



Research Journal of **Forestry**

ISSN 1819-3439



Academic
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Phytosociological Study of Tropical Dry Deciduous Forest of Boudh District, Orissa, India

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Abstract: Phytosociological study was carried out in tropical dry deciduous forest of Boudh district, Eastern Ghats of Orissa, India. We inventoried a total of 187 species (trees 91, shrubs 10, climbers 12 and herbs 74) with in a four hectare sampled area. The predominant tree species are *Shorea robusta*, *Madhuca indica*, *Buchanania lanzan*, *Cleistanthus collinus* and *Diospyros melanoxylon*. Study area shows species rarity (those represented by ≤ 2 individuals) of 18%. The Shannon-Weiner index (H') is 4.51, with Simpson's value 0.92 infer that tropical dry deciduous forests are also species diverse systems. Mean stand density was 591 ha⁻¹ and mean basal area was 25.50 m² ha⁻¹. Stand density and species richness have consistently decreased with increasing girth class of tree species. Girth class having <30 cm gbh contributed to about 68.13% of species richness. The present study can serve as baseline information for monitoring and sustaining the phytodiversity of tropical dry deciduous forests in the State of Orissa.

Key words: Phytosociological study, structure, composition, dry deciduous forest, Boudh, Eastern Ghats, Orissa

INTRODUCTION

Vegetation ecology includes the investigation of species composition and sociological interaction of species in communities (Mueller-Dombois and Ellenberg, 1974). The structural property of a community is the quantitative relationship in between the species growing around. The quantitative study of vegetation is called phytosociology and its principal aim is to describe the vegetation, explain or predict its pattern and classify it in a meaningful way (Ilorkar and Khatri, 2003). It indicates species diversity which determines the distribution of individuals among the species in a particular habitat. With increase in human activity in and around forest ecosystems, biodiversity in terms of numbers of species may decline (Swaine *et al.*, 1987; Abdulhadi *et al.*, 1987). A sound understanding of the richness of species is necessary for appropriate conservation and restoration of the biological diversity.

The Indian subcontinent, with its rich biodiversity, is one of the 12 mega-diversity centres of the world. Primary forests of Asia, particularly those of the Western Ghats and the Eastern Ghats of peninsular India are disappearing at an alarming rate due to anthropogenic activities and are replaced by forests comprising inferior species or their land use pattern changed (Bahuguna, 1999). Studies from Forest Survey of India showed an average of 54.7% of forest is affected by fire and 72.1% of the forest area is subjected to grazing. Annually 3.73 million hectares of the forest area are burnt resulting in economic losses of approximately 440 crores (MoE, 1999).

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Tropical dry deciduous forests are enriched with economically important species. Vegetation composition, diversity of species and their habitats are well understood for other tropical forest types compared to dry deciduous forests. Dry deciduous forests are among the most exploited and endangered ecosystems of the biosphere (Murphy and Lugo, 1986; Janzen, 1988; Gentry, 1992).

The Eastern Ghats are located along the Peninsular India extending over 1750 km under 11°03' to 22°03'N latitudes and 77°02' to 87°02'E longitudes covering 224,290 sq km. The Eastern Ghats are delimited in the north by Similipal hills of Orissa State. The middle section extends from River Krishna (Andhra Pradesh) to near about Chennai city (Tamil Nadu) and includes the Nallamalais, Nigidi, Seshachalam and Veligonda hills. The last section runs in S-SW direction meeting the Western Ghats in the Nilgiris (Reddy *et al.*, 2006).

Boudh is (20° 30' N to 21° 50' S latitude and 83° 45' E longitude) one of the centrally located land locked district of Orissa (Fig. 1) is known for its rich and varied flora because of its unique position in Eastern Ghats. The total geographical area of the district was 3098 sq km. Anonymous (2003) records 1252 sq km of forest cover (40.41%) in the district. The whole area can conveniently be divided into two distinct zones, the northern plains and the southern elevated plateau with a few peaks harboring tropical dry deciduous floristic composition.

The temperature continues to rise till May which is the hottest month with maximum temperature of 40°C. December is the coldest month, the mean day temperature is 13°C. The average annual rainfall is 1595 mm. The rainfall decreases as one proceeds from north-west to south-west. The district is coupled of alluvium, laterite, sandstone and archaean rocks.

In Eastern Ghats of India, few quantitative phytodiversity inventories are available from the forests of Eastern Ghats of Tamil Nadu (Kaduvul and Parthasarathy, 1999a, b; Jayakumar *et al.*, 2002;

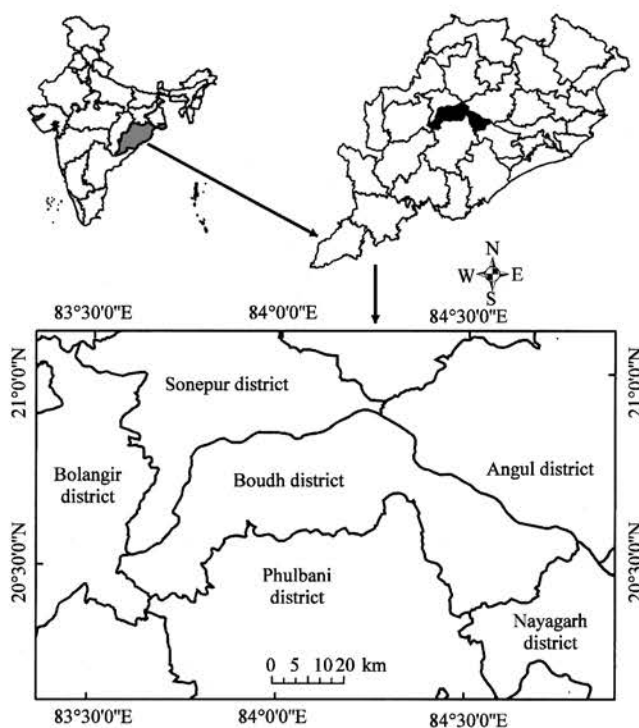


Fig. 1: Location map of Boudh district, Orissa, India

Natarajan *et al.*, 2004). These kinds of studies are poorly explored for these aspects in the State of Orissa, which covers a northern part of Eastern Ghats.

Hence, the present study was undertaken to determine the structure and floristic composition in tropical dry deciduous forests of Eastern Ghats of Orissa, India with special reference to Boudh district.

MATERIALS AND METHODS

Ground Data

Phytosociological studies were carried out during October 2004-January 2005 (wet period), to cover overall spectrum of vegetation. A total of 100 sample plots (each sample plot was 20×20 m) were laid down with sampling intensity of 0.001% based on random sampling method. All the plots were systematically surveyed for all trees = 10 cm girth at breast height (gbh-above 130 cm from the ground). Thus data were obtained from a total of 100 plots (total area = 4 ha). To account overall species diversity (herbs, climbers and shrubs) 5×5 m subplots were laid down in the center of plot. All plots sampled were representative of the most common forest type in the Boudh district, i.e. tropical dry deciduous forest. The species were identified with the help of Flora of Presidency of Madras (Gamble and Fischer, 1915-1935) and Flora of Orissa (Saxena and Brahmam, 1996).

Phytosociological data viz., relative frequency, relative density and relative dominance have been collected to compute the Importance Value Index (IVI) for each strata. IVI has been utilized to calculate species diversity using Shannon-Wiener index.

Data Analysis

The vegetation data were quantitatively analysed for relative density, relative frequency and relative dominance (Phillips, 1959). The Importance Value Index (IVI) for the tree species was determined as the sum of the relative frequency, relative density and relative dominance (Cottam and Curtis, 1956).

Relative density	=	Number of trees of species/total number of trees ×100.
Relative frequency	=	Number of time species occurs/total number of species ×100.
Relative dominance	=	Total basal area of a species/total basal area for all species ×100.
Importance Value Index (IVI)	=	Sum of relative density + relative frequency + relative dominance.
Species diversity of each forest type was determined using Shannon-Weiner Index (H')	=	-Sum ((ni/N) ln(ni/N)) (Shannon and Wiener, 1949; Odum, 1971)
Where ni	=	IVI of individual species.
N	=	IVI of all species.

Concentration of dominance was also measured using the formula (Simpson, 1949): $C = -S(ni/N)$ where ni and N are the same as those for the Shannon-Weiner information function.

RESULTS AND DISCUSSION

Forest Composition

The predominant forest type of the Boudh district in Orissa is northern tropical dry deciduous forest (Champion and Seth, 1968). Total 100 sample plots (4 ha) area represented by 187 species, which contains 91 tree species (2364 individual stems), 10 shrubs, 12 climbers and 74 herbs. The

Table 1: IVI of the ten most important species in dry deciduous forest of Boudh district, Orissa

Species	IVI	Species	IVI
Trees		Shrubs	
<i>Shorea robusta</i>	43.88	<i>Phoenix acaulis</i>	118.97
<i>Madhuca indica</i>	33.24	<i>Flacourtia indica</i>	50.66
<i>Buchanania lanzan</i>	21.81	<i>Flemingia semialata</i>	36.20
<i>Cleistanthus collinus</i>	19.61	<i>Cycas sphaerica</i>	30.29
<i>Diospyros melanoxylon</i>	19.09	<i>Flacourtia sepriaria</i>	15.91
<i>Terminalia alata</i>	17.05	<i>Grewia hirsuta</i>	15.91
<i>Anogeissus latifolia</i>	14.48	<i>Randia malabarica</i>	13.65
<i>Lagerstroemia parviflora</i>	13.68	<i>Grewia sapida</i>	6.89
<i>Lanmea coromandelica</i>	13.22	<i>Lantana camara</i>	6.89
<i>Soymida febrifuga</i>	10.83	<i>Thespesia lampas</i>	4.64
Herbs		Climbers	
<i>Andrographis paniculata</i>	39.55	<i>Hemidesmus indicus</i>	102.77
<i>Eupatorium odoratum</i>	23.47	<i>Combretum decandrum</i>	50.00
<i>Elephantopus scaber</i>	19.88	<i>Cryptolepis buchani</i>	44.27
<i>Phyllanthus urinaria</i>	19.05	<i>Butea superba</i>	18.31
<i>Evolvulus alsinoides</i>	18.18	<i>Dioscorea bulbifera</i>	16.27
<i>Curculigo orchiodes</i>	13.06	<i>Ampelocissus latifolia</i>	16.23
<i>Tridax procumbens</i>	12.45	<i>Smilax zeylanica</i>	15.55
<i>Chlorophytum arundinaceum</i>	12.16	<i>Bauhinia vahlii</i>	13.82
<i>Euphorbia hirta</i>	11.85	<i>Calycopteris floribunda</i>	5.77
<i>Tephrosia purpurea</i>	9.84	<i>Millettia extensa</i>	5.77

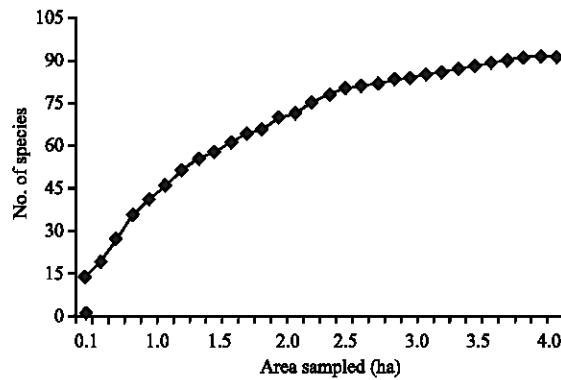


Fig. 2: Species accumulation curve for dry deciduous forest of Boudh district, Orissa

predominant tree species are *Shorea robusta*, *Madhuca indica*, *Buchanania lanzan*, *Cleistanthus collinus* and *Diospyros melanoxylon*. The top ten predominant species with their IVI values are given in Table 1. While top most 10 tree species represents 73.2% of individuals.

Representation of 187 species and the high proportion of dominant species in the study area can directly be attributed to the favourable climatic and edaphic conditions. Species rarity (those represented by ≤ 2 individuals) of 18% was obtained in the present study area. It is lower as compared to Kuzhanthaikuppam and Thirumanikkuzhi (26 and 31%, respectively) dry evergreen forest sites on the Coromandel coast (Parthasarathy and Karthikeyan, 1997) and that of (43%) the Kalrayan hills, Eastern Ghats (Kaduvul and Parthasarathy, 1999).

The species-accumulation curve showed tendency towards flattening (Fig. 2). Similar patterns were noticed in different areas of Eastern Ghats and Western Ghats (Kadavul and Parthasarathy, 1999a, b; Parthasarathy, 1999; Parthasarathy, 2001).

Phoenix acaulis an indicator of fire prone areas, is predominant in shrub layer conclude the study area was under frequent fires. It is degradation sign to the vegetation with reference to succession of forest to savannah. It is interesting to note that *Lantana camara* (exotic species) also invaded the forest ecosystem (Table 1).

Andrographis paniculata, a well known medicinal plant species is predominantly found in herbaceous cover. The second abundant species is *Eupatorium odoratum*. It is one of the worst invasive exotic weed species of the world. Among the climbers *Hemidesmus indicus*, *Combretum decandrum*, *Cryptolepis buchmanii* are predominant.

The Shannon-Weiner index (H') is 4.51, with Simpson's value 0.92. These values infer that dry deciduous systems are also species diverse systems.

Forest Structure

Mean stem density was 591 ha⁻¹ trees. The mean stand density of 591 stems ha⁻¹ is well within the range of 276-905 stems ha⁻¹ reported for trees = 10cm gbh in the tropics (Murali *et al.*, 1996; Sundarapandian and Swamy, 1997; Ghate *et al.*, 1998).

The mean basal area was 25.50 m² ha⁻¹. The distribution of the basal area across gbh interval classes reveals the dominance of small stemmed individuals in the plot (Table 2). The mean diameter of top 10 dominant tree species covers 68% of ground cover. It means minority of species dominate the majority of the available resources. The highest GBH was measured in the case of *Madhuca indica* (400 cm), *Mitragyna parvifolia* (300), *Haldinia cordifolia* (300), *Syzygium cumini* (210).

The mean tree height is 13 m, with a height range from 1 to 28 m. Tree distribution by height intervals shows 38.07% of tree individuals are belongs to 5-10 m category, followed by 30.03% of in 10-15 m, 8.38% in 15-20 m. The height class of more than 20 m includes only 1.70% of total tree individuals. Where as <5 m height trees are around 21.74 infer good regeneration and adaptability. The tallest individual trees were *Anogeissus latifolia* (28 m), *Shorea robusta* (28 m), *Ouigenia dalbergioides* (25 m), *Mitragyna parvifolia* (25 m), *Pterocarpus marsupium* (25 m), *Haldinia cordifolia* (24 m) and *Dalbergia paniculata* (23 m). Tree species show tendency towards shorter and medium stature (72% of individuals are with less than 10 m height) due to edaphic conditions.

In terms of the overall ecological dominance within our plots, the high importance value species (IVI) is *Shorea robusta*. It is commonly found (wide niched) throughout the forests.

The basal area and vertical structure of a forest is difficult to summarise as these relies heavily upon the climate and topographic conditions. Tree heights are heavily influenced by the abundance of saplings, richness of nutrients and anthropogenic pressure (since forest fires are recurrent).

Stem density and species richness have consistently decreased with increasing girth class of tree species from 50 cm girth. The highest number of species are encountered in the low gbh classes (30-50 cm) (Table 2). Girth class having 10-30 cm gbh contributed to about 68.13% of species richness.

Table 2. Population density of tree species across Girth Class intervals in dry deciduous forest of Boudh district, Orissa

gbh class (cm)	No. of species	% of species	No. of individuals	% of individuals
10-30	62	68.13	386	16.33
30-50	80	87.91	735	31.09
50-70	72	79.12	542	22.93
70-90	58	63.74	397	16.79
90-110	42	46.15	162	6.85
110-130	19	20.88	55	2.33
130-150	17	18.68	30	1.27
150-170	14	15.38	27	1.14
170-190	13	14.29	18	0.76
>190	8	8.79	12	0.51
Grand total	91	100.00	2364	100.00

Girth class frequency showed reverse J-shaped population structure of trees exhibited is in conformity with other forest stands in Eastern Ghats such as Shervarayan hills (Kaduvul and Parthasarathy, 1999a) and Kalrayan hills (Kaduvul and Parthasarathy, 1999b).

CONCLUSIONS

Calculations of IVI have helped in understanding the ecological significance of the species in the tropical dry deciduous forest type. Species diversity and stem density were observed to decrease with increasing girth class.

According to the Convention for Biological Diversity, the second worst threat to the existence of biodiversity is the biological invasion of exotic species (WCMC, 1992). There is an urgent action is required to control the predominance of *Eupatorium odoratum* and *Lantana camara*, otherwise these poses survival threat to indigenous flora.

The present study will serve as a primary input towards monitoring and sustaining the phytodiversity of tropical dry deciduous forests in the State of Orissa.

ACKNOWLEDGMENTS

The present work was carried out under national project on biodiversity characterization at landscape level. Authors are grateful to Director, IMMT, Bhubaneswar, Dr. P.S. Roy, Deputy Director, Dr. M.S.R. Murthy, Head, Forestry and Ecology Division, National Remote Sensing Agency for encouragement. The Divisional Forest Officer and forest officials of Boudh District are duly acknowledged for their kind help and cooperation during the field study.

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