

Tree species diversity and distribution patterns in tropical forest of Eastern Ghats, India: a case study

C. Sudhakar Reddy*, Prachi Ugle

Forestry & Ecology Division, National Remote Sensing Agency, Balanagar, Hyderabad 500037, India

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Abstract

The aim of the investigation was to analyze phytosociological characteristics and diversity patterns of tropical forest of Eastern Ghats – R.V. Nagar Range, Visakhapatnam district. The three forest types here include semi evergreen, moist deciduous and savannah. The Shannon index was recorded high for moist deciduous with 5.50 followed by semi evergreen with 5.27 and savannah with 3.71. Similarity index reveals that only 62.4% of floristic composition of semi evergreen forest is similar with moist deciduous, followed by 32% between moist deciduous and savannah and a very low similarity (5%) was observed between semi evergreen and savannah. Phytosociological characteristics reveals that *Pterocarpus marsupium*, *Schleichera oleosa*, *Mangifera indica*, *Syzygium cumini*, *Bauhinia vahlii*, *Mallotus philippensis* and *Grewia tilifolia* were the most frequent species when overall forest types were considered. Based on Raunkier's frequency distribution 81.4% species are falling under A frequency class (1% – 20%), 6.98% species fall in B and C class category (21% – 40% and 41% – 60% respectively) and 4.65% in D class (61% – 80%) in semi evergreen. Moist deciduous showed 82.1% in A class, 8.3% in B class, 7.1% in C class followed by 1.2% in D & E class. In the case of savannah 61% were in B, 28% in D and 11% in E class. The distribution pattern revealed that 107 species showed regular pattern, 12 as random and one species as contiguous pattern. The study provided diversity and distribution pattern of tree species in R.V. Nagar Range, Vishakapatnam district, Andhra Pradesh. [Life Science Journal. 2008; 5(4): 87 – 93] (ISSN: 1097 – 8135).

Keywords: tropical forest; semi evergreen; moist deciduous; savannah; Raunkier's frequency distribution

1 Introduction

Tropical forests are regarded as one of the most species diversity rich terrestrial ecosystems. They are distinguished from all other terrestrial ecosystems by a very high diversity in many levels (species, life forms, etc). However, most of these forests are under immense anthropogenic disturbances and require careful management intervention to maintain overall biodiversity and sustainability (Kumar *et al*, 2006). Information with reference to species diversity and distribution pattern may help in evaluating the ecological significance of the study area.

Convention on biological diversity (CBD) commits

parties to the convention amongst them India, to take an inventory of their biodiversity resources and to organize programmes of regular monitoring (UNEP-CBD, 1991). Nevertheless, there have been few attempts to identify patterns of distribution of species in India, and other parts of the world in terms of forest types or vegetation series or vegetation types. These attempts take the form of classification i.e. identification of discrete classes from what are largely continuous distributions. Such delineation of discrete sets of species may be based on phonology or physiognomy, levels of human disturbances, or identity of the dominant or economically important species. The choice of sampling localities may then be related to the distribution of different forest or vegetation types (Ghate *et al*, 1998).

An understanding of the distribution of tree species and their assemblages must play an important role in elucidating the larger patterns of distribution

*Corresponding author. Tel: 040-23884219; Email: drsudhakarreddy@gmail.com

of biodiversity. In Peninsular India, quantitative phytodiversity inventories are available from the forests of the Western Ghats (Reddy *et al*, 2008a), however Eastern Ghats remains as a neglected area for studies (Kadavul & Parthasarathy, 2000; Jayakumar *et al*, 2002; Natarajan *et al*, 2004), Orissa (Reddy *et al*, 2007) and Andhra Pradesh (Reddy *et al*, 2008b).

The Eastern Ghats are located along the Peninsular India extending over 1750 km with average width of about 100 km and covering the area under 11° 03' to 22° 32' N latitudes and 77° 02' to 87° 02' E longitudes. R.V. Nagar Range is situated between 17° 48' to 18° 00' N and 82° 02' to 82° 16' E in Visakhapatnam district, Andhra Pradesh and covers an area of 312 km². It is a part of proposed Chintapally biosphere reserve and has unique vegetation composition with semi evergreen forests in the tracts of Gudem valley. The highest peak in Andhra Pradesh in Sambarikonda (1527 m), which is found in this range. The forest area in the range is 224.5 km². The forest types within study area are subjected to anthropogenic disturbances, particularly for shifting cultivation.

The present study was undertaken to present a database on diversity and distribution pattern of R.V. Nagar Range, Visakhapatnam.

2 Materials and Methods

Stratified random sampling method was employed to collect tree data. Sample plots (quadrat) size of 20 × 20 were placed and systematically surveyed for all trees at ≥30 cm girth at breast height during 2005 – 2006. The data was obtained from a total of 50 sample plots (area sampled was 2 ha). The species were identified with the help of Flora of Presidency of Madras (Gamble & Fischer, 1915 – 1935) and Flora of Visakhapatnam district (Subbarao & Kumari, 2002).

The following phytosociological characteristics of the tree communities were assessed: % frequency, density, abundance, basal area and IVI. Species diversity of each forest type was determined using Shannon Weiner index (Shannon and Weiner, 1963). Ratio of abundance to frequency (Whitford, 1949) was calculated where in distribution was considered regular: below 0.025, random: 0.025 – 0.05 and contiguous: if > 0.05 (Curtis & Cottam, 1956). Each tree species was grouped into five frequency classes based on Raunkier's law of frequency and the difference between the normal frequency diagram and regional frequency diagram was noted. The frequency classes are A, B, C, D, and E according to

Raunkier's frequency spectrum. The values in range for each class are as follows (Table 1):

Table 1. The values of frequency class for tree species

S/No.	Frequency class	% values
1	A	0 – 20
2	B	21 – 40
3	C	41 – 60
4	D	61 – 80
5	E	81 – 100

The Raunkier's frequency diagram is as follows:

$$A > B \leq C \geq D < E.$$

We have computed Similarity index between three vegetation types using Sorenson's similarity index (Sorenson, 1948) among the three vegetation type.

3 Results and Discussion

The predominant forest types in R.V. Nagar Range of Eastern Ghats are semi evergreen, moist deciduous and savannah.

A total of 1204 trees belonging to 274 tree species among 45 families from 50 sample plots were enumerated. The number of tree species in semi evergreen forest type was 86, followed by 84 in moist deciduous and savannah with 18 tree species. The basal area ranged from 7.792 m²/ha – 49.2 m²/ha with the highest basal area recorded in semi evergreen. Similarity index reveals that only 62.4% of floristic composition of semi evergreen forest is similar with moist deciduous, followed by 32% between moist deciduous and savannah and a very low similarity (5%) was observed between semi evergreen and savannah (Table 2).

Table 2. Comparison of tree parameters among three forest types

Description	Semi evergreen	Moist deciduous	Savannah
No. of tree species	86	84	18
Basal area (m ² /ha)	49.2	43.7	7.79
Shannon index	5.27	5.50	3.71
Similarity index			
Semi evergreen		62.4	
Moist deciduous			32
Savannah	5		

The Shannon Weiner index varied from 3.71 – 5.50

with highest Shannon Weiner index recorded in moist deciduous. *Bauhinia vahlii*, *Mallotus philippensis*, *Syzygium cumini* and *Schleichera oleosa* were the most frequent species in semi evergreen forest type, *Pterocarpus marsupium*, *Grewia tilifolia*, *Syzygium cumini*, *Schleichera oleosa*, *Mallotus philippensis*, *Diospyros sylvatica* and *Bauhinia vahlii* were the most frequent species found in moist deciduous type followed

by *Terminalia chebula*, *Terminalia alata*, *Holarrhena antidysenterica*, *Phyllanthus emblica*, *Sterculia villosa*, *Bombax ceiba* and *Buchanania lanzan* in Savannah. *Pterocarpus marsupium*, *Schleichera oleosa*, *Mangifera indica*, *Syzygium cumini*, *Bauhinia vahlii*, *Mallotus philippensis* and *Grewia tilifolia* were the most frequent species when overall forest types were considered (Table 3).

Table 3. Phytosociological characteristics of overall vegetation type

	Species	Relative density	Relative frequency	Relative Basal area	IVI	Raunkier's frequency %	Raunkier's frequency class	Distribution pattern
1	<i>Pterocarpus marsupium</i>	7.56	5.05	10.63	23.25	62.2	D	Regular
2	<i>Schleichera oleosa</i>	6.89	3.97	8.92	19.78	48.9	C	Regular
3	<i>Mangifera indica</i>	4.15	2.89	8.31	15.35	35.6	B	Regular
4	<i>Syzygium cumini</i>	3.65	4.15	7.34	15.15	51.1	C	Regular
5	<i>Michelia champaca</i>	2.57	2.89	7.93	13.39	35.6	B	Regular
6	<i>Bauhinia vahlii</i>	5.73	4.33	1.39	11.45	53.3	C	Regular
7	<i>Mallotus philippensis</i>	5.56	4.33	1.10	11.00	53.3	C	Regular
8	<i>Grewia tilifolia</i>	4.32	4.33	1.95	10.61	53.3	C	Regular
9	<i>Terminalia alata</i>	2.74	2.17	4.15	9.05	26.7	B	Regular
10	<i>Garuga pinnata</i>	2.66	2.35	3.86	8.87	28.9	B	Regular
11	<i>Aphanamixis polystachya</i>	1.50	2.53	4.49	8.51	31.1	B	Regular
12	<i>Gmelina arborea</i>	2.49	3.07	2.46	8.02	37.8	B	Regular
13	<i>Litsea glutinosa</i>	2.08	2.17	3.36	7.61	26.7	B	Regular
14	<i>Cassia fistula</i>	3.57	3.07	0.87	7.51	37.8	B	Regular
15	<i>Nothopegia heyneana</i>	1.50	1.08	3.94	6.51	13.3	A	Regular
16	<i>Diospyros sylvatica</i>	2.08	2.53	1.27	5.87	31.1	B	Regular
17	<i>Macaranga peltata</i>	1.41	1.99	1.51	4.91	24.4	A	Regular
18	<i>Xylia xylocarpa</i>	2.16	0.36	2.27	4.79	4.4	A	Contiguous
19	<i>Terminalia chebula</i>	2.08	1.81	0.85	4.73	22.2	B	Regular
20	<i>Artocarpus heterophyllus</i>	0.83	0.90	2.47	4.20	11.1	A	Regular
21	<i>Terminalia bellerica</i>	1.16	1.81	0.91	3.88	22.2	B	Regular
22	<i>Diospyros Montana</i>	0.75	0.72	2.17	3.64	8.9	A	Regular
23	<i>Garcinia xanthochymus</i>	1.66	1.08	0.59	3.33	13.3	A	Regular
24	<i>Sterculia villosa</i>	1.58	1.26	0.45	3.29	15.6	A	Regular
25	<i>Ouigenia ougenensis</i>	0.91	1.26	1.00	3.18	15.6	A	Regular
26	<i>Holarrhena antidysenterica</i>	1.58	0.90	0.25	2.73	11.1	A	Regular
27	<i>Dillenia pentagyna</i>	0.75	1.08	0.82	2.65	13.3	A	Regular
28	<i>Garcinia spicata</i>	1.00	1.08	0.44	2.52	13.3	A	Regular
29	<i>Oroxylum indicum</i>	1.16	0.72	0.59	2.48	8.9	A	Regular
30	<i>Bischofia javanica</i>	0.83	0.90	0.69	2.42	11.1	A	Regular
31	<i>Callicarpa arborea</i>	0.91	1.08	0.41	2.41	13.3	A	Regular
32	<i>Miliusa tomentosa</i>	0.66	0.90	0.61	2.18	11.1	A	Regular
33	<i>Bauhinia semla</i>	0.66	1.08	0.42	2.17	13.3	A	Regular
34	<i>Cipadessa baccifera</i>	0.75	1.26	0.13	2.14	15.6	A	Regular
35	<i>Acacia pennata</i>	0.75	1.26	0.10	2.11	15.6	A	Regular
36	<i>Kydia calycina</i>	0.58	1.08	0.27	1.93	13.3	A	Regular
37	<i>Schefflera roxburghii</i>	0.66	0.54	0.61	1.82	6.7	A	Regular
38	<i>Cassine glauca</i>	0.83	0.72	0.25	1.80	8.9	A	Regular
39	<i>Diospyros candollena</i>	0.25	0.36	1.19	1.80	4.4	A	Regular
40	<i>Cinnamomum caudatum</i>	0.66	0.90	0.23	1.80	11.1	A	Regular
41	<i>Dolichandrone atrovirens</i>	0.66	0.72	0.27	1.66	8.9	A	Regular

Continued

42	<i>Antidesma menasu</i>	0.75	0.72	0.17	1.64	8.9	A	Regular
43	<i>Phyllanthus emblica</i>	0.66	0.72	0.13	1.52	8.9	A	Regular
44	<i>Bombax ceiba</i>	0.33	0.72	0.40	1.46	8.9	A	Regular
45	<i>Artabotrys hexapetalus</i>	0.66	0.72	0.04	1.42	8.9	A	Regular
46	<i>Neonauclea purpurea</i>	0.42	0.54	0.45	1.41	6.7	A	Regular
47	<i>Trichilia connaroides</i>	0.58	0.54	0.22	1.34	6.7	A	Regular
48	<i>Ficus arnottiana</i>	0.17	0.18	0.94	1.29	2.2	A	Random
49	<i>Caryota urens</i>	0.42	0.72	0.13	1.27	8.9	A	Regular
50	<i>Ficus religiosa</i>	0.08	0.18	0.93	1.19	2.2	A	Regular
51	<i>Ziziphus xylopyrus</i>	0.42	0.72	0.05	1.19	8.9	A	Regular
52	<i>Sloanea sterculia</i>	0.25	0.54	0.25	1.04	6.7	A	Regular
53	<i>Trema orientalis</i>	0.43	0.54	0.06	1.02	6.7	A	Regular
54	<i>Careya arborea</i>	0.25	0.36	0.37	0.98	4.4	A	Regular
55	<i>Knema attenuata</i>	0.25	0.54	0.15	0.94	6.7	A	Regular
56	<i>Leea indica</i>	0.33	0.54	0.04	0.91	6.7	A	Regular
57	<i>Memecylon edule</i>	0.33	0.54	0.04	0.91	6.7	A	Regular
58	<i>Olea glandulifera</i>	0.42	0.36	0.13	0.91	4.4	A	Regular
59	<i>Drypetes sepiaria</i>	0.25	0.54	0.12	0.91	6.7	A	Regular
60	<i>Dillenia indica</i>	0.33	0.18	0.39	0.91	2.2	A	Random
61	<i>Buchanania lanzan</i>	0.25	0.54	0.08	0.87	6.7	A	Regular
62	<i>Bridelia tomentosa</i>	0.42	0.36	0.08	0.86	4.4	A	Regular
63	<i>Linociera ramiflora</i>	0.25	0.54	0.04	0.83	6.7	A	Regular
64	<i>Piper longum</i>	0.42	0.36	0.02	0.80	4.4	A	Regular
65	<i>Terminalia paniculata</i>	0.45	0.36	0.15	0.76	4.4	A	Regular
66	<i>Ficus asperrima</i>	0.17	0.36	0.18	0.70	4.4	A	Regular
67	<i>Diospyros ebumum</i>	0.25	0.18	0.27	0.70	2.2	A	Random
68	<i>Acronychia pedunculata</i>	0.17	0.36	0.14	0.67	4.4	A	Regular
69	<i>Litsea monopetala</i>	0.25	0.36	0.03	0.64	4.4	A	Random
70	<i>Diospyros assimilis</i>	0.17	0.18	0.29	0.64	2.2	A	Regular
71	<i>Morinda pubescens</i>	0.25	0.36	0.01	0.62	4.4	A	Regular
72	<i>Albizia odoratissima</i>	0.25	0.36	0.01	0.62	4.4	A	Regular
73	<i>Ficus semicordata</i>	0.17	0.36	0.07	0.60	4.4	A	Regular
74	<i>Ehretia laevis</i>	0.17	0.36	0.06	0.59	4.4	A	Regular
75	<i>Alphonsea maderaspatana</i>	0.25	0.18	0.16	0.59	2.2	A	Regular
76	<i>Maerua apetala</i>	0.33	0.18	0.03	0.55	2.2	A	Random
77	<i>Suregada multiflora</i>	0.17	0.18	0.19	0.54	2.2	A	Random
78	<i>Embelia ribes</i>	0.17	0.18	0.11	0.46	2.2	A	Random
79	<i>Atalantia monophylla</i>	0.25	0.18	0.03	0.46	2.2	A	Random
80	<i>Toona ciliata</i>	0.17	0.18	0.10	0.44	2.2	A	Random
81	<i>Haldinia cordifolia</i>	0.25	0.18	0.01	0.44	2.2	A	Random
82	<i>Persea macrantha</i>	0.08	0.18	0.16	0.42	2.2	A	Regular
83	<i>Actinodaphne maderaspatana</i>	0.08	0.18	0.15	0.42	2.2	A	Regular
84	<i>Schrebera swietenoides</i>	0.08	0.18	0.15	0.41	2.2	A	Regular
85	<i>Tectona grandis</i>	0.08	0.18	0.13	0.40	2.2	A	Regular
86	<i>Ixora brachiata</i>	0.17	0.18	0.03	0.37	2.2	A	Random
87	<i>Linociera malabarica</i>	0.17	0.18	0.01	0.36	2.2	A	Random
88	<i>Lannea coromandeliana</i>	0.08	0.18	0.08	0.34	2.2	A	Regular
89	<i>Protium serratum</i>	0.08	0.18	0.08	0.34	2.2	A	Regular
90	<i>Cleistanthus patulus</i>	0.08	0.18	0.07	0.34	2.2	A	Regular
91	<i>Ehretia acuminata</i>	0.08	0.18	0.06	0.32	2.2	A	Regular
92	<i>Walsura trifolia</i>	0.08	0.18	0.06	0.32	2.2	A	Regular
93	<i>Rivea hypocrateriformis</i>	0.08	0.18	0.05	0.32	2.2	A	Regular

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94	<i>Dalbergia paniculata</i>	0.08	0.18	0.05	0.31	2.2	A	Regular
95	<i>Alphonsea sclerocarpa</i>	0.08	0.18	0.03	0.30	2.2	A	Regular
96	<i>Trewia nudiflora</i>	0.08	0.18	0.03	0.29	2.2	A	Regular
97	<i>Casearia graveolens</i>	0.08	0.18	0.03	0.29	2.2	A	Regular
98	<i>Siphonodon celastrinus</i>	0.08	0.18	0.02	0.29	2.2	A	Regular
99	<i>Xylosma longifolium</i>	0.08	0.18	0.02	0.28	2.2	A	Regular
100	<i>Diospyros melanoxyton</i>	0.08	0.18	0.02	0.28	2.2	A	Regular
101	<i>Limonia crenulata</i>	0.08	0.18	0.02	0.28	2.2	A	Regular
102	<i>Limonia alata</i>	0.08	0.18	0.01	0.28	2.2	A	Regular
103	<i>Bambusa arundinacea</i>	0.08	0.18	0.01	0.28	2.2	A	Regular
104	<i>Ficus oligodon</i>	0.08	0.18	0.01	0.28	2.2	A	Regular
105	<i>Ixora undulata</i>	0.08	0.18	0.01	0.28	2.2	A	Regular
106	<i>Meyna spinosa</i>	0.08	0.18	0.01	0.28	2.2	A	Regular
107	<i>Phoebe wightii</i>	0.08	0.18	0.01	0.28	2.2	A	Regular
108	<i>Antidesma bunius</i>	0.08	0.18	0.01	0.27	2.2	A	Regular
109	<i>Neolitsea zeylanica</i>	0.08	0.18	0.01	0.27	2.2	A	Regular
110	<i>Randia dumetorum</i>	0.08	0.18	0.01	0.27	2.2	A	Regular
111	<i>Anthocephalus chinensis</i>	0.08	0.18	0.01	0.27	2.2	A	Regular
112	<i>Diospyros melanoxyton</i>	0.08	0.18	0.01	0.27	2.2	A	Regular
113	<i>Schefflera venulosa</i>	0.08	0.18	0.01	0.27	2.2	A	Regular
114	<i>Stereospermum suaveolens</i>	0.08	0.18	0.01	0.27	2.2	A	Regular
115	<i>Strychnos potatorum</i>	0.08	0.18	0.01	0.27	2.2	A	Regular
116	<i>Schefflera clarkiana</i>	0.08	0.18	0.01	0.27	2.2	A	Regular
117	<i>Casearia elliptica</i>	0.08	0.18	0.01	0.27	2.2	A	Regular
118	<i>Uvaria hamiltonii</i>	0.08	0.18	0.00	0.27	2.2	A	Regular
119	<i>Gardenia latifolia</i>	0.08	0.18	0.00	0.27	2.2	A	Regular
120	<i>Chloroxylon swietenia</i>	0.08	0.18	0.00	0.26	2.2	A	Regular

81.4% species are falling under A Frequency class (1% – 20%), 6.98% species fall in B and C class category (21% – 40% and 41% – 60% respectively) and 4.65% in D class (61% – 80%) in semi evergreen. Moist deciduous showed 82.1% in A class, 8.3% in B class, 7.1% in C class followed by 1.2% in D & E class. In the case of Savannah 61% were in B, 28% in D and 11% in E class. Tables 3 and 4 given mentions a brief comparative statistics of frequency classes of which species. With regard to distribution pattern 107 species shows regular distribution pattern, 12 species shows random pattern and only one species shows contiguous pattern.

The number of species with reference to family dominance reveals that Caesalpiniaceae, Anacardiaceae, Euphorbiaceae and Sapindaceae were dominant among semi evergreen and Savannah type. Whereas in moist deciduous forest, Papilionaceae and Euphorbiaceae showed dominance with reference to family (Table 5).

Analysis of Raunkier’s frequency classes revealed that most of the tree species had low frequency but the species are showing diversity pattern when analyzed in terms of Shannon Weiner index. The similarity index also revealed that species are showing low similarity in

Table 4. Raunkier’s frequency class distribution for three forest types

Forest type	No. in various frequency class	% of frequency	Frequency class
Semi evergreen ¹	70	81.40	A
	6	6.98	B
	6	6.98	C
	4	4.65	D
Moist deciduous ²	69	82.1	A
	7	8.3	B
	6	7.1	C
	1	1.2	D
	1	1.2	E
Savannah ³	11	61	B
	5	28	D
	2	11	E

¹: A > B = C > D; ²: A > B > C > D = E; ³: B > D > E.

the three forest types further proving the diversity pattern in Mudumalai Wildlife Sanctuary. There seems to be a deviation between normal frequency class and regional

Table 5. List of species with reference to family dominance

Family name	SEG	MDF	Savannah
Anacardiaceae	62	8	2
Anonaceae	8	13	-
Apocynaceae	-	10	9
Araliaceae	5	4	1
Bignoniaceae	9	13	1
Bombacaceae	2	-	2
Burseraceae	25	8	-
Caesalpiniaceae	87	45	-
Capparaceae	4	-	-
Celastraceae	5	2	4
Clusiaceae	30	2	-
Combretaceae	27	29	19
Convolvulaceae	1	-	-
Dilleniaceae	8	5	-
Ebenaceae	19	20	5
Ehretiaceae	-	2	1
Euphorbiaceae	60	53	8
Flacourtiaceae	1	1	-
Flindersiaceae	-	1	-
Lauraceae	30	10	-
Lecythidaceae	-	3	-
Leeaceae	4	-	-
Loganiaceae	1	-	-
Magnoliaceae	27	4	-
Malvaceae	4	3	-
Meliaceae	24	15	-
Memecylaceae	1	3	-
Mimosaceae	6	32	-
Moraceae	14	4	-
Myrsinaceae	3	3	-
Myrtaceae	29	15	-
Oleaceae	7	4	-
Palmae	5	-	-
Papilionaceae	30	61	-
Piperaceae	5	-	-
Poaceae	1	-	-
Rhamnaceae	1	6	-
Rubiaceae	4	11	2
Rutaceae	1	4	-
Sapindaceae	64	19	-
Sterculiaceae	10	8	4
Tiliaceae	31	20	1
Ulmaceae	1	5	-
Verbenaceae	27	13	2

frequency class, the studies relevant to Raunkier's frequency distribution class will help in understanding the forest type diversity and dominance.

4 Conclusion

The quantitative characters with reference to density, diversity and frequency distribution could well act as indicators of anthropogenic disturbances that are affecting the various forest types and such studies would help in understanding the threats that are being faced by the tropical forests and would help in deriving conservation policies.

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