0.21	0.76	0.24
<i>Pterocarpus marsupium</i>	4.00	12.50	2.00	0.96	1.18	3.20	5.34	0.16
<i>Pterygota alata</i>	0.67	4.17	1.00	0.16	0.39	0.00	0.55	0.24
<i>Sapindus trifoliatus</i>	2.67	12.50	1.33	0.64	1.18	0.35	2.17	0.11
<i>Schleichera oleosa</i>	7.33	29.17	1.57	1.77	2.75	3.41	7.93	0.05
<i>Scolopia crenata</i>	4.00	8.33	3.00	0.96	0.78	0.29	2.04	0.36
<i>Senegalia pennata</i> *	4.67	12.50	2.33	1.12	1.18	0.03	2.33	0.19
<i>Senegalia rugata</i> *	4.00	12.50	2.00	0.96	1.18	0.10	2.24	0.16
<i>Spatholobus parviflorus</i> *	3.33	16.67	1.25	0.80	1.57	0.09	2.46	0.08
<i>Sterculia guttata</i>	3.33	16.67	1.25	0.80	1.57	0.25	2.62	0.08
<i>Stereospermum colais</i>	1.33	8.33	1.00	0.32	0.78	0.18	1.28	0.12
<i>Strychnos nux-vomica</i>	0.67	4.17	1.00	0.16	0.39	0.08	0.64	0.24
<i>Syzygium cumini</i>	1.33	8.33	1.00	0.32	0.78	0.29	1.39	0.12
<i>Tabernaemontana alternifolia</i>	0.67	4.17	1.00	0.16	0.39	0.00	0.56	0.24
<i>Terminalia anogeissiana</i>	6.67	16.67	2.50	1.61	1.57	2.64	5.82	0.15
<i>Terminalia bellirica</i>	17.33	58.33	1.86	4.17	5.49	10.43	20.09	0.03
<i>Terminalia elliptica</i>	1.33	8.33	1.00	0.32	0.78	0.40	1.50	0.12
<i>Terminalia paniculata</i>	20.67	50.00	2.58	4.98	4.71	12.83	22.52	0.05
<i>Tetrapilus dioicus</i>	13.33	29.17	2.86	3.21	2.75	1.09	7.04	0.10
<i>Vitex altissima</i>	2.00	4.17	3.00	0.48	0.39	0.23	1.10	0.72
<i>Wrightia tinctoria</i>	30.00	45.83	4.09	7.22	4.31	3.49	15.03	0.09
<i>Xylia xylocarpa</i>	64.67	66.67	6.06	15.57	6.27	19.36	41.20	0.09
<i>Ziziphus oenopolia</i> *	0.67	4.17	1.00	0.16	0.39	0.00	0.55	0.24
<i>Ziziphus rugosa</i>	1.33	4.17	2.00	0.32	0.39	0.03	0.74	0.48

*Liana

Southern Dry Mixed Deciduous Forest (5A/C3)

A total of 52 woody species, comprising 48 trees and 4 lianas, belonging to 45 genera and 21 families, were recorded. The Family Importance Value Index (FIVI) revealed that Fabaceae was the most ecologically dominant family with the highest FIVI value (105.84), followed by

Combretaceae (60.17) and Apocynaceae (35.12). Moderate FIVI values were observed for Malvaceae (16.72), Sapindaceae (15.12), Phyllanthaceae (11.41), Meliaceae (11.40), and Rubiaceae (11.37), indicating their substantial ecological representation within the forest community. In contrast, families such as Salicaceae (0.80), Ulmaceae

(0.78), and Connaraceae (0.77) exhibited very low FIVI values, reflecting comparatively lower ecological dominance and poor representation in the forest stand.

The total stand density was 488 stems ha^{-1} . Species density values ranged from 1 to 101 stems ha^{-1} . Among the recorded species, *Xylia xylocarpa* exhibited the highest density (101 stems ha^{-1}), followed by *Wrightia tinctoria* (52 stems ha^{-1}), *Terminalia paniculata* (45 stems ha^{-1}), *Terminalia anogeissiana* (44 stems ha^{-1}), and *Dalbergia lanceolaria* (35 stems ha^{-1}), indicating their ecological dominance within the forest stand. In contrast, several species such as *Combretum latifolium*, *Vepris bilocularis*, *Antidesma acidum*, *Connarus wightii*, *Holoptelea integrifolia* and *Psydrax dicoccos* showed very low density values (1 stem ha^{-1} each), reflecting poor representation and lower ecological dominance in the forest.

Analysis of the abundance to frequency (A/F) ratio showed that most species exhibited contiguous (clumped) distribution patterns. Species such as *Ochlandra scriptoria* (0.64), *Sterculia guttata* (0.48) (Figure 1F), *Dalbergia horrida* (0.48), *Atalantia racemosa* (0.32), *Falconeria insignis* (0.32), and *Flueggea virosa* (0.32) showed high A/F values, indicating strongly contiguous distribution. Several species including *Albizia odoratissima* (0.06), *Bauhinia racemosa* (0.06), *Grewia tilifolia* (0.058), *Terminalia anogeissiana* (0.058), *Terminalia paniculata* (0.060), and *Wrightia tinctoria* (0.058) also exhibited clumped distribution patterns. Random distribution was observed in a few species such as *Dalbergia lanceolaria* (0.039), *Dalbergia sissooides* (0.042), *Bombax ceiba* (0.040), *Pterocarpus marsupium* (0.040), *Sapindus trifoliatus* (0.040), and *Phyllanthus emblica* (0.027). No species showed regular distribution (<0.025). According to IUCN status, 3 Data Deficient (DD) species, 1 Endangered (EN) species, 4 Near Threatened (NT) species, and 1 Vulnerable (VU) species recorded in this forest (Table 7).

The regeneration and population structure analysis indicated active regeneration in several dominant species. *Albizia odoratissima* (85.04%), *Terminalia anogeissiana* (77.36%), and *Wrightia tinctoria* (72.87%) showed high seedling representation, while *Holarrhena pubescens* recorded both

high seedlings (51.76%) and saplings (46.01%), indicating successful regeneration. Species such as *Xylia xylocarpa* (95.22%) and *Dalbergia lanceolaria* (79.87%) were mainly represented by saplings, reflecting developing population structures. Several species including *Bombax ceiba*, *Terminalia bellirica*, and *Toona ciliata* were concentrated in middle girth classes, indicating comparatively fewer regenerating individuals. In the lower canopy, *Vitex altissima* was entirely confined to the 10-30 cm girth class (100%), representing an early population stage.

Among the recorded species, *Xylia xylocarpa* contributed the highest share of the total basal area (14.77%), followed by *Terminalia paniculata* (14.28%), *Dalbergia lanceolaria* (14.20%), *Terminalia bellirica* (5.25%), and *Wrightia tinctoria* (5.23%). Together, these dominant species accounted for a major proportion of the total stand basal area, indicating their strong ecological dominance within the forest community. In contrast, species such as *Combretum latifolium* (0.004%), *Antidesma acidum* (0.004%), *Connarus wightii* (0.004%), and *Vepris bilocularis* (0.007%) contributed very low basal area percentages, reflecting poor representation in the stand structure.

The ecological dominance of woody species was assessed using the Importance Value Index (IVI). *Xylia xylocarpa* recorded the highest IVI value (43.94), followed by *Terminalia paniculata* (29.72), *Dalbergia lanceolaria* (28.15), *Wrightia tinctoria* (22.66), and *Terminalia anogeissiana* (18.18), indicating their strong ecological dominance and greater influence on the forest structure. Other species with comparatively high IVI values included *Holarrhena pubescens* (12.46), *Terminalia bellirica* (11.50), *Dalbergia sissooides* (11.00), and *Toona ciliata* (10.07). In contrast, species such as *Combretum latifolium* (0.77), *Antidesma acidum* (0.77), *Connarus wightii* (0.77), and *Vepris bilocularis* (0.78) showed very low IVI values, reflecting poor ecological representation within the forest community (Table 4). The Shannon-Wiener diversity index (2.318) and Simpson diversity index (0.888) indicated moderately high woody species diversity and ecological stability within the Tropical Dry Deciduous Forest.

Table 4: Phyto-sociological parameters of trees and lianas in the Southern Dry Mixed Deciduous Forest of the Silent Valley buffer zone with details on density (D), frequency (F), abundance (A), relative density (RD), relative frequency (RF), relative dominance (RDO), Importance Value Index (IVI), and abundance-to-frequency (A/F) ratio.

Species name	D	F	A	RD	RF	RDO	IVI	A/F
<i>Albizia odoratissima</i>	6.00	25.00	1.50	1.23	2.26	3.77	7.26	0.06
<i>Antidesma acidum</i>	1.00	6.25	1.00	0.20	0.56	0.00	0.77	0.16
<i>Antidesma montanum</i> var. <i>montanum</i>	4.00	12.50	2.00	0.82	1.13	0.23	2.18	0.16
<i>Atalantia racemosa</i>	2.00	6.25	2.00	0.41	0.56	0.02	1.00	0.32
<i>Bauhinia racemosa</i>	6.00	25.00	1.50	1.23	2.26	0.60	4.09	0.06
<i>Bombax ceiba</i>	4.00	25.00	1.00	0.82	2.26	1.48	4.56	0.04
<i>Butea monosperma</i>	1.00	6.25	1.00	0.20	0.56	0.91	1.68	0.16
<i>Canthium travancoricum</i>	1.00	6.25	1.00	0.20	0.56	0.01	0.78	0.16
<i>Chukrasia tabularis</i>	1.00	6.25	1.00	0.20	0.56	0.56	1.33	0.16
<i>Clerodendrum infortunatum</i>	3.00	18.75	1.00	0.61	1.69	0.27	2.58	0.05
<i>Combretum latifolium</i> *	1.00	6.25	1.00	0.20	0.56	0.00	0.77	0.16
<i>Connarus wightii</i> *	1.00	6.25	1.00	0.20	0.56	0.00	0.77	0.16
<i>Cycas circinalis</i>	1.00	6.25	1.00	0.20	0.56	0.13	0.90	0.16
<i>Dalbergia horrida</i> *	3.00	6.25	3.00	0.61	0.56	0.05	1.23	0.48
<i>Dalbergia lanceolaria</i>	35.00	75.00	2.92	7.17	6.78	14.20	28.15	0.04
<i>Dalbergia sissooides</i>	13.00	43.75	1.86	2.66	3.95	4.38	11.00	0.04
<i>Dimocarpus longan</i>	18.00	31.25	3.60	3.69	2.82	2.10	8.61	0.12
<i>Falconeria insignis</i>	2.00	6.25	2.00	0.41	0.56	0.91	1.88	0.32
<i>Ficus arnottiana</i>	2.00	12.50	1.00	0.41	1.13	0.35	1.89	0.08

<i>Ficus racemosa</i>	1.00	6.25	1.00	0.20	0.56	0.15	0.92	0.16
<i>Flacourtia indica</i>	1.00	6.25	1.00	0.20	0.56	0.03	0.80	0.16
<i>Flueggea virosa</i>	2.00	6.25	2.00	0.41	0.56	0.01	0.98	0.32
<i>Grewia tilifolia</i>	9.00	31.25	1.80	1.84	2.82	3.76	8.43	0.06
<i>Holarrhena pubescens</i>	27.00	56.25	3.00	5.53	5.08	1.84	12.46	0.05
<i>Holoptelea integrifolia</i>	1.00	6.25	1.00	0.20	0.56	0.01	0.78	0.16
<i>Hymenodictyon orixense</i>	11.00	31.25	2.20	2.25	2.82	3.30	8.38	0.07
<i>Kydia calycina</i>	1.00	6.25	1.00	0.20	0.56	0.11	0.88	0.16
<i>Lagerstroemia microcarpa</i>	5.00	18.75	1.67	1.02	1.69	2.56	5.28	0.09
<i>Litsea coriacea</i>	1.00	6.25	1.00	0.20	0.56	0.24	1.01	0.16
<i>Macaranga peltata</i>	4.00	18.75	1.33	0.82	1.69	0.49	3.00	0.07
<i>Mallotus philippensis</i>	2.00	12.50	1.00	0.41	1.13	0.08	1.62	0.08
<i>Mitragyna parvifolia</i>	1.00	6.25	1.00	0.20	0.56	0.61	1.38	0.16
<i>Ochlandra scriptoria</i>	4.00	6.25	4.00	0.82	0.56	0.01	1.40	0.64
<i>Phyllanthus emblica</i>	6.00	37.50	1.00	1.23	3.39	0.98	5.60	0.03
<i>Psydrax dicoccos</i>	1.00	6.25	1.00	0.20	0.56	0.06	0.83	0.16
<i>Pterocarpus marsupium</i>	4.00	25.00	1.00	0.82	2.26	2.55	5.63	0.04
<i>Sapindus trifoliatus</i>	4.00	25.00	1.00	0.82	2.26	0.82	3.90	0.04
<i>Schleichera oleosa</i>	2.00	12.50	1.00	0.41	1.13	1.06	2.60	0.08
<i>Spatholobus parviflorus</i> *	1.00	6.25	1.00	0.20	0.56	0.01	0.78	0.16
<i>Sterculia guttata</i>	3.00	6.25	3.00	0.61	0.56	0.28	1.46	0.48
<i>Sterculia urens</i>	1.00	6.25	1.00	0.20	0.56	0.62	1.39	0.16
<i>Stereospermum colais</i>	1.00	6.25	1.00	0.20	0.56	0.10	0.87	0.16
<i>Tamarindus indica</i>	2.00	12.50	1.00	0.41	1.13	0.53	2.07	0.08
<i>Tectona grandis</i>	9.00	25.00	2.25	1.84	2.26	2.95	7.05	0.09
<i>Terminalia anogeissiana</i>	44.00	68.75	4.00	9.02	6.21	2.95	18.18	0.06
<i>Terminalia bellirica</i>	14.00	37.50	2.33	2.87	3.39	5.25	11.50	0.06
<i>Terminalia paniculata</i>	45.00	68.75	4.09	9.22	6.21	14.28	29.72	0.06
<i>Toona ciliata</i>	17.00	25.00	4.25	3.48	2.26	4.33	10.07	0.17
<i>Vepris bilocularis</i>	1.00	6.25	1.00	0.20	0.56	0.01	0.78	0.16
<i>Vitex altissima</i>	5.00	12.50	2.50	1.02	1.13	0.05	2.20	0.20
<i>Wrightia tinctoria</i>	52.00	75.00	4.33	10.66	6.78	5.23	22.66	0.06
<i>Xylia xylocarpa</i>	101.00	93.75	6.73	20.70	8.47	14.77	43.94	0.07

*Liana



Fig 1: Plant species recorded from different forest of the buffer zone of Silent Valley National Park during the study period. A. *Cullenia exarillata* A. Robyns., B. *Dimocarpus longan* Lour., C. *Ligustrum robustum* (Roxb.) Blume., D. *Myristica beddomei* King., E. Seedling of *Palaquium ellipticum* (Dalzell) Baill., F. *Sterculia guttata* Roxb.

Southern Montane Wet Temperate Forest (11A/C1)

A total of 63 woody species were recorded from the Southern Montane Wet Temperate Forest (Shola Forest),

comprising 57 tree species and 6 liana species. These species belonged to 51 genera distributed among 34 families. The Family Importance Value Index (FIVI) revealed that Lauraceae was the most ecologically dominant family with the highest FIVI value of 60.40, followed by Myrtaceae (37.49), Oleaceae (28.09), and Euphorbiaceae (20.58). Moderate FIVI values were recorded for Rubiaceae (17.21), Sapindaceae (16.83), Phyllanthaceae (13.50), Rutaceae (8.84), Salicaceae (8.40), and Lamiaceae (8.27), indicating their considerable ecological representation within the forest community. In contrast, families such as Gnetaceae (0.99), Ancistrocladaceae (0.97), Rhamnaceae (0.97), and Menispermaceae (0.97) exhibited very low FIVI values, reflecting comparatively poor ecological dominance and representation in the forest stand.

The total stand density of the Shola Forest was 1032 stems ha^{-1} . Species density values ranged from 8 stems ha^{-1} to 416 stems ha^{-1} . Among the recorded species, *Ligustrum robustum* (Figure 1C) exhibited the highest density with 416 stems ha^{-1} , followed by *Machilus macranthus* (360 stems ha^{-1}), *Tetrapilus dioicus* (240 stems ha^{-1}), *Cinnamomum sulphuratum* (200 stems ha^{-1}), and *Dimocarpus longan* (200 stems ha^{-1}), indicating their dominance within the forest community. In contrast, several species such as *Callicarpa tomentosa*, *Canarium strictum*, *Cycas circinalis*, *Ficus beddomei*, and *Palaquium ellipticum* (Figure 1E), were represented by only 8 stems ha^{-1} , reflecting their comparatively poor occurrence within the forest stand. Since the Vannampara shola forest is located adjacent to a moist deciduous forest, a single individual of *Xylia xylocarpa* (12 cm GBH), a typical deciduous tree species, was observed in

this area, indicating slight encroachment from the adjoining moist deciduous forest.

Analysis of the abundance to frequency (A/F) ratio revealed that the majority of species in the Shola forest exhibited a contiguous (clumped) distribution pattern with A/F values greater than 0.05. Higher A/F values were recorded for *Cinnamomum perrottetii* (0.96), *Chionanthus ramiflorus* (0.46), *Gmelina arborea* (0.40), *Nothopegia castaneifolia* (0.36), and *Diospyros buxifolia* (0.32), indicating a strongly clumped distribution. Moderate contiguous distribution was observed in species such as *Ligustrum robustum* (0.26) (Figure 1C), *Lasianthus jackianus* (0.26), *Hydnocarpus alpinus* (0.24), *Myristica beddomei* (0.24) (Figure 1D), and *Helicteres isora* (0.22). A few species, such as *Phyllanthus candolleanus* (0.044), *Carissa spinarum* (0.044), and *Sterculia guttata* (0.04) (Figure 1F) showed random distribution patterns, while no species exhibited regular distribution (<0.025). One species was categorized as Data Deficient (DD), 4 species as Endangered (EN), 3 species as Near Threatened (NT), and 4 species as Vulnerable (VU) according to the IUCN Red List categories (Table 7).

Population structure and regeneration analysis indicated active natural regeneration and stable population dynamics. Among the upper canopy species, *Machilus macranthus* (94.44%), *Syzygium densiflorum* (93.70%), *Cinnamomum sulphuratum* (91.74%), and *Dimocarpus longan* (89.29%) (Figure 1B) showed high sapling representation, indicating successful regeneration. Species such as *Cinnamomum perrottetii* and *Myristica beddomei* (Figure 1D) were mainly concentrated in lower girth classes (10-30 cm), reflecting developing population structure. In the lower canopy, *Phoebe lanceolata* recorded the highest seedling percentage (95.74%), followed by *Helicteres isora* (92.66%) and *Nothopegia castaneifolia* (79.93%). High sapling representation was observed in *Scolopia crenata* (97.70%) and *Clerodendrum infortunatum* (87.41%). Overall, the dominance of seedlings, saplings, and lower girth classes

indicates healthy regeneration and continuous recruitment within the Shola forest community.

Among the recorded species, *Syzygium gardneri* contributed the highest basal area (8.45%) to the total stand basal area, followed by *Dimocarpus longan* (7.87%) (Figure 1B), *Mallotus tetracoccus* (7.74%), *Machilus macranthus* (7.32%), and *Syzygium densiflorum* (6.72%). Other notable contributors included *Ligustrum robustum* (5.32%) (Figure 1C), *Cinnamomum sulphuratum* (4.86%), and *Syzygium calophyllifolium* (4.78%). In contrast, species such as *Callicarpa tomentosa*, *Diploclisia glaucescens*, and *Ancistrocladus heyneanus* contributed negligibly to the total basal area, indicating poor representation within the forest stand. Overall, the wide variation in basal area contribution reflects the heterogeneous structure and ecological complexity of the forest.

The ecological dominance of species was assessed using the Importance Value Index (IVI). Among the recorded species, *Machilus macranthus* exhibited the highest IVI value (20.66), followed by *Ligustrum robustum* (18.48) (Figure 1C), *Dimocarpus longan* (15.79) (Figure 1B), *Mallotus tetracoccus* (15.47), and *Tetrapilus dioicus* (12.95). Other ecologically important species included *Cinnamomum sulphuratum* (12.79), *Syzygium densiflorum* (12.51), *Syzygium gardneri* (11.92), and *Chionanthus ramiflorus* (9.62). Moderate IVI values were recorded for *Atalantia racemosa* (8.84), *Syzygium calophyllifolium* (8.25), and *Scolopia crenata* (8.40), indicating their considerable contribution to the community structure. In contrast, species such as *Callicarpa tomentosa* (0.97), *Diploclisia glaucescens* (0.97), *Xylia xylocarpa* (0.97), and *Ancistrocladus heyneanus* (0.97) exhibited very low IVI values, reflecting poor ecological representation within the forest stand (Table 5). The Shannon-Wiener diversity index (2.527) and Simpson diversity index (0.897) indicated high woody species diversity and good ecological stability in the Shola forest.

Table 5: Phyto-sociological parameters of trees and lianas in the Southern Montane Wet Temperate Forest of the Silent Valley buffer zone with details on density (D), frequency (F), abundance (A), relative density (RD), relative frequency (RF), relative dominance (RDO), Importance Value Index (IVI), and abundance-to-frequency (A/F) ratio.

Species name	D	F	A	RD	RF	RDO	IVI	A/F
<i>Actinodaphne bourdillonii</i>	4.00	12.50	2.00	0.39	0.77	0.99	2.15	0.16
<i>Actinodaphne lawsonii</i>	12.00	37.50	2.00	1.16	2.31	0.11	3.58	0.05
<i>Allophylus cobbe</i>	2.00	12.50	1.00	0.19	0.77	0.07	1.03	0.08
<i>Alstonia scholaris</i>	4.00	12.50	2.00	0.39	0.77	0.22	1.37	0.16
<i>Ancistrocladus heyneanus</i> *	2.00	12.50	1.00	0.19	0.77	0.01	0.97	0.08
<i>Antidesma montanum</i> var. <i>montanum</i>	12.00	37.50	2.00	1.16	2.31	0.41	3.88	0.05
<i>Apollonia arnottii</i>	18.00	25.00	4.50	1.74	1.54	1.53	4.81	0.18
<i>Artocarpus heterophyllus</i>	6.00	25.00	1.50	0.58	1.54	3.04	5.16	0.06
<i>Atalantia racemosa</i>	44.00	50.00	5.50	4.26	3.08	1.50	8.84	0.11
<i>Berberis napaulensis</i> var. <i>napaulensis</i>	6.00	25.00	1.50	0.58	1.54	0.39	2.51	0.06
<i>Callicarpa tomentosa</i>	2.00	12.50	1.00	0.19	0.77	0.00	0.97	0.08
<i>Canarium strictum</i>	2.00	12.50	1.00	0.19	0.77	0.54	1.50	0.08
<i>Carissa spinarum</i>	10.00	37.50	1.67	0.97	2.31	0.04	3.31	0.04
<i>Chionanthus ramiflorus</i>	46.00	25.00	11.50	4.46	1.54	3.62	9.62	0.46
<i>Cinnamomum perrottetii</i>	24.00	12.50	12.00	2.33	0.77	1.11	4.20	0.96
<i>Cinnamomum sulphuratum</i>	50.00	50.00	6.25	4.84	3.08	4.86	12.79	0.13
<i>Cinnamomum wightii</i>	4.00	12.50	2.00	0.39	0.77	0.82	1.98	0.16
<i>Clerodendrum infortunatum</i>	14.00	37.50	2.33	1.36	2.31	0.72	4.39	0.06
<i>Cycas circinalis</i>	2.00	12.50	1.00	0.19	0.77	0.69	1.66	0.08
<i>Dimocarpus longan</i>	50.00	50.00	6.25	4.84	3.08	7.87	15.79	0.13
<i>Diospyros buxifolia</i>	8.00	12.50	4.00	0.78	0.77	0.05	1.59	0.32
<i>Diospyros saldanhae</i>	16.00	25.00	4.00	1.55	1.54	2.42	5.51	0.16
<i>Diploclisia glaucescens</i> *	2.00	12.50	1.00	0.19	0.77	0.00	0.97	0.08

<i>Elaeocarpus munronii</i>	4.00	12.50	2.00	0.39	0.77	1.06	2.22	0.16
<i>Elaeocarpus serratus</i>	14.00	37.50	2.33	1.36	2.31	1.01	4.67	0.06
<i>Erythrina variegata</i>	2.00	12.50	1.00	0.19	0.77	0.22	1.19	0.08
<i>Ficus beddomei</i>	2.00	12.50	1.00	0.19	0.77	0.11	1.07	0.08
<i>Ficus microcarpa</i>	2.00	12.50	1.00	0.19	0.77	0.04	1.00	0.08
<i>Garcinia gummi-gutta</i>	2.00	12.50	1.00	0.19	0.77	0.73	1.69	0.08
<i>Gmelina arborea</i>	10.00	12.50	5.00	0.97	0.77	1.18	2.92	0.40
<i>Gnetum edule</i> *	2.00	12.50	1.00	0.19	0.77	0.03	0.99	0.08
<i>Helicteres isora</i>	22.00	25.00	5.50	2.13	1.54	0.10	3.77	0.22
<i>Hydnocarpus alpinus</i>	6.00	12.50	3.00	0.58	0.77	0.02	1.37	0.24
<i>Lasianthus jacksonius</i>	26.00	25.00	6.50	2.52	1.54	0.20	4.26	0.26
<i>Ligustrum robustum</i>	104.00	50.00	13.00	10.08	3.08	5.32	18.48	0.26
<i>Litsea floribunda</i>	8.00	25.00	2.00	0.78	1.54	1.15	3.46	0.08
<i>Macaranga peltata</i>	6.00	12.50	3.00	0.58	0.77	0.50	1.85	0.24
<i>Machilus macranthus</i>	90.00	75.00	7.50	8.72	4.62	7.32	20.66	0.10
<i>Magnolia nilagirica</i>	6.00	12.50	3.00	0.58	0.77	0.71	2.06	0.24
<i>Mallotus philippensis</i>	10.00	25.00	2.50	0.97	1.54	0.75	3.26	0.10
<i>Mallotus tetracoccus</i>	48.00	50.00	6.00	4.65	3.08	7.74	15.47	0.12
<i>Meliosma simplicifolia</i> subsp. <i>Simplicifolia</i>	4.00	12.50	2.00	0.39	0.77	0.90	2.06	0.16
<i>Myristica beddomei</i>	24.00	25.00	6.00	2.33	1.54	1.51	5.38	0.24
<i>Nothopelia castaneifolia</i>	36.00	25.00	9.00	3.49	1.54	2.32	7.35	0.36
<i>Palaquium ellipticum</i>	2.00	12.50	1.00	0.19	0.77	1.16	2.13	0.08
<i>Phoebe lanceolata</i>	28.00	50.00	3.50	2.71	3.08	0.98	6.77	0.07
<i>Phyllanthus candolleanus</i>	10.00	37.50	1.67	0.97	2.31	3.91	7.19	0.04
<i>Phyllanthus emblica</i>	6.00	25.00	1.50	0.58	1.54	0.31	2.43	0.06
<i>Reinwardtiadendron anamalaiense</i>	4.00	12.50	2.00	0.39	0.77	0.19	1.34	0.16
<i>Rhododendron arboreum</i> subsp. <i>nilagiricum</i>	2.00	12.50	1.00	0.19	0.77	0.17	1.13	0.08
<i>Scolopia crenata</i>	36.00	50.00	4.50	3.49	3.08	1.84	8.40	0.09
<i>Senegalia rugata</i> *	14.00	25.00	3.50	1.36	1.54	0.33	3.23	0.14
<i>Sterculia guttata</i>	4.00	25.00	1.00	0.39	1.54	0.57	2.50	0.04
<i>Strobocalyx arborea</i>	18.00	37.50	3.00	1.74	2.31	1.16	5.22	0.08
<i>Syzygium calophyllifolium</i>	12.00	37.50	2.00	1.16	2.31	4.78	8.25	0.05
<i>Syzygium densiflorum</i>	28.00	50.00	3.50	2.71	3.08	6.72	12.51	0.07
<i>Syzygium gardneri</i>	12.00	37.50	2.00	1.16	2.31	8.45	11.92	0.05
<i>Syzygium laetum</i>	10.00	25.00	2.50	0.97	1.54	0.36	2.87	0.10
<i>Syzygium lanceolatum</i>	2.00	12.50	1.00	0.19	0.77	0.98	1.95	0.08
<i>Tetrapilus dioicus</i>	60.00	50.00	7.50	5.81	3.08	4.06	12.95	0.15
<i>Uvaria narum</i> *	12.00	37.50	2.00	1.16	2.31	0.07	3.54	0.05
<i>Xylia xylocarpa</i> (encroach)	2.00	12.50	1.00	0.19	0.77	0.01	0.97	0.08
<i>Ziziphus rugosa</i>	2.00	12.50	1.00	0.19	0.77	0.01	0.97	0.08

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The phytosociological analysis of the five major forest types in the buffer zone of Silent Valley National Park showed considerable variation in species diversity and stand structure. The West Coast Tropical Evergreen Forest (1A/C4) recorded the highest species richness (142 taxa), stand density (1035.0 stems ha⁻¹), basal area (584175.6), and Shannon diversity index (2.767), indicating high ecological stability and structural complexity. The Southern Montane Wet Temperate Forest (11A/C1) also exhibited

high stand density (1032.0 stems ha⁻¹) and diversity values, reflecting its unique montane vegetation characteristics. In contrast, Moist Deciduous (3B/C2) and Dry Deciduous Forests (5A/C3) showed comparatively lower diversity and stand density, indicating lower floristic heterogeneity and dominance of fewer species. Overall, evergreen and shola forests exhibited greater ecological stability and woody species diversity than the deciduous forest types (Table 6).

Table 6: Study area details, Diversity Indices, Stand Density, and Basal Area of Woody Taxa Across Major Forest Types of the Buffer Zone of Silent Valley National Park, Kerala

S. No.	Forest Types (Code)	Area studied (ha)	Taxa	Simpson (λ)	Shannon-Wiener (H')	Stand density (stems ha ⁻¹)	Total Basal Area (cm ² ha ⁻¹)
1	1A/C4	1.25	141	0.900	2.767	1035.0	521632.9
2	2A/C2	1	83	0.895	2.496	699.0	265063.9
3	3B/C2	1.5	77	0.877	2.253	415.3	390502.5
4	5A/C3	1	52	0.888	2.318	488.0	268193.2
5	11A/C1	0.5	63	0.897	2.527	1032.0	179720.6

Table 7: IUCN Red List status of woody species recorded during the quadrat study in different forest types of the buffer zone of Silent Valley National Park, Kerala

S. No.	Species name	IUCN Category	Forest Types				
			1A/C4	2A/C2	3B/C2	5A/C3	11A/C1
1	<i>Canarium strictum</i>	EN (Amitha Bachan & Devika, 2024(b))	*	*	-	-	*
2	<i>Cinnamomum wightii</i>	EN (Saha <i>et al.</i> , 2015(b))	-	-	-	-	*
3	<i>Cycas circinalis</i>	EN (Bösenberg, 2023)	-	-	-	*	*
4	<i>Dysoxylum malabaricum</i>	EN (Ved <i>et al.</i> , 2015(a))	*	-	-	-	-
5	<i>Prunus ceylanica</i>	EN (World Conservation Monitoring Centre, 1998(d))	*	*	-	-	-
6	<i>Syzygium calophyllifolium</i>	EN (Amitha Bachan & Devika, 2023)	-	-	-	-	*
7	<i>Archidendron bigeminum</i>	VU (World Conservation Monitoring Centre, 1998(a))	*	-	-	-	-
8	<i>Baccaurea courtallensis</i>	VU (Amitha Bachan & Devika, 2025(a))	*	*	-	-	-
9	<i>Casearia wynadensis</i>	VU (Amitha Bachan & Devika, 2025(b))	*	-	-	-	-
10	<i>Cayratia pedata</i>	VU (Saha <i>et al.</i> , 2015(a))	*	*	-	-	-
11	<i>Cinnamomum sulphuratum</i>	VU (Saha <i>et al.</i> , 2015(c))	-	-	-	-	*
12	<i>Dalbergia sissooides</i>	VU (Ahmedullah, 2022)	-	-	*	*	-
13	<i>Hydnocarpus alpinus</i>	VU (Deepu & Geethakumary, 2020)	*	*	-	-	-
14	<i>Litsea ghatica</i>	VU (de Kok, 2020)	*	-	-	-	-
15	<i>Litsea oleoides</i>	VU (de Kok, 2023)	*	-	-	-	-
16	<i>Magnolia nilagirica</i>	VU (Haridasan <i>et al.</i> , 2015)	-	-	-	-	*
17	<i>Mesua ferrea</i>	VU (Amitha Bachan & Devika, 2024(c))	*	*	-	-	-
18	<i>Myristica malabarica</i>	VU (Amitha Bachan & Devika, 2024(d))	*	*	-	-	-
19	<i>Reinwardtiadendron anamalaiense</i>	VU (Amitha Bachan & Devika, 2024(e))	-	*	-	-	*
20	<i>Salacia oblonga</i>	VU (Ved <i>et al.</i> , 2015(b))	*	-	-	-	-
21	<i>Syzygium densiflorum</i>	VU (Devika & Amitha Bachan, 2025)	-	-	-	-	*
22	<i>Calophyllum polyanthum</i>	NT (Amitha Bachan & Devika, 2024(a))	*	*	-	-	-
23	<i>Cullenia exarillata</i>	NT (Gole, 2024)	*	*	-	-	-
24	<i>Dalbergia horrida</i>	NT (Barker, 2022)	-	-	*	*	-
25	<i>Discospermum apiocarpum</i>	NT (Dhyani, 2024)	*	*	-	-	-
26	<i>Elaeocarpus munronii</i>	NT (World Conservation Monitoring Centre, 1998(b))	*	-	-	-	*
27	<i>Litsea coriacea</i>	NT (de Kok & Geethakumary, 2020(a))	-	-	*	*	-
28	<i>Litsea floribunda</i>	NT (de Kok & Geethakumary, 2020(b))	-	-	-	-	*
29	<i>Litsea stocksii</i>	NT (de Kok & Geethakumary, 2020(c))	*	-	-	-	-
30	<i>Nothopegia castaneifolia</i>	NT (Watve & Gole, 2025)	-	-	*	-	*
31	<i>Nothopegia heyneana</i>	NT (World Conservation Monitoring Centre, 1998(c))	*	*	-	-	-
32	<i>Pterocarpus marsupium</i>	NT (Barstow, 2017)	*	-	*	*	-
33	<i>Canthium travancoricum</i>	DD (IUCN SSC Global Tree Specialist Group & BGCI, 2024(a))	-	-	-	*	-
34	<i>Dimocarpus longan</i>	DD (Barstow, 2022)	*	*	*	*	-
35	<i>Mangifera indica</i>	DD (Ganesan, 2021)	-	-	*	-	-
36	<i>Sapindus trifoliatus</i>	DD (IUCN SSC Global Tree Specialist Group & BGCI, 2024(b))	-	-	*	*	-
37	<i>Syzygium lanceolatum</i>	DD (IUCN SSC Global Tree Specialist Group & BGCI, 2024(c))	*	-	-	-	*

Abbreviations used: EN-Endangered, VU-Vulnerable, NT-Near Threatened, DD-Data Deficient, *- Presence, - Not recorded

Conclusion

The present study demonstrated considerable variation in woody species composition, stand structure, regeneration pattern, and ecological dominance among the five major forest types of the southern Western Ghats. Evergreen and semi-evergreen forests showed comparatively higher species richness, stand density, and diversity, indicating greater structural complexity and ecological stability. In contrast, moist and dry deciduous forests were dominated by a few ecologically significant species, reflecting comparatively lower floristic heterogeneity. The Southern Montane Wet Temperate Forest exhibited a distinct floristic composition with strong representation of Lauraceae and Myrtaceae, emphasizing its unique montane ecosystem characteristics. The predominance of contiguous distribution patterns across the forest types suggested heterogeneous environmental conditions and clustered species occurrence. Regeneration analysis revealed that most dominant species were largely represented by seedlings, saplings, and lower girth classes, indicating active regeneration and stable population

recruitment. The occurrence of several threatened species under different IUCN categories further highlights the conservation importance of these forest ecosystems.

Basal area and IVI analyses confirmed the ecological dominance of a limited number of species within each forest type, while diversity indices reflected overall moderate to high ecological stability throughout the study area. Overall, the forests of the southern Western Ghats represent ecologically significant reservoirs of woody plant diversity, emphasizing the need for effective conservation and sustainable management strategies for their long-term protection.

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References

- Ahmedullah M. *Dalbergia sissooides*. The IUCN Red List of Threatened Species 2022. 2022:e.T62022606A62022610. <https://dx.doi.org/10.2305/IUCN.UK.2022-1.RLTS.T62022606A62022610.en>
- Amitha Bachan KH, Devika MA. *Syzygium calophyllifolium*. The IUCN Red List of Threatened Species 2023. 2023:e.T210010463A210023247. <https://dx.doi.org/10.2305/IUCN.UK.2023-1.RLTS.T210010463A210023247.en>
- Amitha Bachan KH, Devika MA. *Mesua ferrea*. The IUCN Red List of Threatened Species 2024. 2024:e.T61987931A61987933. <https://dx.doi.org/10.2305/IUCN.UK.2024-2.RLTS.T61987931A61987933.en>
- Amitha Bachan KH, Devika MA. *Calophyllum polyanthum*. The IUCN Red List of Threatened Species 2024. 2024:e.T169056566A169056803. <https://dx.doi.org/10.2305/IUCN.UK.2024-2.RLTS.T169056566A169056803.en>
- Amitha Bachan KH, Devika MA. *Canarium strictum*. The IUCN Red List of Threatened Species 2024. 2024:e.T117894243A117894247. <https://dx.doi.org/10.2305/IUCN.UK.2024-2.RLTS.T117894243A117894247.en>
- Amitha Bachan KH, Devika MA. *Myristica malabarica*. The IUCN Red List of Threatened Species 2024. 2024:e.T31219A115932548. <https://dx.doi.org/10.2305/IUCN.UK.2024-2.RLTS.T31219A115932548.en>
- Amitha Bachan KH, Devika MA. *Reinwardtiadendron anamalaiense*. The IUCN Red List of Threatened Species 2024. 2024:e.T169578317A169589635. <https://dx.doi.org/10.2305/IUCN.UK.2024-2.RLTS.T169578317A169589635.en>
- Amitha Bachan KH, Devika MA. *Baccaurea courtallensis*. The IUCN Red List of Threatened Species 2025. 2025:e.T169054032A169055765. <https://dx.doi.org/10.2305/IUCN.UK.2025-2.RLTS.T169054032A169055765.en>
- Amitha Bachan KH, Devika MA. *Casearia wynadensis*. The IUCN Red List of Threatened Species 2025. 2025:e.T38774A115933213. <https://dx.doi.org/10.2305/IUCN.UK.2025-2.RLTS.T38774A115933213.en>
- Barker A. *Dalbergia horrida*. The IUCN Red List of Threatened Species 2022. 2022:e.T171981537A171989614. <https://dx.doi.org/10.2305/IUCN.UK.2022-1.RLTS.T171981537A171989614.en>
- Barstow M. *Pterocarpus marsupium*. The IUCN Red List of Threatened Species 2017. 2017:e.T34620A67802995. <https://dx.doi.org/10.2305/IUCN.UK.2017-3.RLTS.T34620A67802995.en>
- Barstow M. *Dimocarpus longan*. The IUCN Red List of Threatened Species 2022. 2022:e.T32399A67808402. <https://dx.doi.org/10.2305/IUCN.UK.2022-2.RLTS.T32399A67808402.en>
- Bösenberg JD. *Cycas circinalis*. The IUCN Red List of Threatened Species 2023. 2023:e.T42089A2959396. <https://dx.doi.org/10.2305/IUCN.UK.2023-1.RLTS.T42089A2959396.en>
- Curtis JT, Cottam G. Plant ecology work book: Laboratory field reference manual. Minnesota: Burgess Publishing Company; 1956.
- Curtis JT, McIntosh RP. The interrelations of certain analytic and synthetic phytosociological characters. Ecology. 1950;31(3):434-455.
- de Kok R, Geethakumary MP. *Litsea coriacea*. The IUCN Red List of Threatened Species 2020. 2020:e.T153115300A153622873. <https://dx.doi.org/10.2305/IUCN.UK.2020-3.RLTS.T153115300A153622873.en>
- de Kok R, Geethakumary MP. *Litsea floribunda*. The IUCN Red List of Threatened Species 2020. 2020:e.T152954472A153622473. <https://dx.doi.org/10.2305/IUCN.UK.2020-3.RLTS.T152954472A153622473.en>
- de Kok R, Geethakumary MP. *Litsea stocksii*. The IUCN Red List of Threatened Species 2020. 2020:e.T153115866A153622893. <https://dx.doi.org/10.2305/IUCN.UK.2020-3.RLTS.T153115866A153622893.en>
- de Kok R. *Litsea ghatica*. The IUCN Red List of Threatened Species 2020. 2020:e.T153115951A153622898. <https://dx.doi.org/10.2305/IUCN.UK.2020-3.RLTS.T153115951A153622898.en>
- de Kok R. *Litsea oleoides*. The IUCN Red List of Threatened Species 2023. 2023:e.T153115088A153622868. <https://dx.doi.org/10.2305/IUCN.UK.2023-1.RLTS.T153115088A153622868.en>
- Deepu S, Geethakumary MP. *Hydnocarpus alpinus*. The IUCN Red List of Threatened Species 2020. 2020:e.T169575659A169589575. <https://dx.doi.org/10.2305/IUCN.UK.2020-3.RLTS.T169575659A169589575.en>
- Devika MA, Amitha Bachan KH. *Syzygium densiflorum*. The IUCN Red List of Threatened Species 2025. 2025:e.T38820A115933387. <https://dx.doi.org/10.2305/IUCN.UK.2025-2.RLTS.T38820A115933387.en>
- Dhyani A. *Discospermum apiocarpum*. The IUCN Red List of Threatened Species 2024. 2024:e.T119043667A119043708. <https://dx.doi.org/10.2305/IUCN.UK.2024-2.RLTS.T119043667A119043708.en>
- Elouard C, Pascal JP, Pelissier R, Ramesh BR, Houllier F, Durand M, et al. Monitoring the structure and dynamics of a dense moist evergreen forest in the Western Ghats (Kodagu District, Karnataka, India). Wageningen: Tropenbos International; 1997.
- Gamble JS, Fischer CEC. Flora of the Presidency of Madras. London: Adlard & Son Ltd.; 1915-1936.
- Ganesan SK. *Mangifera indica*. The IUCN Red List of Threatened Species 2021. 2021:e.T31389A67735735. <https://dx.doi.org/10.2305/IUCN.UK.2021-2.RLTS.T31389A67735735.en>

27. Ganesh T, Ganesan R, Devy MS, Davidar P, Bawa KS. Assessment of plant biodiversity at a mid-elevation evergreen forest of Kalakad-Mundanthurai Tiger Reserve, Western Ghats, India. *Current Science*. 1996;71(5):379-392.
28. Gole CN. *Cullenia exarillata*. The IUCN Red List of Threatened Species 2024. 2024:e.T228008406A228009914. <https://dx.doi.org/10.2305/IUCN.UK.2024-2.RLTS.T228008406A228009914.en>
29. Hammer Ø, Harper DAT, Ryan PD. PAST: Paleontological Statistics Software Package for Education and Data Analysis. *Palaeontologia Electronica*. 2001;4(1):1-9.
30. Haridasan K, Ved D, Saha D, Ravikumar K. *Magnolia nilagirica*. The IUCN Red List of Threatened Species 2015. 2015:e.T15114888A15114897. <https://dx.doi.org/10.2305/IUCN.UK.2015-2.RLTS.T15114888A15114897.en>
31. IPNI. International Plant Names Index. 2024. <https://www.ipni.org>
32. IUCN SSC Global Tree Specialist Group, Botanic Gardens Conservation International (BGCI). *Canthium travancoricum*. The IUCN Red List of Threatened Species 2024. 2024:e.T242359629A242359639. <https://dx.doi.org/10.2305/IUCN.UK.2024-1.RLTS.T242359629A242359639.en>
33. IUCN SSC Global Tree Specialist Group, Botanic Gardens Conservation International (BGCI). *Sapindus trifolius*. The IUCN Red List of Threatened Species 2024. 2024:e.T250631854A250631856. <https://dx.doi.org/10.2305/IUCN.UK.2024-1.RLTS.T250631854A250631856.en>
34. IUCN SSC Global Tree Specialist Group, Botanic Gardens Conservation International (BGCI). *Syzygium lanceolatum*. The IUCN Red List of Threatened Species 2024. 2024:e.T242356493A242356495. <https://dx.doi.org/10.2305/IUCN.UK.2024-1.RLTS.T242356493A242356495.en>
35. IUCN. The IUCN Red List of Threatened Species. Version 2024-1. International Union for Conservation of Nature; 2024. <https://www.iucnredlist.org>
36. Kerala Forest Department. Management Plan of Silent Valley National Park. Thiruvananthapuram: Government of Kerala; 2007.
37. Kunhikannan C, Venkatasubramanian N, Sivalingam R, Pramod Kumar N, Thomas S, Thampan S. Diversity of woody species in the Medicinal Plant Conservation Area (MPCA) of Silent Valley National Park, Kerala. *Biodiversity*. 2011;12(2):97-107.
38. Manilal KS. Flora of Silent Valley Tropical Rain Forests of India. Calcutta: Botanical Survey of India; 1988.
39. Misra R. Ecology Workbook. New Delhi: Oxford and IBH Publishing Co.; 1968.
40. Mori SA, Boom BM, de Carvalho AM, dos Santos TS. Ecological importance of Myrtaceae in an eastern Brazilian wet forest. *Biotropica*. 1983;15(1):68-70.
41. Nair SC. The Southern Western Ghats: A Biodiversity Conservation Plan. New Delhi: Indian National Trust for Art and Cultural Heritage (INTACH); 1991.
42. Odum EP. Fundamentals of Ecology. 3rd ed. Philadelphia: W.B. Saunders Company; 1971.
43. Parthasarathy N. Tree diversity and distribution in undisturbed and human-impacted tropical wet evergreen forests of the southern Western Ghats, India. *Biodiversity and Conservation*. 1999;8:1365-1381.
44. Parthasarathy N, Karthikeyan R. Biodiversity and population density of woody species in a tropical evergreen forest in Courtallum Reserve Forest, Western Ghats, India. *Tropical Ecology*. 1997;38:297-306.
45. Pascal JP. Wet Evergreen Forests of the Western Ghats of India: Ecology, Structure, Floristic Composition and Succession. Pondicherry: French Institute; 1988.
46. Pascal JP, Ramesh BR. A Field Key to the Trees and Lianas of the Evergreen Forests of the Western Ghats (India). Pondicherry: French Institute; 1987.
47. POWO. Plants of the World Online. Kew: Royal Botanic Gardens; 2024. <https://powo.science.kew.org>
48. Saha D, Ved D, Ravikumar K, Haridasan K. *Cayratia pedata*. The IUCN Red List of Threatened Species 2015. 2015:e.T50126571A50131290. <https://dx.doi.org/10.2305/IUCN.UK.2015-2.RLTS.T50126571A50131290.en>
49. Saha D, Ved D, Ravikumar K, Haridasan K. *Cinnamomum wightii*. The IUCN Red List of Threatened Species 2015. 2015:e.T50126581A50131315. <https://dx.doi.org/10.2305/IUCN.UK.2015-2.RLTS.T50126581A50131315.en>
50. Saha D, Ved D, Ravikumar K, Haridasan K. *Cinnamomum sulphuratum*. The IUCN Red List of Threatened Species 2015. 2015:e.T50126579A50131310. <https://dx.doi.org/10.2305/IUCN.UK.2015-2.RLTS.T50126579A50131310.en>
51. Sasidharan N. Flowering Plants of Kerala (CD-ROM Version 2). Peechi: Kerala Forest Research Institute; 2013.
52. Satish KV, Reddy CS. Long term monitoring of forest fires in Silent Valley National Park, Western Ghats, India using remote sensing data. *Journal of the Indian Society of Remote Sensing*. 2016;44(2):207-215.
53. Sundarapandian SM, Swamy PS. Forest ecosystem structure and composition along an altitudinal gradient in the Western Ghats, South India. *Journal of Tropical Forest Science*. 2000;12(1):104-123.
54. Vajravelu E. Flora of Palghat District. Calcutta: Botanical Survey of India; 1990.
55. Ved D, Saha D, Ravikumar K, Haridasan K. *Dysoxylum malabaricum*. The IUCN Red List of Threatened Species 2015. 2015:e.T50126590A50131335. <https://dx.doi.org/10.2305/IUCN.UK.2015-2.RLTS.T50126590A50131335.en>
56. Ved D, Saha D, Ravikumar K, Haridasan K. *Salacia oblonga*. The IUCN Red List of Threatened Species 2015. 2015:e.T50126639A50131425. <https://dx.doi.org/10.2305/IUCN.UK.2015-2.RLTS.T50126639A50131425.en>
57. Watve A, Gole CN. *Nothopegia castaneifolia*. The IUCN Red List of Threatened Species 2025. 2025:e.T285612033A227711460. <https://dx.doi.org/10.2305/IUCN.UK.2025-2.RLTS.T285612033A227711460.en>
58. World Conservation Monitoring Centre. *Abarema bigemina*. The IUCN Red List of Threatened Species 1998. 1998:e.T30843A9582379.

- <https://dx.doi.org/10.2305/IUCN.UK.1998.RLTS.T30843A9582379.en>
59. World Conservation Monitoring Centre. *Elaeocarpus munronii*. The IUCN Red List of Threatened Species 1998. 1998:e.T33641A9799947.
<https://dx.doi.org/10.2305/IUCN.UK.1998.RLTS.T33641A9799947.en>
60. World Conservation Monitoring Centre. *Nothopegia heyneana*. The IUCN Red List of Threatened Species 1998. 1998:e.T33485A9781562.
<https://dx.doi.org/10.2305/IUCN.UK.1998.RLTS.T33485A9781562.en>
61. World Conservation Monitoring Centre. *Prunus ceylanica*. The IUCN Red List of Threatened Species 1998. 1998:e.T38028A10093677.
<https://dx.doi.org/10.2305/IUCN.UK.1998.RLTS.T38028A10093677.en>