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Dominance of *Shorea robusta* Gaertn. in Tropical Dry Deciduous Forest of Ranchi, Jharkhand, India

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Abstract*—The forest cover of Ranchi comes under the tropical dry deciduous forest region and our study is located here. It emphasizes on the community characteristics of naturally regenerated sal forest of Ranchi, Jharkhand. Sal is one of the most important timber yielding plants. These forests are exposed to over-exploitation and deforestation and are replaced by secondary regenerated sal forest. Altogether, 64 plant species were recorded from the forest. Among the plant species in the forest, trees was the most species rich (30 species) followed by shrub (22 species) and herbs (12 species). Fabaceae and Poaceae were among the most dominant families in the forest. Shorea robusta has contributed maximum of the total stand density (513.5 individual ha^{-1}) of the forest. Trees basal area varied from 0.053 –31.44 m^2ha^{-1} for different species. Total density of shrubs and herbs was recorded 1.45 individuals/m^2 and 39.45 individuals/m^2, respectively. Based on the dominance, Shorea robusta showed highest dominance followed by Butea monosperma. Shorea robusta exhibited the highest IVI (48.59) which indicated that the forest is dominated by Shorea robusta trees. Forest showed rich diversity as Shannon-Wiener's index and Simpson's index for trees was found to be 2.46 and 0.83 respectively. More than 50% of the plant species showed clumped distribution.*
Keywords: *Basal area, Clumped distribution, Dominance, Diversity, Density, Simpson's index.*

1. INTRODUCTION

Sal (*Shorea robusta* Gaertn.) is one of the most dominant tree species in tropical dry deciduous forest [1]. Sal forests are widely distributed and cover approximately 13.30% of the total forest area of the country [1]. In the northern region, there is almost a continuous belt of sal stretching along the sub-Himalayan tract from Punjab to Assam and at some places it extends some distance into the Plains of the terai region [2]. Sal belonging to the family Dipterocarpaceae is one of the most important timber trees in India. Sal is also a good source of 'aromatic gum' which is known to have medicinal properties [3]. Because of its high timber value, socio-economic importance for fodder, fuel-wood, leaf litter and for minor forest product sal forests are considered one among the most disturbed types of forest in Southeast Asia [4]. The governments saw sal forests more as a timber source rather than for other forest products and government attempted to manage sal forests for commercial timber production in order to increase revenue [5].

Understanding of forest structure is a pre-requisite to describe various ecological processes of forest [6]. Species diversity of forest has functional consequences, because the number and kinds of species present in any area determine the organisamal traits, which influence the ecosystem processes [7]. The biodiversity of sal forests is very wide and interesting both from ecological and conservation point of view [8]. Various workers have studied Indian sal forest to understand the community composition [9-13]. Till date no documentation has been done on composition and regeneration of sal forest of Ranchi district, hence the present study was carried out in this secondary regenerated sal forest. Present study aims to provide quantitative information on the community structure of tree species in this secondary Sal forest.

2. MATERIAL AND METHODS

2.1 Study site

The present study was carried out in Ranchi which is located on southern part of the Chota Nagpur plateau. It is located at 23°21′N 85°20′E/ 23.35°N 85.33°E and its average elevation is 651 m above sea level. Ranchi has a hilly topography and is surrounded by dense tropical forests (Figure 1). The forests come under the Dry peninsular sal- Type 5B/C -IC. Sampling was done from the Kanke and Mahilong range. Relative humidity of the region remains low. December is the coldest month with minimum temperature of 10.3°C and May is the hottest month with maximum temperature of 37.2°C. Average annual rainfall of the district is 1375 mm and more than 80 percent precipitation received during monsoon months. From June to September the rainfall is about 1,100 mm.

3. METHODS

The vegetation was analyzed via random sampling to obtain the most representative composition of the vegetation. The vegetation survey was carried out using the quadrat method. Twenty quadrats, each of 20 x 100 m^2 were laid on each site for the purpose of studying the trees. In each tree quadrat, the circumference at breast height (cbh at 1.37 m above ground level) of each tree was measured [14]. Basal area was calculated by the formula: 0.7854* DBH^2. The dominance of the plant species was determined using the Importance Value Index (IVI) of these species. Vegetation composition was evaluated by analyzing the frequency, density, abundance, and IVI, using the following formula given by Mishra (1968) [15] and Curtis and McIntosh (1951) [16].

Species diversity index was calculated following Shannon-Wiener index as: H' = -Σ (ni/N) ln ni/N where H' = Shannon- Wiener index of general diversity, ni = importance value index of ith species, N=sum of importance value index of all the species. Species dominance index was calculated by the formula given by Simpson, Cd = Σ(ni/N)2, ni = importance value index of ith species, N=sum of importance value index of all the species.

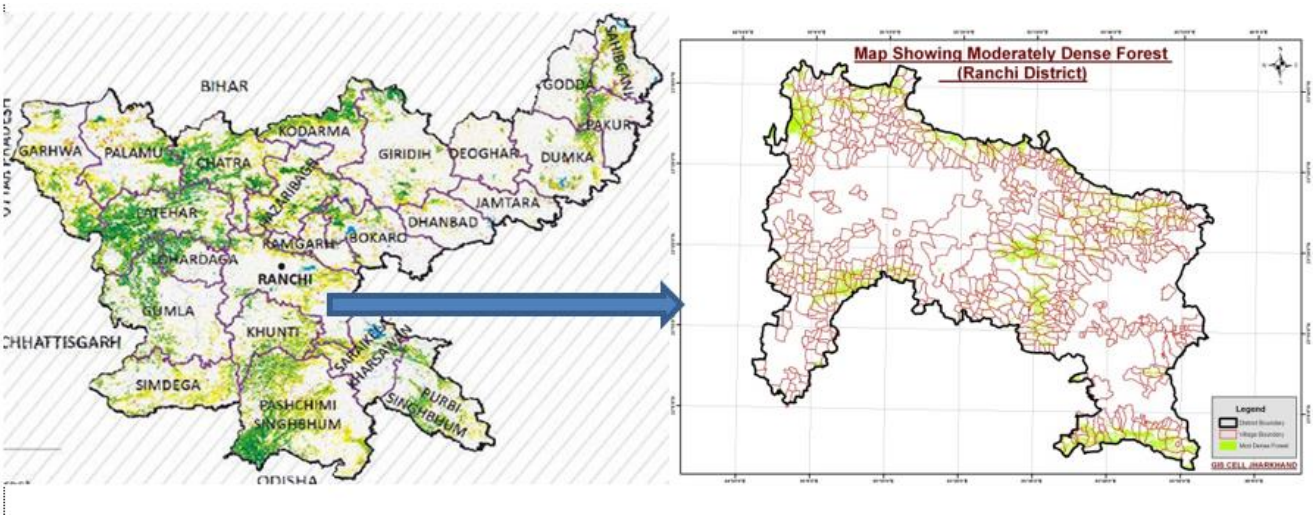

Figure 1: Forest map of Ranchi District
(Source: Forest Department, Jharkhand).

4. RESULTS

A total of 64 plant species belonging to 24 families were recorded from the present study. This was represented by 30 trees, 22 shrubs and 12 herbs. Fabaceae was the dominant family having 15 species followed by Moraceae with 3 tree species. Rubiaceae, Lamiaceae and Combretaceae had 2 species each. Families like Lauraceae, Ebenaceae, Phyllanthaceae, Sapotaceae, Sapindaceae, Anacardaceae, Dipterocarpaceae, Mytaceae and Rhamaceae were represented by 1 species each. For shrubs species, Apocynaceae was the dominant family with 4 species followed by Fabaceae with 3 species. Lamiaceae and Solanaceae had 2 species each. Among herb species, Poaceae was the most dominant family with 11 different species followed by Euphorbiaceae with only 1 species. Based on the density, *Cynodon dactylon was* recorded as the most dominant herb species (Table 1, 2 and 3).

Total stem density in the present study was found to be 1360 individual ha^{-1}. The present study exhibited that lower girth class contributed highest number of individuals which proportionally decrease with the increase in girth size. Stem density was found to be maximum (545 ha^{-1}) in the girth class 25-30 cm, which accounts for 40.08 % of the total stem density, followed by girth class 20-25 cm (497 ha^{-1}, 36.53 %), 15-20 cm (288 ha^{-1}, 21.16 %), 30-35 cm (25 ha^{-1}, 1.95%) and 40-45 cm (5 ha^{-1}, 0.37 %), respectively. 35-40 cm girth class had no stem density. Among the trees, *Shorea robusta* exhibited highest stem density of 514 ha^{-1}. Maximum number of individuals of *Shorea robusta* was recorded between girth classes 25-30 cm and lowest in girth classes > 35 cm. (Figure 2). Basal area varies from 0.053 – 31.44 m^2ha^{-1} for different species (Table 1) of which *Shorea robusta* comprises the highest basal area. Among the total basal area of *Shorea robusta*, highest basal area (19.62 m^2ha^{-1}) was recorded in 25-30 cm girth class followed by 20-25 cm (8.32 m^2ha^{-1}) and 15-20 cm (2.48 m^2ha^{-1}) girth class (Figure 3).

Among the tree species *Shorea robusta* exhibited the highest IVI (48.59) followed by *Butea monosperma* (19.47) and *Pongamia pinnata* (15.29), which indicates that the forest is dominated by *Shorea robusta* trees. The least dominant species of the stand includes *Albizia stipulata* (IVI- 2.33) (Table 1). Stand density of shrubs and herbs species was 1.45 individuals m^{-2} and 39.45 individuals m^{-2}, respectively (Table 2). Among shrubs, *Lantana camara* was the dominant species with highest IVI (25.26)

having density (1580 individuals ha-1) followed by *Cassia tora* with IVI (21.79) with density of 1300 individuals ha-1 and *Andrographis paniculata* with IVI (20.28) and density 1080 individuals ha^{-1}. The least dominant species was *Tephrosia purpurea* having 220 individuals ha^{-1}. Among the herb species, *Cynodon dactylon* was dominant with IVI (61.77) and density of 111500 individuals m^{-2} whereas *Thysanolaena agrostis* was found to be least dominant with IVI (6.43) and density 3000 individuals m^{-2} (Table 2). Dominance-diversity curve for tree, shrub and herb species (Figure 3) showed that the forest stand had higher dominance or low evenness among trees and herbs, while comparatively low dominance or higher evenness among shrubs. Shannon-Wiener's index was 2.46 for the tree species, 2.98 for shrub species and 2.19 for herbaceous species. Simpson's dominance index for tree species was recorded 0.83 while for shrub species it was 0.94 and for the herbs it was found to be 0.85. About 52% of the species exhibited clumped distribution, 28% species showed random distribution and 20% species exhibited regular distribution.

Table 1: Phytosociological analysis of trees of the forest

SPECIES	Family	Density ha^{-1}	TBA (m^2 ha^{-1})	IVI	A/F	D*
Acacia catechu (L.F) Wild	Fabaceae	24.25	0.741	8.37	0.12	C
Acacia nilotica L.	Fabaceae	18	0.406	6.68	0.13	C
Acacia pinnata (L.) Wild	Fabaceae	10.25	0.229	4.62	0.12	C
Adina cardifolia (Roxb.) Brandis	Rubiaceae	53.5	1.825	11.69	0.16	C
Albizia stipulata (DC.) Boivin	Fabaceae	2.75	0.053	2.33	0.14	C
Anthocephalus cadamba Roxb.	Rubiaceae	11.5	0.819	8.94	0.11	C
Bauhinia purpurea L.	Fabaceae	6.75	0.151	3.77	0.09	C
Bauhinia tomentosa L.	Fabaceae	4.25	0.134	4.03	0.05	Ra
Butea monosperma (Lam.)Taub	Fabaceae	136.25	6.013	19.47	0.27	C
Cassia fistula L.	Fabaceae	10.25	0.238	4.39	0.10	C
Cinnamomum tamala (Buch.-Ham.) Nees & Eberm	Lauraceae	12.5	1.041	9.68	0.15	C
Dalbergia latifolia Roxb.	Fabaceae	16.25	0.563	6.93	0.11	C
Dalbergia sissoo Roxb.	Fabaceae	79	3.167	14.64	0.18	C
Diospyros melanoxylon Roxb.	Ebenaceae	90.75	2.841	15.09	0.18	C
Ficus benghalensis L.	Moraceae	5	0.667	14.34	0.03	Ra
Ficus hispida L. f.	Moraceae	23.5	0.623	7.40	0.15	C
Ficus racemosa L.	Moraceae	12	0.468	5.79	0.11	C
Gmelina arborea Roxb.	Lamiaceae	26.75	0.998	9.39	0.12	C
Bridelia retusa (L.) A. Juss.	Phyllanthaceae	57.25	1.625	11.80	0.16	C
Madhuca longifolia (J.Konig) J.F.Macbr.	Sapotaceae	35.5	1.546	12.01	0.07	C
Pongamia pinnata (L.) Pierre	Fabaceae	84.5	3.339	15.29	0.17	C
Schleichera oleosa (Lour.) Oken	Sapindaceae	23	0.975	8.64	0.16	C
Semecarpus anacardium L.f.	Anacardiaceae	4	0.134	3.88	0.09	C

Shorea robusta Gaertn.	Dipterocarpaceae	**513.5**	**31.440**	**48.59**	**1.03**	C
Syzygium cumini (L.) Skeels	Myrtaceae	21.75	0.956	8.38	0.09	C
Tamarindus indica L.	Fabaceae	1.25	0.095	6.83	0.06	C
Tectona grandis L.f.	Lamiaceae	31.5	1.553	10.41	0.14	C
Terminalia alata Heyne ex Roth	Combretaceae	5	0.154	3.44	0.25	C
Terminalia arjuna (Roxb.) Wight & Arn.	Combretaceae	7	0.189	3.28	0.35	C
Ziziphus jujuba Mill.	Rhamnaceae	32	0.655	9.90	0.06	C

TBA- total basal area, IVI- Importance value index, A/F- abundance frequency ratio, D*-distribution, C- clumped, Ra- random, R- regular

Table 2. Phytosociological analysis of shrubs of the forest.

SPECIES	**FAMILY**	**Density ha^{-1}**	**IVI**	**A/F**	**D***
Achyranthus aspara L.	Amaranthaceae	860	16.66	0.044	Ra
Andrographis paniculata (Burm.f.) Nees	Acanthaceae	1080	20.28	0.064	Ra
Asparagus racemosa Willd.	Asparagaceae	680	14.01	0.035	Ra
Berberis aristata DC.	Berberidaceae	620	13.37	0.043	Ra
Calotropis gigantea (L.) Dryand.	Apocynaceae	520	12.13	0.013	R
Carisa spinarum L.	Apocynaceae	700	14.22	0.022	R
Cassia tora (L.) Roxb.	Fabaceae	1300	21.79	0.033	Ra
Cleistanthus collinus (Roxb.)Benth.	Phyllanthaceae	340	9.11	0.015	R
Clerodendron infortunatum L.	Lamiaceae	580	12.54	0.023	R
Croton oblongifolius Roxb.	Euphorbiaceae	640	13.39	0.022	R
Gardenia gummifera L.f.	Rubiaceae	300	8.20	0.025	Ra
Lantana camara L.	Verbenaceae	1580	**25.26**	0.040	Ra
Mimosa pudica L.	Fabaceae	840	16.10	0.021	R
Nyctanthes arobortristis L.	Oleaceae	260	7.50	0.026	Ra
Rauwolfia vomitoria Afzel.	Apocynaceae	740	14.79	0.020	R
Solanum nigrum L.	Solanaceae	480	11.36	0.015	R
Solanum xanthocarpum L.	Solanaceae	600	12.92	0.019	R
Tephrosia purpurea (L.) Pers.	Fabaceae	220	7.08	0.013	R
Thespesia lampas (Cav.) Dalzell	Malvaceae	440	10.56	0.036	Ra
Vitex negundo L.	Lamiaceae	680	14.01	0.035	Ra
Wrightia tinctoria (Roxb.) R.Br.	Apocynaceae	460	11.10	0.014	R
Zizyphus oenoplia (L.) Mill.	Rhamnaceae	640	13.62	0.016	R

Table 3. Phytosociological analysis of herbs of the forest.

SPECIES	**FAMILY**	**Density ha^{-1}**	**IVI**	**A/F**	**D***
Apluda varia L.	Poaceae	27000	22.86	0.09	C
Arundinella setosa Trin.	Poaceae	49000	34.77	0.12	C
Chrysopogon aciculatus (Retz.) Trin.	Poaceae	16000	16.92	0.03	Ra

Cymbopogon martini (Roxb.) Wats.	Poaceae	59000	38.13	0.06	Ra
Cynodon dactylon (L.) Pers.	Poaceae	111500	**61.77**	0.11	C
Eulaliopsis binata (Retz.) C.E. Hubb.	Poaceae	27000	22.53	0.06	C
Euphorbia hirta L.	Euphorbiaceae	19000	19.04	0.03	Ra
Imperata cylindrica (L.) P. Beauv.	Poaceae	23000	20.74	0.04	Ra
Heteropogon contortus (L.) P. Beauv.	Poaceae	26000	22.44	0.04	Ra
Panicum montana L.	Poaceae	23500	20.66	0.05	Ra
Saccharum munja Roxb.	Poaceae	10500	13.71	0.02	R
Thysanolaena agrostis Nees.	Poaceae	3000	6.43	0.13	C

5. DISCUSSION

The plant species richness in the present study was recorded quite high (64 species in 1 ha). Uma Shankar[17] also reported high species richness from Sal forests in Eastern Himalaya and reported 87 species in 2 ha plot. The present species richness was found higher as compared to those reported from Central Himalayas and Central India [18,19]. However, it was found to be lower than the sal forest in Gorakhpur division of eastern *terai* region (208 species in 24 ha) [20] and Madhupur sal forest of Bangladesh (94 in 3 ha)[21], which may be due to much lesser sampled area in the present study. Fabaceae was found to be the largest family among plant species and is represented by 18 species.

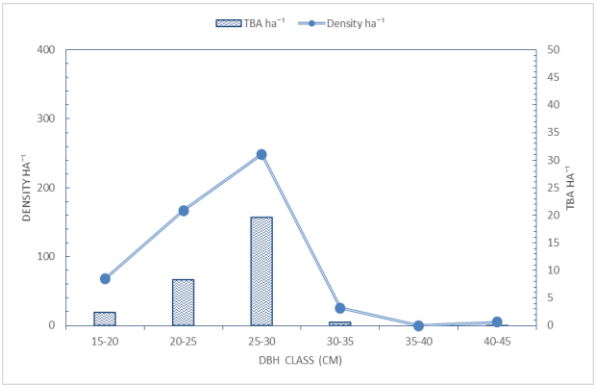

Figure 2. Density and basal area of *Shorea robusta* in different girth class.

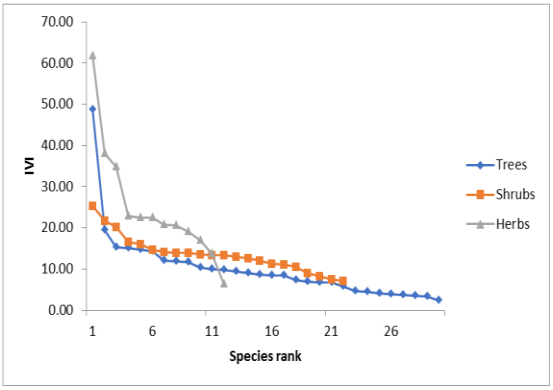

Figure 3. Dominance-diversity curve of trees, shrubs and herbs in the forest.

Several authors have also reported Fabaceae as the prominent family for Indian deciduous forests [22-24]. Among trees, Fabaceae was found to be the dominant families with 15 species each followed by Moraceae. Uma Shankar [17] reported Euphorbiaceae as the most dominant group in the Eastern Himalayan lowland forests. Gentry [25] reported Bignoniaceae as the second most specious family from neo-tropical deciduous forests. The stem density of tree species decreases with increase of girth size observed in the present study was in agreement with the findings of other workers [26-28]. The stem density of 1330 stems ha^{-1} (>30 cm GBH) obtained in the present study was quite high than the reported value (180-860) from tropical forests of different parts of India [19,20, 29]. However, Swamy *et al*. [36] reported that the tree density (> 30 cm GBH) varies from 245-859 individuals ha^{-1} in the tropical forest of Tamil Nadu, India. Further, the present study confirms to the findings of Singh *et al*. [30] who reported 1233 individuals ha^{-1} from the tropical moist deciduous sal forest of Achanakmar Wildlife Sanctuary. Total basal area in the present study was recorded 63.64 m^2 ha^{-1}. Shukla and Pandey [31] reported basal area (22.23 m^2 ha^{-1}) from Sal forest of Gorakhpur division. While, Jha and Singh [29] reported basal area between 7-29 m^2 ha^{-1} from Sal forest in Central India. On the other hand, Uma Shankar [17] reported basal area 26.3 m^2 ha^{-1} from Sal forest of Eastern Himalaya. Similarly, Tiwari *et al.* [32] also reported a basal area (26.1 m^2 ha^{-1}) form Sal Forest in Subtropical Submontane Zone of Garhwal Himalaya. Presence of large number of individuals in the lower girth classes contributed the maximum basal area compared to the other sal forests of India. The tree species *Shorea robusta* shared the maximum IVI (48.59) then the other plant species, which was much higher than the reported values [17,31,32]. However, Kushwaha and Nandy [33] reported an higher IVI value of 221.78 for *Shorea robusta* from Chotanagpur Plateau in West Bengal.

The diversity index of trees in the present study was recorded 2.46 was within the range of earlier reported values [20,30,41,42]. Nath *et al*. [34] reported a diversity value of 1.46 for tropical forest of north-east India. Generally, Shannon-Weiner diversity for

tropical forests, ranged from 0.81 to 4.1 for the Indian sub-continent [35,36]. Further, diversity index for shrubs and herbs was recorded 2.98 and 2.19 respectively. Sobuj and Rahman [37] reported diversity index of 2.56 and 3.27 for shrubs and herbs respectively from tropical moist deciduous forest of Khadimnagar national park in Bangladesh. The Simpson's dominance index in the present study ranges between 0.82 and 0.94 which is in accordance with the reported value (0.047- 2.11) from 24 different sal communities in Gorakhpur Division [33].

Abundance/frequency ratio exhibited that most of the species have clumped distribution. Similar distribution 0pattern was also reported by Tripathi and Singh [38] for sal forest from Katerniaghat Wildlife Sanctuary. Odum [39] reported that clumped distribution is the commonest pattern in nature. Thus, from the present study it can be established that the forest is heterogenous in composition with high dominance of *Shorea*. Girth class distribution structure of the population also confirms that the forest is under regenerating stage. Girth class distribution decreases with increasing GBH are characteristic for species with continuous regeneration [40].

6. CONCLUSION

From the present study, it can be concluded that the Ranchi forest has high species diversity. Presence of large number of individuals in the lower girth class in the forest gives a good indication of better regeneration potential in the prevailing climatic condition. It can also be concluded that the present study stand has faced a huge destruction in the past, which at present is regenerating once again into its natural habitat. Thus, effective conservation and management initiatives are most important for sal and its associate plant species in order to conserve this sal forest.

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