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RESEARCH ARTICLE

SPECIES RICHNESS, DIVERSITY PATTERNS AND SIMILARITY OF TREE SPECIES ALONG THE ALTITUDINAL ZONES OF DALMA WILDLIFE SANCTUARY, JHARKHAND

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ABSTRACT

The present study is concerned with tree populations and the attempt was made to study the effect of anthropogenic according to altitudinal height in Dalma Wildlife Sanctuary of Jharkhand, India. We have compared the few tree based species characteristics like density, basal area, diversity, and tree species composition along three altitude based study zones existing between 199m – 603m height creating 54 quadrates, each of size 10m × 10m. The total richness of tree species in the study area was recorded as 2471 individuals of 25 families were reported among the three zones. Shannon Weinner diversity index varied from 25 to 41 and 3.07 to 3.997 respectively along study zones of Dalma Wildlife Sanctuary. Lowest number of species (SR=25) was found from lower zone due to maximum disturvance of anthropogenic cause while least disturbed zone possessed highest number of species (SR=41). Middle zone occupied an intermediate position with respect to species richness (SR=29). The Similarity value (Si) also indicates that the highest value shown by the combination of upper zone and middle zone forest (0.707) followed by upper zone and lower zone (0.609). The combination of upper zone and middle zone, upper and lower zone, middle and lower zone forest exhibits slightly lower degree of similarity with the value of 0.707, 0.609 and 0.606 respectively. In conclusion, the degree of similarity for the entire three zone forest is low. The floristic similarity analysis between the three zones of Dalma Wildlife Sanctuary of Jharkhand show the similarity value range from 0.606 – 0.707 which is floristically low in similarity indicating heterogeneity in the species composition.

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INTRODUCTION

Tropical forests of world are one of the richest store houses of biodiversity which are functioning as source of economy for human survival and keeping balance on earth by conserving and preventing the vegetation and soil erosion in natural habitat of plants as well as animals (Amenteras *et al*. 2009). It has been observed for last few decades that a common Global problems on economic and environments are dominating on human wing life because of fast rate of deforestation and disappearing of plants and animals species from the earth surface. Topography, Aspect, inclination of slope and soil are also affecting the composition of forests (Holland and Steyn 1975). In a study Bongers *et al*. (1999) has found that the drought period play a greater role in study of species distribution.

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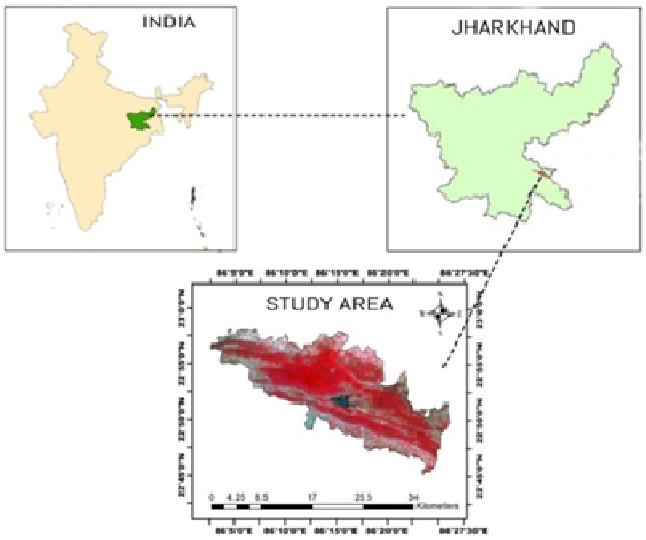
These all important factors have a lead role on richness and diversity of plant species. Natural as well as anthrapogenic incident, such as land slide, over raining (Cloud rupturing), grazing, fuel wood extraction, leaf collection, road and RCC watershed formation for irrigation and built up of hydro electric producing unit are identified as very fast damaging agencies to affect the stability of ecosystem in all around the world. In recent last century, the government has declared the larger area of natural forest as reserve forest and named as wildlife biodiversity rich sanctuary in India have also faced degradation in plant composition, because of frequent interference of human selfishness, which are giving result as demographic change in identity of the Sanctuary.

Species richness and diversity pattern are also the form of forest community structure; it helps in planning for conservation in present status of vegetation to maintain the balance ecosystem of the surrounded area.

Keeping in view of the aforesaid circumstances, we have carried out the research in one of the biggest Dalma Wildlife Sanctuary of Jharkhand.

MATERIALS AND METHODS

Study area: The study was conducted during 2016 to 2018 in partial fulfilment of the requirement of the degree of Doctor of Philosophy in forestry of Mizoram University, Aizawl. The data were collected from Dalma wildlife sanctuary which is situated on the Chhotanagpur plateau of Jharkhand near the steel city of Jamshedpur and extends into portions of the East Singhbhum and Saraikela-Kharshanwa districts of Jharkhand it lies between Latitudes 22^0 46' 30" N and 22^0 57'N and Longitudes 86^0 3' 15" E and 86^0 26'30"E. Its eastern limit extends up to the border of Purulia district of West Bengal on the eastern side.



Study Area

The entire Forest of Dalma Sanctuary fall in the catchment *area* of Subarnarekha River and Dimna Lake of Jamshedpur. The Sanctuary is 193.22 sq. kms (R.F. 45.56 sq. km, and P.F.—147.44 sq.km out of which 157.71 sq. kms were transferred by Dhalbhum Forest Division and the remaining 35.51 Sq.kms by Chaibasa North presently Saraikela Forest Division. Out of this, 193.22 sq. kms, the core area consists of 59.27 sq. kms. Soil of the sanctuary area is generally sandy-loam and clayey-loam, often at places, pure laterite and moorum exist. On the hills and their slopes, soil is generally missing or very shallow. Erosion has exposed rocks, but due to water & soil conservation measures by contour trenches done in past years, the soil depth has built-up. In valleys, however, clayey-loam and clay do occur which sustain better quality of forests. Soil is generally shallow and mixed with rock and pebbles. Nutrient status of soil is low. The area has three distinct seasons- summer, rainy and winter. An unpleasant hot and dry weather prevails from March to June and hot westerly winds blow during the period. The maximum day temperature reaches 48°C and more. In the peak summer, the maximum day temperature recorded is 47°C in core area and *50*°C in buffer area. The rainy season extends from middle of June to middle of October and moderate temperature prevails in the area. The average rainfall in this area is 57 inches (1400 mm) and (lie average number of rainy days observed in a year are 85. The core area of the sanctuary experiences a bit more rainfall than the other parts of the sanctuary.

METHODOLOGY

Diversity index and Evenness: Community diversity is the most direct measure of ecosystem fitness. The study of diversity is the study of variation in the number of different ecological circumstances. It has therefore been suggested that the 'Index of Diversity' can be an indication of the relative importance of the factors that are affecting the population balance as a whole. Diversity is composed of two distinct components, *viz.* the total number of species and how the abundance data are distributed among the species. First component refers to the richness and the second component is evenness or equitability.

Shanon and Wiener diversity index (H^1) is calculated by the formulae using

$$H^1 = \sum_{i=1}^{s} p_i \ln p_i$$

Where, S = the number of species, pi = the proportion of individuals or abundance of the ¡th Species expressed as a proportion of total cover, ln = log base n

Species richness (SR): Species richness is a measure of the number of species found in a sample. Since the larger the sample, the more species we would expect to find, the number of species is divided by the square root of the number of individuals in the sample. This particular measure of species richness is known as SR. (Menhinick's index 1964)

$$SR = \frac{S}{\sqrt{N}}$$

Where,

S = Number of species in a community
N = Number of individuals of all species in a community

Similarity between study zones: There are few indices are available that compare the similarity and dissimilarity between sites. The main objectivesis to express the ecological similarity of different sites.

Jaccard[S] index of similarity(Si): The Jaccard's index (Krebs 1989; Krebs 2014) was used to calculate the species similarities between the forest ecosystem types. Jaccard's index is an approach based on abundance-based similarity index by comparing two cosystems depend on three incidence counts which takes into consideration the number of species shared by two ecosystems and the number of unique species found in each ecosystem (Chao et al.,2006; Loice, 2010).

Si = a /a+ b + c

Where;

Si = Jaccard's index of similarity
a = number of the same species appear in both ecosystem
b = number of unique species found in ecosystem 1
c = number of unique species found in ecosystem 2

RESULT AND DISCUSSION

In the present study, the species richness and Shannon Weinner diversity index varied from 25 to 41 and 3.07 to 3.997 respectively along study zones of Dalma Wildlife Sanctuary

Result

Table 1. Forest Flora Species in Dalma Wildlife Sanctuary, Jharkhand.

Sl. No.	Botanical Name	Family	Sl. No.	Botanical Name	Family
	Tree			Shrub	
1	*Terminalia tomentosa*	Combretaceae	1	*Clerodendron Infortunatum*	Verbinaceae
2	*Shorea robusta*	Dipterocarpaceae	2	*Desmodium Cephalotes*	Papalionaceae
3	*Lagerstroemia parviflora*	Lythraceae	3	*Melastoma Alabathricum*	Melastomaceae
4	*Aegle elephantum*	Rutceae	4	*Agave vera*	Amaryllidaceae
5	*Bauhinia retusu*	Caesalpiniaceae	5	*Vernonia Anthelmintica*	Compositae
6	*Calicarpa arborea*	Verbinaceae	6	*Vitex Negundu*	Verbinaceae
7	*Diospyros embryopteris*	Ebenaceae	7	*Hibiscus Cannabinus*	Malvaceae
8	*Adina cordifolia*	Rubiaceae	8	*Alangium lamarki*	Cornaceae
9	*Aegle marmelos*	Rutaceae	9	*Antedesma Ghaesmbilia*	Euphorbiaceae
10	*Morinda citrifolia*	Rubiaceae	10	*Melia azedarch*	Miliaceae
11	*Cassia fistula*	Caesalpiniaceae	11	*Diospyrus Melanoxylon*	Ebenaceae
12	*Albizia stipulate*	Compositeae	12	*Phylanthus emblica*	Euphorbiaceae
13	*Kydia calycina*	Marvaceae	13	*Flacourtia Romantechi*	Bixaceae
14	*Cassia siamia*	Caesalpinnaceae	14	*Gordenia Gumnifera*	Rubiaceae
15	*Schrebera swieteniodes*	Oleaceae	15	*Flacartia Cramalatum*	Bixaceae
16	*Alstonia scholaris*	Apocynaceae	16	*Helicteris isora*	Sterculiceae
17	*Bauhinia racemosa*	Caesalpiniaceae	17	*Holarrhena Antidysenterica*	Apocynaceae
18	*Albizzia stipulae*	Mimosaeae	18	*Randia dumetorum*	Rubiaceae
19	*Anogeisus latifolia*	Combretaceae	19	*Xylosma Longifolium*	Bixaceae
20	*Bridelia aretusa*	Euphorbibiceae	20	*Zyzyphus Cenoplia*	Rhanaceae
21	*Buchnania latifolia*	Anacardiaceae		Herb	
22	*Casearia graviolens*	Bixaceae	1	*Antidesma Ghaesmbilia*	Euphorbiaceae
23	*Caseria tomentosa*	Samydaceae	2	*Curcuma amada*	Zingiberaceae
24	*Cedrella toona (Toona ciliate)*	Meliaceae	3	*Echinochloa Crusgali*	Graminae
25	*Cochlospermum gossipium*	Bixaceae	4	*Heteropogon Contortus*	Gramineae
26	*Cleistanthus collinus*	Euphorbiaceae	5	*Chrysopogan Aciculate*	Gramineae
27	*Cleistanthus patulas*	Euphorbiaceae	6	*Panicum Maximum*	Gramineae
28	*Dillenia pentagyna*	Dilieniaceae	7	*Chrysopogan Gryllus*	Gramineae
29	*Eugenia jambolana*	Myrtaceae	8	*Imperata Cylindrical*	Gramineae
30	*Feronia elephant*	Rutaceae	9	*Cynodon Dactylon*	Gramineae
31	*Ficus hispida*	Moraceae	10	*Ischaemum amjustifolium*	Gramineae
32	*Grewia tiliaefolia*	Tiliaceae	11	*Pennisetum setaria*	Gramineae
33	*Odina wodier*	Anacardiaceae	12	*Ipomea batatas*	Convolvulaceae
34	*Oroxylom indicum*	Bignoniaceae	13	*Clerodendron siphonanthus*	Verbenaceae
35	*Pterocarpus marsupium*	Papilionaceae	14	*Ruellia berlaria*	Acanthaceae
36	*Semicarpus anacardium*	Anacardiaceae	15	*Basella latefolia*	Amarantaceae
37	*Soymida febrifuga*	Meliaceae	16	*Apluda varia*	Gramineae
38	*Pterospermum pteragonum*	Sterculiaceae	17	*Cryptolepis buchanani*	Asclepidaceae
39	*Terminalia belerica*	Combretaceae	18	*Justicia betonica*	Acanthaceae
40	*Terminalia chebula*	Combretaceae	19	*Vernonia cinerea*	Compositeae
41	*Zizyphus jujube*	Rhamnaceae	20	*Indigophera pulchella*	Papilonaceae
			21	*Wrightia tomentosa*	Apocynaceae
	Climber				
1	*Melothria heterophylla*	Cucurbitaceae	8	*Rivea hypocrateriformis*	Covolvulaceae
2	*Vigna catjang*	Papilionaceae	9	*Abrus precatorius*	Papilionaceae
3	*Chonemorpha macrophylla*	Apocynaceae	10	*Celastrus paniculata*	Acanthaceae
4	*Barleria spp.*	Acanthaceae	11	*Bauhinia vahlii*	Caesalpiniaceae
5	*Barleria cristata*	Acanthaceae	12	*Vitis repanda*	Ampelidaceae
6	*Cryptolepis buchanani*	Asclepiadaceae	13	*Smilex macrophylla*	Liliaceae
7	*Dioscorea belophylla*	Dioscoreaceae	14	*Asparagus racemosus*	Liliaceae

Table 2. Species richness and diversity pattern along study zones

Study zone	Species Richness(SR)	Shannon Diversity Index(H)
Upper Zone(454m – 603 m)	41	3.333
Middle Zone(250m – 452m)	29	3.997
Lower Zone(199m – 250m)	25	3.073

Table 3. Whittaker (β diversity)

Species	Upper zone	Middle zone	Lower zone
Tree	2.32	3.28	3.80
Shrub	2.70	3.60	2.84
Herb	2.48	3.25	3.47
Climber	2.54	3.00	3.67

Table 4. Similarity Value of tree species in all three study zones

Comparisons between	Number of species in study zones			Similarity value
Study zones	Upper zone	Middle zone	Lower zone	
UZ and MZ	41	29	0	0.707
UZ and LZ	41	0	25	0.609
MZ and LZ	29	0	25	0.606

UZ: Upper zone, MZ: Middle zone and LZ: Lower zone , Si: Similarity value.

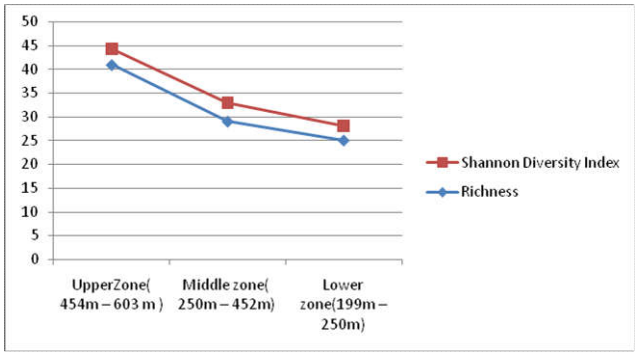


Figure 1. Species richness and diversity pattern of tree species in upper, middle and lower zones

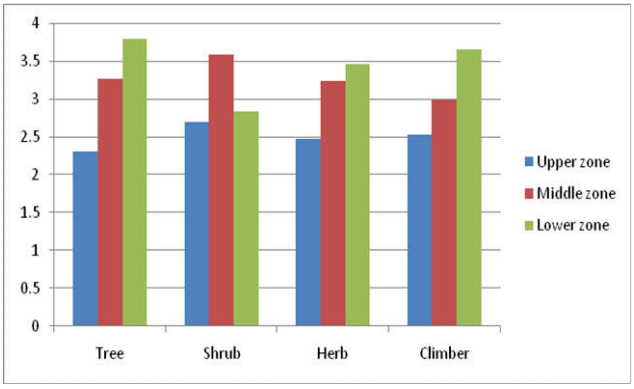


Figure 2. Whittaker (β diversity) of existing vegetation in all three zones

(Table 5.20) Lowest number of species (SR=25) was found from lower zone due to maximum disturbances of anthropogenic cause while least disturbed zone possessed highest number of species (SR=41). Middle zone occupied an intermediate position with respect to species richness (SR=29). The highest value of Shannon Wiener index (3.997) was found for middle zones followed by upper zone (3.33) and lower zone (3.073). In the lower zone maximum and minimum species diversity was recorded for *Shorea robusta* (H= 0.518) and *Odina wodier (H=0.015)* respectively. In the middle zone maximum and minimum species diversity was recorded for Shorea robusta H = 0.798) and *Cleistanthus collinus (D =0.010)* respectively while the maximum and minimum value for upper zone was recorded for *Shorea robusta (D =0.257)* and *Pterospermum pteragonum* (D = 0.006) respectively.

Beta Diversity (β): The Beta diversity of different plant type like Tree, Shrub, herb, and Climber (table 3)Perusal of the data indicated in upper zone value of β – diversity is found maximum for Shrubby species(2.70), while in middle zone similar situation observed i.e. for shrub beta diversity is found maximum. On the other hand, for lower maximum beta diversity was calculated for tree species (3.80). The comparative of β- diversity value of tree, shrub, herb and climber species found at Dalma Wildlife Sanctuary for upper, middle and lower zone is also shown with graph (Figure 2). In upper zone the value of beta diversity was observed low for tree, shrub, herb and climber.

Similarity: The Similarity value(Si) also indicates that the highest value (Table 4) shown by the combination of upper zone and middle zone forest(0.707) followed by upper zone and lower zone(0.609). The combination of upper zone and middle zone, upper and lower zone, middle and lower zone forest exhibits slightly lower degree of similarity with the value of 0.707, 0.609 and 0.606 respectively. In conclusion, the degree of similarity for the entire three zone forest is low and indicating heterogeneity in the species composition.

DISCUSSION

In upper zone maximum number of genera (4) belonged to Combretaceae and Caesalpiniaceae, whereas in middle zone similar to upper zone maximum genera were found from Caesalpiniaceae and in lower zone again Caesalpiniaceae is reported by three (3) species. Bixaceae family showed maximum plant in under shrub groups, upper zone (3) and middle zone (2) respectively. While in lower zone Rubiaceae and Euphorbiaceae have found from 2 genera in each. Under the herbaceous category in all these zones, members of Gramineae dominated indicating 10, 7, and 6 for upper, middle and lower zone respectively (Table 1). In upper zone for trees, maximum IVI was found for *Shorea robusta* (19.25) whereas in case of middle zone, the *Terminalia tomentosa* showed maximum IVI (15.52) and on the other hand in the lower zone again *Terminalia belerica* represented 18.81 IVI value. Similar results were obtained by Lalfakawma *et al* (2009) while studying community composition and tree population structure in undisturbed and disturbed tropical semi-evergreen forest stands of north-east India. Similar patterns of diversity across altitudinal gradients have been observed in other studies in the Himalayan regions (Kharkwal *et al*. 2005; Tanner *et al*. 1998; Vazquez and Givnish, 1998), Diversity of life-forms usually decreases with increasing altitude and one or two lifeforms remain at extreme altitudes (Pavón *et al.* 2000). Altitude itself represents a complex combination of related climatic variables closely correlated with numerous other environmental properties (soil texture, nutrients, substrate stability, etc.; Ramsay and Oxley, 1997). Within one altitude the cofactors like topography, aspect, inclination of slope and soil type further effect the forest composition (Holland and Steyn, 1975). The highest value of Shannon Wiener index (3.997) was found for middle zones followed by upper zone (3.33) and lower zone(3.073). In the lower zone maximum and minimum species diversity was recorded for *Shorea robusta* (H= 0.518) and *Odina wodier (H=0.015)* respectively. In the middle zone maximum and minimum species diversity was recorded for *Shorea robusta* (H = 0.798) and *Cleistanthus collinus (D =0.010)* respectively while the maximum and minimum value for upper zone was recorded for *Shorea robust (D =0.257)* and *Pterospermum pteragonum* (D = 0.006) respectively. In the present study, the species richness and Shannon Weinner diversity index varied from 25 to 41 and 3.07 to 3.997, respectively in study zones of Dalma Wildlife Sanctuary (table 2) Lowest number of species (SR=25) was found from lower zone due to maximum disturbance of anthropogenic cause while least disturbed zone possessed highest number of species (SR=41). Middle zone occupied an intermediate position with respect to species richness (SR=29). In a study Singh *et al.* (1994) reported that *P. roxburghii*-mixed broad-leaved forests had the highest species richness, while high elevation forests had the lowest. Burns (1995) and Austin *et al*. (1996) have found that the total species richness was greatest at lower elevation and warmer sites. The overall pattern of species richness showed a sharp decline as the altitude increased beyond 3000m asl. A similar pattern of tree species richness (deciduous) in timberline area was reported by Rawal et al. (1991). The low elevation appeared likely to be drier although

precipitation varied inconsistently with elevation (Singh *et al.* 1994). At the highest elevation (2800-2700m asl) the maximum species diversity (0.52). They observed that overall maximum species diversity (Shannon-Wiener index) (2.37) was recorded at comparatively lower elevation (2600-2400m asl). The overall pattern of species richness, Margalef's index, Menheink's index, Shannon-Wiener index (species diversity) and Simpson's diversity index showed a sharp decline at the highest altitude (2800- 2700m asl). A similar pattern of tree species richness in timberline area was reported by Rawal *et al*. (1991). Tree species richness increases with increasing moisture in the Indian Central Himalaya (Rikhari *et al.*1989).

The floristic similarity analysis between the three zones of Dalma Wildlife Sanctuary of Jharkhand show the similarity value range from 0.606 – 0.707 which is floristically low in similarity indicating heterogeneity in the species composition. This is attributed to Anthropogenic activities like over-exploitation of plant resources for economic uses, heavy grazing pressure of local livestock, utilization of land for construction and agricultural purposes, and population density are continuously changing the species composition and vegetation structure in the Dalma Wildlife Sanctuary. Potts et.al (2002) also indicated that the range of floristic similarity value within the ecosystem of northwest Borneo in Lambir Hills Sarawak varies from 0 to 0.5. A similar conclusion was drowned by Lopes et.al. (2012) in their study on Forest in Southeast Brazil.

Conclusion

Due to major interference (anthropogenic effect) of local inhabitants in lower zone of the study area for their daily needs and generation of income by way of fuel wood collection and other important extraction of NTFPs, the tree species richness, diversity and other related parameters were found lesser, when ever canopy height was found maximum for trees existing in lower zone because non approach of wild/ domestic animals.

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