69
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Tree Diversity Pattern in Sub-Humid Tropical Foothill Forest of Indian Eastern Himalayas

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ABSTRACT

A study was conducted at Chilapatta Reserve Forest, West Bengal India to assess its tree diversity and to document its floristic characteristics. Stratified random nested quadrate sampling was adopted for analyzing the quantitative characters. One hundred fifty nine tree species were recorded, of which twenty nine are yet to be identified. Identified species represented 41 families and 91 genera. The tree diversity index, concentration of dominance, Shannon and Wiener index and evenness index estimated was 2.07, 0.018, 4.70 and 1.43, respectively. Highest and lowest frequency recorded was 0.19 and 54.39 while relative frequency varied from 0.01 to 5.15.Tree density ranged from 0.44 to 172.81 individuals ha^{-1} and relative density ranged from 0.01to 1.96 %.Trees were widely distributed and its abundance ranged from 0.60 to 17.83 while relative abundance ranged from 0.07 to 1.89. %. IVI ranged between 0.13 and 8.74. The tree stratum was clearly distinguished in to three layers according to the size of the trees i.e. the height they attained (tall, medium and low heights). The forest can be classified as dense forest having more or less continuous tree canopy with more than 80 % interception of incident PAR. Higher IVI value indicates ecological significance of the tree species in the forest. The tree density, dominance and diversity will indicate changes and susceptibility to anthropogenic stressors among various vegetation categories and their formation.

Keywords:

Chilapatta reserve, duars, eastern Himalaya, forest, tree diversity

INTRODUCTION

Tropical forests are one of the most structurally and functionally complex systems on earth. Forest diversity, especially the trees provide resources and habitat for almost all life forms of the forest (Huston 1994; Cannon et al. 1998). Tree diversity has attracted the attention of people in general and scientist community in particular because of increasing awareness of its importance on one hand and the anticipated massive reduction on the other hand. The rarer tree species with poor representation need proper attention to determine their conservation status and key functions. Mapping concentration areas of these species and further study on their key ecological and cultural functions would help identify locations for conservation actions and determine which wildlife species may depend on them in the forest. Forest manager can use such information on rare and common species to manage wildlife habitat as well as provide cultural resource values of these species.

This information of tree community will be helpful to understand the structural and functional attributes specific to locate for better landscape management. Systematic floristic, qualitative and quantitative analysis of forests at Terai Duars region of Indian eastern Himalayas is lacking. Such an understanding is very important for developing natural resource management and conservation ideas for these forests which are a part of the Indo-Malayan Biodiversity Hotspot (Myers and Mittermeier 2000).

MATERIALS AND METHODS

The study was conducted at Chilapatta Reserve Forest in the West Bengal foothills of Indian sub-Himalayan mountain belts with forest type from tropical wet evergreen to tropical moist deciduous (Champion and Seth 1968). The elevation of the working site as measured by GPS (Germin 72) was latitude 26° 32.85' N and longitude 89° 22.99' E. Altitude of the area was 47 m above MSL. The climate of the study site was moist tropical. The soil was high in organic carbon and available nitrogen, medium in phosphorus and potash with acidic reaction. Tree composition was analyzed by stratified random nested quadrat sampling in which 57 quadrats of 20 m x 20 m dimension were laid throughout the forest having an area of 2200 ha. Identification of the specimens was done on the spot as far as possible with help of local names. Unidentified specimens were taken either to Taxonomy and Environment Biology Laboratory, Department of Botany, University of North Bengal, Siliguri or to National Herbarium, Shibpur Howrah for identification. Raunkiaer's law of frequency, density, basal area and importance value index (IVI) were estimated following the standard method (Raunkiaer 1934; Cintron and Novelli 1984; Chauhan et al. 2009). Commonly used diversity indices like species richness, species diversity index (Menhinick, 1964), concentration of dominance (Simpson 1949), Shannon-Wiener diversity index (Shannon and Weiner 1963) and species evenness index (Pielou 1975) were used to analyze the diversity pattern of the forest.The size of the trees were recorded by visual observations of their height they attained which was found as tall, medium and low heights of about 75-90, 50-75 and < 50 feet, respectively.

RESULTS AND DISCUSSION

Tree species richness recorded was 154 but 29 of these species remained unidentified (Table 1 and 2). Identified species represented 39 families and 90 genera. The dominating families were Lauraceae, Fabaceae and Meliaceae. Among families, Fabaceae and Meliaceae dominated with eight genera each followed by Euphorbiaceae, Lauraceae and Rubiaceae with seven genera each. Genera Litsea of Lauraceae was recorded with highest number of seven species followed by Syzygium and Terminalia with five species each (Table 1).The values worked out for species diversity index, concentration of dominance, Shannon and Wiener index, and evenness are given in Table 2. The species diversity index or Menhinick's index of the tree species was 2.07. The index considers the total number of tree species and total number of individuals of all the tree species and based on this index it can be stated that though the tree species found in this forest were more diverse but are rarer or less frequently present. The concentration of dominance estimated was 0.018. This reflects number of chance the species were encountered during sampling and lower value means the chances of encountering being more. Shannon and Wiener index, that determine diversity, was inversely proportional to concentration of dominance and the corresponding value was 4.70. Species diversity index or Shannon and Wiener index of diversity is generally higher for tropical forests (Knight 1975). This index is also an expression of community structure and complexity of a habitat. A high index value is suggestive of more diverse and stable community. It was also observed that the tree species in the forest were distributed evenly (1.43). Concentration of dominance recorded in this study was low which was in accordance with higher diversity and related inversely to the index of dominance (Odum 1971). The lower concentration of dominance recorded in this study can be attributed to the fact that in the Chilapatta Reserve Forest dominance was shared by more than one species which was otherwise higher due to single or few species dominance.

Frequency, relative frequency, density, relative density, abundance, relative abundance, important value index and size of the tree are presented in Table 1.Frequency or the degree of dispersion ranged from 0.19-54.39 %. The species whose chances of occurrence (frequency) were recorded as more than 40 % were regarded as the prominent species in the forest. Only *Persea glaucescens* (40.35 %), *Machilus villosa* (42.11 %), *Tectona grandis* (47.37), *Pterygota alata* (49.12 %) and *Lagerstroemia parviflora* (54.39 %) were prominently found. Similarly the chance of occurrence of *Tectona grandis* relative to all other species in the forest was highest with 5.15 % while *Ficus neriifolia* recorded lowest with 0.01 %. The frequency and relative frequency values of the forest indicate that these ranges from low to medium which can be attributed to higher diversity/species richness of the tropical or sub-

Table 1: Quantitative characters of tree communities of Chilapatta Reserve Forest

Sl. no.	Family	Scientific Name	H	F	RF	D	RD	A	RA	IVI
1.	Anacardiaceae	*Drymicarpus racemosus*	m	12.28	0.30	10.09	0.11	3.29	0.38	0.79
2.		*Saurindia madagascarensis*	m	17.54	0.35	11.84	0.13	2.70	0.26	0.75
3.	Annonaceae	*Uvaria hamiltonii*	t	14.91	0.48	16.23	0.18	3.00	0.25	0.92
4.		*Polyalthia simiarum*	m	29.82	0.58	19.30	0.22	2.18	0.28	1.08
5.	Apocynaceae	*Alstonia scholaris*	l	9.65	0.27	9.21	0.10	2.91	0.30	0.68
6.		*Wrightia arborea*	m	25.44	0.27	9.21	0.10	3.21	0.24	0.62
7.		*Wrightia tomentosa*	m	15.79	0.46	15.35	0.17	2.33	0.31	0.94
8.	Arecaceae	*Calamus erectus*	m	1.75	0.05	1.75	0.02	1.00	0.23	0.30
9.		*Calamus guruba*	m	1.75	0.05	1.75	0.02	1.00	0.23	0.30
10.		*Pinangra gracilis*	m	5.96	0.12	3.95	0.04	4.41	0.21	0.37
11.	Bignoniaceae	*Oroxylum indicum*	m	12.63	0.34	11.40	0.13	9.36	0.25	0.72
12.	Bombacaceae	*Bombax ceiba*	m	21.05	0.24	7.89	0.09	2.17	0.26	0.58
13.	Boraginaceae	*Cordia obliqua*	m	8.77	0.12	3.95	0.04	1.00	0.17	0.34
14.	Burseraceae	*Canarium sikkimense*	t	14.04	0.35	11.84	0.13	1.13	0.31	0.80
15.	Capparidaceae	*Capparis multiflora*	t	5.26	0.35	11.84	0.13	4.33	0.39	0.88
16.		*Capparis sikkimensis*	m	8.77	0.22	7.46	0.08	3.40	0.14	0.45
17.		*Stixis suaveolens*	m	10.53	0.39	13.16	0.15	4.50	0.27	0.81
18.	Combretaceae	*Termenalia bellirica*	m	11.23	0.80	26.75	0.30	5.59	0.39	1.49
19.		*Terminalia chebula*	m	22.81	0.73	24.56	0.28	4.69	0.43	1.44
20.		*Terminalia crenulata*	m	35.09	0.17	5.70	0.06	2.80	0.30	0.53
21.		*Terminalia myriocarpa*	m	22.81	0.39	13.16	0.15	1.77	0.23	0.77
22.		*Termenalia tomentosa*	m	26.32	1.02	34.21	0.39	4.80	0.69	2.10
23.	Dilleniaceae	*Dillenia indica*	m	17.54	0.46	15.35	0.17	3.00	0.34	0.97
24.		*Dillenia pentagyna*	l	8.77	0.65	21.93	0.25	2.60	0.44	1.35
25.		*Tetracera sarmentosa*	m	26.32	0.59	19.74	0.22	2.00	0.47	1.28
26.	Diptrocarpaceae	*Shorea robusta*	t	24.56	2.30	77.19	0.88	2.64	0.78	3.96
27.	Ehretiaceae	*Ehretia acuminata*	m	11.93	0.44	14.91	0.17	9.24	0.44	1.05
28	Elaeocarpaceae	*Elaeocarpus lanceifolius*	m	12.28	0.47	15.79	0.18	1.86	0.35	1.00

29.		Sloania sterculiaceae	t	22.81	0.33	10.96	0.12	3.85	0.21	0.66
30.	Euphorbiaceae	Baliospermum montanum	m	8.14	0.24	7.89	0.09	7.12	0.17	0.50
31.		Croton caudatus	t	8.77	0.43	14.47	0.16	1.80	0.32	0.91
32.		Macaranga denticulata	m	24.56	1.05	35.09	0.40	1.79	0.58	2.02
33.		Macaranga indica	m	21.05	0.71	23.68	0.27	3.00	0.39	1.36
34.		Mallotus philippensis	m	29.82	0.84	28.07	0.32	3.12	0.43	1.59
35.		Phyllanthus reticulatus	m	21.05	0.47	15.79	0.18	2.75	0.32	0.97
36.		Sapium baccatum	s	28.07	0.60	20.18	0.23	5.00	0.38	1.21
37.		Trewia nudiflora	t	8.77	0.51	17.11	0.19	3.80	0.41	1.11
38.	Fabaceae	Acacia concenna	m	12.28	0.04	1.32	0.01	1.43	0.12	0.17
39.		Acacia lenticularis	t	28.07	0.31	10.53	0.12	1.75	0.20	0.63
40.		Albizia chinensis	t	14.04	0.25	8.33	0.09	1.63	0.31	0.66
41.		Albizia lebbeck	t	15.79	0.44	14.91	0.17	3.67	0.18	0.79
42.		Albizia lucidior	m	20.18	0.75	25.00	0.28	2.09	0.47	1.50
43.		Albizia procera	t	1.75	0.05	1.75	0.02	1.00	0.23	0.30
44.		Butea parviflora	m	14.04	0.13	4.39	0.05	5.75	0.19	0.37
45.		Bridelia sikkimensis	m	1.75	0.42	14.04	0.16	1.00	0.26	0.84
47.		Bauhinia variegata	m	22.81	0.60	20.18	0.23	3.23	0.35	1.18
48.		Bauhinia scandens	m	24.56	0.25	8.33	0.09	3.29	0.20	0.54
49		Dalbergia latifolia	t	29.82	0.51	17.11	0.19	2.06	0.28	0.99
50.		Dalbergia stipulacea	t	11.40	0.37	12.28	0.14	2.62	0.20	0.71
51.		Pterocarpus marsupium	m	5.61	0.39	13.16	0.15	5.19	0.38	0.93
52.		Tephrosia candida	m	19.30	0.38	12.72	0.14	1.73	0.30	0.83
53.	Fagaceae	Castaneaindica	m	24.56	0.31	10.53	0.12	2.86	0.31	0.74
54.		Castanopsis indica	t	10.53	0.56	18.86	0.21	1.67	0.50	1.27
55.		Quercus castanopsis	t	17.54	0.12	3.95	0.04	2.70	0.21	0.37
56.	Flacourtiaceae	Gynocardia odorata	m	17.54	0.21	7.02	0.08	1.80	0.23	0.52
59.	Lauraceae	Actinodaphne obovata	m	5.96	0.94	31.58	0.36	5.24	0.42	1.72
60.		Actinodaphne sikkimensis	m	12.28	0.73	24.56	0.28	2.29	0.92	1.93
61.		Beilschmiedia dalzellii	m	10.53	0.25	8.33	0.09	1.50	0.27	0.62
62.		Cinnadenia paniculata	m	14.04	0.20	6.58	0.07	3.75	0.25	0.52

63.		*Cinnamomum bejolghota*	m	21.05	0.42	14.04	0.16	4.00	0.31	0.89
64.		*Litsea cubeba*	l	12.28	0.38	12.72	0.14	3.43	0.28	0.80
65.		*Litsea glutinosa*	m	14.04	0.89	29.82	0.34	2.38	0.60	1.83
66.		*Litsea hookeri*	m	12.28	0.92	30.70	0.35	2.14	0.73	2.00
67.		*Litsea lacta*	m	21.05	0.72	24.12	0.27	2.67	0.42	1.42
68.		*Litsea monopetala*	m	21.05	0.89	29.82	0.34	2.42	0.33	1.55
69.		*Litsea panamanja*	t	22.81	1.01	33.77	0.38	5.23	0.52	1.91
70.		*Litsea salicifolia*	m	19.30	0.68	22.81	0.26	6.36	0.30	1.24
71.		*Machilus villosa*	s	26.32	1.43	47.81	0.54	3.67	0.42	2.39
72.		*Persea glaucescens*	m	42.11	0.95	32.02	0.36	4.21	0.42	1.74
73.		*Persea odoratissima*	m	40.35	0.73	24.56	0.28	3.35	0.36	1.37
74.		*Phoebe lanceolata*	l	31.58	0.46	15.35	0.17	2.89	0.18	0.82
75.	Lecythidaceae	*Careya arborea*	m	24.56	0.99	33.33	0.38	2.86	0.58	1.96
76.	Lythraceae	*Lagerstroemia parviflora*	t	4.91	4.40	147.37	1.67	2.86	1.21	7.28
77.		*Lagerstroemia speciosa*	t	54.39	0.88	29.39	0.33	10.74	0.43	1.64
78.		*Duabanga sonneratioides*	t	22.81	0.12	3.95	0.04	2.08	0.21	0.37
79.	Magnoliaceae	*Michelia champaca*	t	12.28	1.02	34.21	0.39	1.14	0.35	1.75
80.	Meliaceae	*Amoora wallichii*	m	33.33	0.84	28.07	0.32	4.32	0.30	1.45
81.		*Artocarpus chama*	m	21.05	0.44	14.91	0.17	1.83	0.20	0.81
82.		*Artocarpuschaplasha*	m	19.30	0.55	18.42	0.21	1.91	0.30	1.06
83.		*Artocarpus lakoocha*	m	26.32	0.39	13.16	0.15	1.67	0.27	0.81
84.		*Cedrela toona*	t	38.60	0.27	9.21	0.10	1.45	0.19	0.57
85.		*Chukrasia tabularis*	t	21.05	0.90	30.26	0.34	1.50	0.36	1.61
86.		*Ficuselastica*	t	5.26	0.08	2.63	0.03	1.33	0.17	0.28
87.		*Ficus neriifolia*	t	10.53	0.01	0.44	0.00	5.33	0.12	0.13
88.		*Ficus religiosa*	t	21.05	0.04	1.32	0.01	2.00	0.17	0.23
89.		*Morus laevigata*	m	1.75	0.05	1.75	0.02	1.00	0.23	0.30
90.		*Swetenia mahogany*	t	35.09	0.59	19.74	0.22	1.85	0.27	1.09
91.		*Streblus asper*	m	1.75	0.05	1.75	0.02	1.00	0.23	0.30
93.	Myrsinaceae	*Ardisia thyrsiflorus*	l	14.04	0.21	7.02	0.08	1.75	0.21	0.49
94.	Myrtaceae	*Eugenia cumini*	m	5.26	0.21	7.02	0.08	1.00	0.18	0.47

95.		Myristicaerotica	m	10.53	0.10	3.51	0.04	5.67	0.07	0.22
96.		Myristica longifolia	m	19.30	0.14	4.82	0.05	3.36	0.21	0.41
97.		Syzygium balsameum	m	15.79	0.25	8.33	0.09	1.78	0.22	0.56
98.		Syzygium claviflorum	m	22.81	0.27	9.21	0.10	4.38	0.40	0.78
99.		Syzygiumcumunii	m	10.53	0.75	25.00	0.28	1.83	0.27	1.30
100.		Syzygium formosum	m	14.04	0.20	6.58	0.07	1.75	0.25	0.52
101.		Syzygium operculatum	m	15.79	0.48	16.23	0.18	2.11	0.22	0.89
102.	Phyllanthaceae	Bischofia javanica	m	7.37	0.51	17.11	0.19	3.62	0.56	1.27
103.	Rhamnaceae	Ziziphus rugosa	m	15.79	0.30	10.09	0.11	3.28	0.19	0.60
104.		Ziziphus mauritiana	m	10.53	0.18	6.14	0.07	1.83	0.10	0.35
105.	Rubiaceae	Haldina cordifolia	t	7.02	0.60	20.18	0.23	2.25	0.38	1.21
106.		Hyptianthera stricta	m	17.54	0.29	9.65	0.11	1.60	0.23	0.63
107.		Ixora javanica	m	8.77	0.44	14.91	0.17	2.00	0.30	0.92
108.		Ixora nigricans	m	15.79	0.30	10.09	0.11	2.44	0.29	0.71
109.		Morinda angustifolia	l	28.07	0.44	14.91	0.17	3.25	0.21	0.82
110.		Mussaenda roxburghii	m	24.56	0.77	25.88	0.29	3.29	0.62	1.68
111.		Neolamarikia kadamba	t	17.54	0.29	9.65	0.11	1.60	0.23	0.63
112.		Psychotria calocarpa	m	19.30	0.61	20.61	0.23	2.00	0.19	1.04
113.	Rutaceae	Aegle marmelos	m	5.26	0.07	2.19	0.02	4.00	0.29	0.38
114.		Zanthoxylum rhetsa	m	22.81	0.71	23.68	0.27	2.62	0.31	1.29
115.	Sabiaceae	Meliosma pinnata	m	33.33	0.61	20.61	0.23	2.00	0.27	1.12
116.	Sapindaceae	Aesculus assamica	m	33.33	0.55	18.42	0.21	1.79	0.37	1.13
117.	Sapotaceae	Mimusops elengi	m	5.96	0.64	21.49	0.24	5.12	0.28	1.17
118.	Simaroubaceae	Ailanthus grandis	m	8.77	0.22	7.46	0.08	5.90	0.22	0.52
119.		Ailanthus integrifolia	m	19.30	0.25	8.33	0.09	2.64	0.27	0.62
120.	Solanaceae	Ardisia solanacea	l	3.16	0.52	17.54	0.20	3.00	0.17	0.89
121.	Sterculiaceae	Pterygota alata	m	35.09	4.68	157.02	1.78	3.30	1.53	8.00
122.		Sterculia villosa	t	6.32	1.16	39.04	0.44	4.64	0.93	2.54
123.	Tetraceraceae	Tetracera sarmentosa	m	26.32	0.65	21.93	0.25	2.67	0.38	1.29
124.	Theaceae	Eurya cerasifolia	m	35.09	0.14	4.82	0.05	3.95	0.21	0.41
125.		Eurya japonica	l	35.09	0.04	1.32	0.01	4.00	0.12	0.17

126.		Schima wallichii	t	22.81	0.85	28.51	0.32	3.23	0.83	2.01
127.	Ulmaceae	Trema orientalis	m	14.04	0.08	2.63	0.03	2.38	0.69	0.80
128.	Verbenaceae	Gmelina arborea	t	15.79	1.07	35.96	0.41	1.89	1.89	3.37
129.		Tectona grandis	t	47.37	5.15	172.81	1.96	1.48	1.62	8.74
130		Vitex quinata	m	21.05	0.07	2.19	0.02	17.83	0.29	0.38
131.		Un-1	t	14.04	0.13	4.39	0.05	1.63	0.16	0.35
132.		Un-2	t	7.02	0.17	5.70	0.06	1.50	0.19	0.42
133.		Un-3	t	3.51	0.08	2.63	0.03	1.50	0.17	0.28
134.		Un-4	t	8.77	0.04	1.32	0.01	1.40	0.17	0.23
135.		Un-5	m	10.53	0.09	3.07	0.03	1.67	0.16	0.29
136.		Un-6	m	10.53	0.13	4.39	0.05	1.83	0.19	0.37
137.		Un-7	m	5.26	0.14	4.82	0.05	2.00	0.21	0.41
138.		Un-8	m	8.77	0.08	2.63	0.03	2.00	0.23	0.34
139.		Un-9	m	8.77	0.13	4.39	0.05	2.00	0.23	0.41
140.		Un-10	t	10.53	0.13	4.39	0.05	1.33	0.23	0.41
141.		Un-11	m	10.53	0.10	3.51	0.04	1.67	0.15	0.30
142.		Un-12	m	14.04	0.13	4.39	0.05	1.50	0.19	0.37
143.		Un-13	m	7.02	0.16	5.26	0.06	1.50	0.17	0.39
144.		Un-14	m	8.77	0.08	2.63	0.03	2.60	0.17	0.28
145.		Un-15	m	14.04	0.17	5.70	0.06	1.38	0.21	0.45
146.		Un-16	m	14.04	0.14	4.82	0.05	1.25	0.16	0.36
147.		Un-17	m	3.51	0.13	4.39	0.05	2.00	0.14	0.32
148.		Un-18	m	8.77	0.05	1.75	0.02	1.60	0.15	0.23
149.		Un-19	m	12.28	0.10	3.51	0.04	1.57	0.18	0.33
150.		Un-20	m	12.28	0.14	4.82	0.05	1.71	0.18	0.38
151.		Un-21	t	5.26	0.16	5.26	0.06	2.00	0.20	0.41
152.		Un-22	t	12.28	0.08	2.63	0.03	2.14	0.23	0.34
153.		Un-23	t	8.77	0.20	6.58	0.07	1.40	0.19	0.46
154.		Un-24	m	8.77	0.22	7.46	0.08	5.60	0.33	0.63
155.		Un-25	t	5.26	0.37	12.28	0.14	1.33	0.40	0.91
156.		Un-26	m	8.77	0.05	1.75	0.02	1.40	0.15	0.23
157.		Un-27	m	8.77	0.17	5.70	0.06	1.80	0.50	0.73
158.		Un-28	m	5.26	0.09	3.07	0.03	2.67	0.16	0.29
159.		Un-29	m	0.19	0.12	3.95	0.04	0.60	0.21	0.37

Un-Unidentified; **H**- Height (**l-** low, **m-** medium, **t-**tall, **s-**seedling); **F**- Frequency; **RF**- Relative frequency; **D**- Density (individuals/ha); **RD**- Relative density; **A**- Abundance; **RA**- Relative abundance; **IVI**- Importance value index

Table 2: Diversity indices of plant communities of Chilapatta Reserve Forest

SL No	Index	Value
1.	Species richness	159
2.	Number of family	41
3.	Number of genera	91
4.	Species diversity index	2.07
5.	Concentration of dominance	0.018
6.	Shannon and Wiener index	4.70
7.	Evenness index	1.43
8.	Individuals ha^{-1}	2615

Table 3: PAR interception by canopy of Chilapatta Reserve Forest ($\mu molm^{-2}s^{-1}$)

Sl No	Life form	PARI (%)	PARI
January, 2008			
1.	Total PAR	1146	
2.	Tree	86.07	986
May, 2008			
1.	Total PAR	1434	
2.	Tree	81.85	1173
September, 2008			
1.	Total PAR	1376	
2.	Tree	86.65	1192
December, 2008			
1.	Total PAR	1132	
2.	Tree	86.94	984

tropical forest (Odum 1971) leading to nearly equally fairer chance of all the species to occur with less deviation from each other due to favorable/optimum climatic and edaphic conditions for all the species or not a single species highly dominating over the other.

Density or numerical strength of tree species per unit area ranged from 0.44 to 172.81 individuals ha^{-1} while, relative density ranged from 0.01 to 1.96 %. Overall tree density in the forest estimated was 2615 trees ha^{-1}. This estimation is much higher than those reported earlier (Ashton 1964; Campbell et al. 1992; Richards 1996; Ferreira and Prance 1998). Higher tree density can be attributed to high tree species richness of this forest. Plant density varies with forest community type, forest age class, tree species and size class, site history, site condition and other factors (Kumar et al. 2006). Evaluation of density-dependent status of a species in a study site is important for conservation and management of forests. Overall the tree density of the forest is high because of lesser disturbance owing to its protection from the law as a Reserve Forest or Protected Forest for wildlife.

Species abundance ranged from 0.60 to 17.83 which indicate the numerical strength of species in sampled area. Abundance, however did not give a total picture of the numerical strength of a species because it considers only the quadrats of occurrence of a species. Therefore the abundance of a species relative to total abundance of all the species in all sampled quadrats is indicative of actual numerical strength of a species. It was wider from lowest of 0.07 % for *Myristica erotica* to highest of 1.89 % for *Gmelina arborea*. This wider variation can be attributed to the wide range of occurrence of individuals between the species. *Ficus neriifolia* recorded lowest IVI of 0.13 while *Tectona grandis* highest with 8.74.This clearly indicates the ecological importance of *Tectona grandis* in Chilapatta Reserve Forest as the species was relatively most abundant and had the maximum occurrence in the forest. The second most dominant species in terms of IVI was *Pterygota alata* (8.00). Other associate trees species were *Lagerstroemia parviflora* (7.28), *Shorea robusta* (3.96) and *Gmelina arborea* (3.37).

The tree stratum was clearly distinguished in to three layers according to the size of the trees (Table 1). Medium tree species dominated with

68.15 % followed by taller height species with 26.75 % and only 5.10 % tree species were of low height. However, a tree of *Ficus religiosa* and an unidentified species with a height of about 120 feet was recorded as the tallest trees in the forest. Species like *Tectona grandis*, *Shorea robusta*, *Albizia lebbeck*, *A. procera*, *Swetenia mahogany*, *Gmelina arborea*, *Lagerstroemia parviflora*, *Bombax ceiba* and *Terminalia tomentosa* were dominant species in terms of their solar radiation interception without any interference because they occupied the top most layer of the tree stratum/canopy. The medium tree stratum/canopy where left over solar radiation could penetrate through the dominant canopy above were occupied by species which are co-dominants like *Dillenia indica*, *Bahunia variegata*, *Cinnamomum bejolghota*, *Terminalia bellirica*, *T. chebula*, *Oroxylum indicum* and *Mallotus philippens*. Species like *Dillenia pentagyna*, *Litsea cubeba*, *Eurya japonica*, *Phoebe lanceolata*, *Alstonia scholaris*, *Ardisia thyrsiflorus* and *Morinda aungustifolia* were the suppressed tree species as they inhabited the lowermost tree stratum/canopy down to which very less solar radiation penetrated (Table 3).

CONCLUSION

In Chilapatta Reserve Forest, trees were fairly even distributed in diverse communities with higher chances of encountering during sampling which was evidenced from the higher values of species diversity index, concentration of dominance, Shannon and Wiener index, and evenness because of lesser disturbance owing to its status of protection from the law as a Reserve Forest or Protected Forest for wildlife. Wider variation of tree species can be attributed to wide range of occurrence of individuals between the species. *Tectona grandis* was the most ecologically important species in the forest as it was relatively most abundant, had the maximum occurrence, highest IVI and dominant occupying the top most layer of the tree stratum/canopy, intercepting solar radiation without any interference.

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