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VEGETATION ANALYSIS OF OVER STOREY LAYER OF SOUTHERN CORE AREAS OF SIMILIPAL BIOSPHERE RESERVE: A MANAGEMENT IMPLICATION

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ABSTRACT

This paper reports diversity and distribution pattern of tree species at four different sites of southern core areas of Similipal Biosphere Reserve (SBR) at elevations ranging from 785-869 meter above sea level. Shorea robusta was the dominant tree species in all the study sites. The total basal area and diversity of trees recorded in the study sites showed a range of 78.47-104.92 m^2 ha^{-1} *and 895-985 trees* ha^{-1}*, respectively. Likewise, the species diversity and ß-diversity of the four study sites were between 1.798-3.107 and 3.0-4.425, respectively. As the species diversity and ß-diversity increased with altitude, ß-diversity showed a significant positive correlation with altitude. These two attributes also showed a negative correlation with maturity index, where the correlation established between species diversity and maturity index is statistically insignificant.*

Key Words: Altitude, Diversity, ß-diversity, Distribution, maturity index, Tree layer, SBR

INTRODUCTION

Tropical forests are the richest and complex logical communities formed by the aggregation of individual species. Each species occurring independently within its own tolerance limit and exhibit tremendous intrinsic ability for self maintenance (Whittaker, 1975; Singh and Chaturvedi, 2017). However, most of the forests have lost this ability due to increasing biotic disturbance such as anthropogenic perturbations and cattle grazing. The substantial reduction of the forests at an estimated rate of 1-2% per annum (Soule, 1986; Kothandaraman and Sunderpandian, 2017) leads to serious ecological disasters like soil erosion, loss of fertility and violent floods. As the rate of forests and species destruction continues to rise, inventorying plant diversity and monitoring efficiency of measures for its conservation have emerged as important scientific challenge of recent years (Majumdar et al., 2012; Kothandaraman and Sunderpandian, 2017). For raising efficient conservation strategy plant diversity measurement especially the tree layer vegetation which influence community structure and function of forest ecosystem must be studied both on detailed level (species) and general level (biotopes and landscapes) by understanding the effects caused through rapid changes (Tuller, 1991).

Similipal, the only biosphere reserve of the state of Odisha and the 9th in the UNESCO list of biosphere reserves situated at the northern terminus of the Eastern Ghat range of India supports a wide variety of floral diversity. It also contains several paleo endemic species which are botanically a “relict “of ancient and unique vegetation (Champion and Seth, 1968). In these contexts it needs quantification of its vegetation cover both at species and landscape level. Though several qualitative descriptions of the vegetation of the forest covers of Similipal are available (Panigrahi *et al.*, 1964; Saxena and Brahmam, 1989; Misra, 1989; Biswal et al., 2008; Reddy et al., 2008; Misra et al., 2013*;*Mohapatra et al., 2014*;* Kumar et al., 2017*)*, attempts on quantitative examinations have only recently been made by Mishra et al. (2008, 2011 and 2012) and Reddy et al. (2007). Hence, the present study is aimed to examine the diversity and distribution pattern of tree layer of this forest in southern core areas with two broad based objectives: (i) distribution and diversity of the tree layer in each study site; and (ii) the impact of altitude and maturity index on species diversity and ß-diversity.

MATERIAL AND METHODS

The study was carried out at four different sites of the southern core areas of SBR located between 21°35′ -21°50′ N latitude and 86°15′ -86°25′ E longitude. The whole area is mountainous with an elevation between785-869 meter above the mean sea level. The sites were selected so as to represent the whole array of major vegetational variations found in the area. The sites selected were named after their localities. Some topographic data of these sites are presented in Table -1.

The phytosociological analysis of the forest was done on 20 ×20 m^2 quadrats on each site. In each site 20 randomly selected quadrats were placed and care was taken to sample the most representative area for each site. The size and number of quadrats needed were determined using the species area curve (Misra, 1968) and the running mean method (Kershaw, 1973). Circumference at breast height (cbh at 1.37m from the ground) of all the trees with ≥ 30cm gbh in each quadrat was measured and recorded individually per species. The vegetation data of each quadrat thus gathered together to analyze frequency, density, and abundance (Curtis and Mc Intosh, 1950). The Importance Value Index (IVI) for the tree species was determined as the sum of the relative frequency, relative density and relative dominance following Phillips (1959).

The ratio of abundance to frequency was used to interpret the distribution pattern of the species (Whitford, 1949). This ratio indicates regular (<0.025), random (0.025-0.05) and contiguous (>0.05) distribution following Curtis and Cottam (1956). Similarity of vegetation between pairs of stand was also calculated. Species diversity of each stand was determined with the Shannon Wiener (1963) information function, which reads: $H' = -\Sigma$ (ni/N) in (ni/N), where "ni" is the total number of individuals of ith species and "N" is the number of individuals of all species in that stand. Concentration of dominance was measured by Simpson's Index $C = \Sigma (ni/N)^2$, where "ni" and "N" were the same as per the Shannon-Wiener information function (Simpson, 1949). ß-diversity of different forest sites was calculated following Whittaker (1975) i.e. ß = Sc/s, where "Sc" is the total number of species encountered in all the stands counting each species once whether or not it occurs more than once and "s" is the average numbers of species per stand. Species evenness was calculated as per Pielou (1975) and the species richness index (RI) was calculated as per Margalef (1958).

Table 1: characteristic features of study sites.

Site/locality biotic	Compartment No.	Elevation (meter)	Latitude	Longitude	Aspect	Level of interference
S-I (Bhanjabasa)	TK-I	785	21º35′-21º40′	86º20′-86º25′	South	NB
S-II (UBK)	WD-28	824	21º35′-21º45′	86º15′-86º25′	South	NB
S-III (Solamundi)	WD-22	850	21º40′-21º45′	86º15′-86º20′	South	NB
S-IV (Jenabil)	KH-26	869	21º40′-21º50′	86º20′-86º25′	South	NB

UBK-Upper Barakamda, NB-No biotic interference

RESULTS AND DISCUSSION

Vegetation structure and composition:

In total 57 tree species with ≥30cm gbh occurred in the four sites consisting of 36 families and 50 genera. The species richness in all sites ranged between 19 to 31 with the richest site (Jenabil) having 31 species nearly equal to two times of the species of floristically poorest site (Upper Barakamda) with 19 species (Table-2). The other two sites had 22 (Bhanjabasa) and 25 (Solamundi) species, respectively. A marked difference in species richness reflects the microclimatic difference between study sites.

In all the four study sites, total density ranged from 895-985 trees ha^{-1} and the total basal area from 78.47 to 104.92 m^2 ha^{-1}. The data on density and basal area of the tree species having gbh ≥ 30cm are obtained in the present study is well within the limits (500-1800 plants ha^{-1} and 10.73-107 m^2 ha^{-1}) of various Indian tropical forests (Visalakshi, 1995). On the basis of importance value index (IVI), *Shorea robusta* was the dominant species in all the study sites (Fig.1). But in each site the co-dominants associated with *Shorea robusta* were different, such as *Syzygium cumini* and *Syzygium cerasoides* at Site-I, *Terminalia tomentosa* and *Dillenia pentagyna* at Site-II, *Terminalia tomentosa* and *Dillenia pentagyna* at Site-III, and *Michelia champaca*, *Dillenia pentagyna* and *Bombax ceiba* at Site-IV (Fig.1). The highest IVI was represented by *Shorea robusta* at Site-II due to single species dominance (around 43% of IVI) of

Site-II). However, low value observed at Site-IV might be due to lack of absolute dominance by any single species.

Table 2: Total number of species (TS), total basal cover (TBC) and density percentage (D %) of tree layer of SBR.

Site/ Locality	Total no. of species	Density (Plants/ha)	Total basal Cover(m^2/ha)	Density in %	Total Basal Cover in %
Site-I	22	950	85.92	25	24.26
Site-II	19	970	84.86	25.53	23.96
Site-III	25	985	78.47	25.92	22.16
Site-IV	31	895	104.92	23.55	29.62

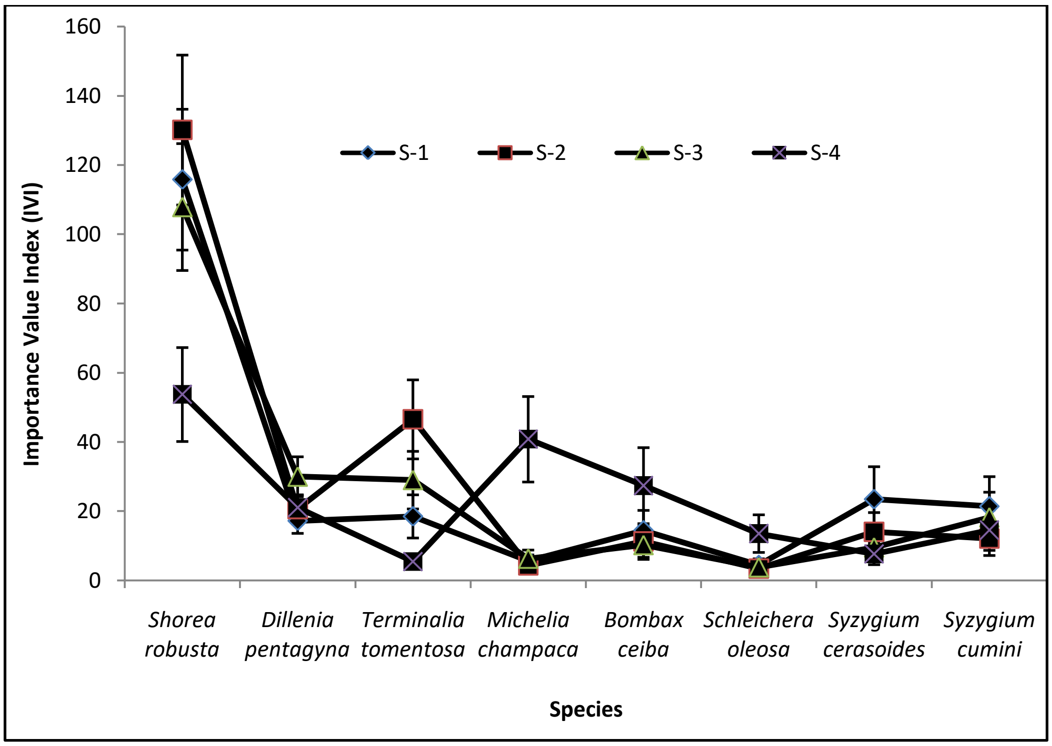

Fig.1: Importance Value Index (IVI) of dominance tree species of Similipal.

Distribution Pattern and Similarity Indices

Percentage of distribution pattern of the tree species in different study sites is presented in Table 3. The analysis of distribution pattern (A/F ratio) of tree species in the present study revealed that contiguous distribution of tree species dominates over regular and random distribution pattern. In general, contiguous distribution in natural vegetation has been reported by several workers (Ralhan et al., 1982; Singh et al., 1991). Odum (1971) stressed that contiguous (clumped) distribution is the commonest pattern in nature and it is due to small significant variations in the environment. Regular distribution occurs where severe competition between the individuals exists. Further Odum (1971) also stated that higher value of regular as well as random distribution reflects the magnitude of biotic interferences such as lopping in natural forest stand. In the present study all sites showed maximum percentage of contiguous type of distribution pattern, which reflects the absence of biotic distribution in these study sites.

Similarity index determination by comparison of the tree species of the study sites indicated that the species were 36 to 55.32% similar among themselves (Table- 3). The difference in similarity is due to the difference in co-dominants at different altitudes. It is interesting to note that maximum similarity was observed between Site-I and Site-III while minimum between Site-II and Site-IV reflecting the gradual change in species composition from sites of lower altitude to sites of higher altitude.

Table 3: Distribution pattern (%) and similarity index of tree species at different sites in southern core areas of SBR.

Site	**Distribution pattern**			**Similarity indices**		
	Regular	**Random**	**Contiguous**	**Site-II**	**Site-III**	**Site-IV**
S-I	4.54	39.45	61.00	43.91	55.32	41.51
S-II	6.53	19.79	73.68	-	45.45	36.00
S-III	0	32.26	67.74	-	-	42.86
S-IV	0	32.00	68.00	-	-	-

Diversity and related measurements

Most Ecologist are convinced that species diversity is important for the stability and proper functioning of ecosystems (Schlapfer et al., 1999), however, with increasing disturbance in the forests the plant species diversity, richness and evenness are significantly reduced (Rad et al., 2009). Species diversity refers to the variation that exists among the different plant life forms. Diversity is also considered to be an outcome of the co-evolution of species in a biogeographic region as well as a synthetic measure of the structure, complexity, stability and proper functioning of ecosystems (Schlapfer et al., 1999). In the present study the diversity of trees (≥30 cm gbh) laying in the range from 1.798 to 3.107 (Table-4), is very much similar with that of newly established preservation plot inside Similipal (Swain and Nanda, 1997) and less than Ranjin preservation plot in the Balugaon range of Puri division (Verma *et.al.,* 1996). In other way, it was also recorded that the observed species diversity index (1.798-3.107) of the present study is well within the limit (0.83-4.1) of various Indian tropical forests (Singh et al., 1984; Visalakshi, 1995*).*

Simpson diversity index or Concentration of dominance (Cd) as a diversity index has swift convergence to limit diversity value for minor sample size, therefore, is principally suitable for rapidly evaluating regions for conservation (Lande et al., 2000).The concentration of dominance (Cd) followed almost inverse relation to species diversity. The value obtained for the concentration of dominance for tree layer in the present study ranged between 0.069 and 0.316 is also well comparable to various Indian tropical forests (0.21- 0.92) as reported by Visalakhi(1995).

Table 4: species richness (S.R.), species evenness (E.I), species diversity (H′), concentration of dominance (Cd), species turnover rate (ß-diversity) and maturity index (M.I) of tree layer in different study sites of SBR.

Site	S.R	E.I	H′	Cd	ß-diversity	M.I
S-I	4.002	0.715	2.209	0.288	3.0	26.45
S-II	3.417	0.611	1.798	0.316	3.267	24.42
S-III	4.543	0.729	2.306	0.206	4.425	22.6
S-IV	5.803	0.872	3.107	0.069	4.299	21.71

The evenness of species ranges between 0.611 and 0.872. Very high evenness value observed at Site-IV is due to higher value of Shannon-Weinner's diversity index and species richness in comparison to other three sites. Shaukat *et al.,*(1981) stated that evenness with species richness incorporate divergence index diversity. It was also examined that when species diversity was compared with evenness a positive correlation was established between two attributes ($y=5.132x-1.381$, $r=0.994$, $P<0.001$).

In association to species diversity, evenness and richness, the spatial distribution of species assemblages is often described using three components of species diversity viz. alpha or local diversity, beta diversity, and gamma or regional diversity (Whittaker *et al.*, 2001). Alpha and gamma diversities describe the species composition observed within sampling units, and are differentiated only by the scale (sampling unit size) at which species inventories are conducted (Jurasinsky, 2009). In contrast, the beta diversity concept describes the variation in species composition observed when comparing sampling units to one another. There are two main approaches to define beta diversity (Anderson et al., 2010) i.e. directional turnover and non-directional variation. Studies addressing beta diversity as directional turnover measure the change in community composition from one sampling unit to another along a spatial, temporal or environmental gradient (Morlon et al., 2008). In contrast, the non-directional variation approach to beta diversity does not define it in relation to any specific spatial or environmental structure, but as the variation in community structure among a set of sampling units within a given spatial extent (Anderson et al., 2006). In both cases beta diversity plays a pivotal role in linking local and regional diversity and it captures a fundamental facet of the spatial pattern of species assemblages. In the present study the ß-diversity calculated for tree layer vegetation differ across study sites situated at different altitudes of the reserve (Table- 4). Among the study sites maximum species turnover rate was observed at Solamundi (4.425) and minimum at Bhanjabasa (3.0). The change in ß-diversity in different altitude is probably due to the change in topography and soil nutrient status. When ß-diversity was compared with altitude of each site, a positive correlation was marked ($y=0.018x-11.2679$, $r=0.9121$, $P<0.05$).

The maturity index one of the important diversity measures of plant species signifies about the successional status of the forest cover and also states about the state of vegetation with respect to variation in elevation. In the present study maturity index of tree species decreases with the altitude and ranged between 21.71 and 26.45. When compared to Andaman Islands (36.60; Roy *et al.*, 1993) the maturity index value of Similipal was low but more or less similar to the maturity index of Agasthyamalai of Western Ghat region (22.39; Varghese and Balasubramanyan, 1999). The correlation regression analysis between the maturity index and altitude showed inverse relationship which was statistically significant ($r= -0.998$, $P<0.01$). Similarly when maturity index was compared with ß-diversity of each site a significantly negative correlation was marked($y=11.38398-0.3209x$, $r=0.93695$, $P<0.05$).

Conclusion

Quantitative floristic data with respect to tree species from the present study are highly useful for the forest management practices. Presence of high species richness and diversity, stand density and basal area indicates the uniqueness and potentiality of southern core areas of SBR for conservation of ecosystem in its totality. Furthermore, high plant species richness, diversity and evenness of tree species in this part of the reserve may also envisaged about habitat heterogeneity which provides favorable conditions that brought about nurse effects to support diverse plant species. In association to these, this study also serve as a primary input towards further study on biodiversity characterization, gradient based community structure, carbon pool assessment, ecological niches, germination compatibility, phenology of flora and utilization of geo-informatics for decision making and monitoring of natural resources of the reserve.

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