COMPOSITION, STRUCTURE AND FLORAL DIVERSITY OF FOREST COMMUNITIES OF ACHANAKMAR- AMARKANTAK BIOSPHERE RESERVE :A COMPARISON AND CONSERVATION IMPLICATION

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Abstract

The core region of Achanakmar- Amarkantak Biosphere Reserve falls in Chhattisgarh State (India) and lies between lat.22 ^{0}15' to 20 ^{0}58' N and long. 81 ^{0}25'N to 82 ^{0} 5'E. *Shorea robusta* Gaertn F. (sal) is the dominant species occurring in this region.The present study deals with the comparative account of composition and diversity of pure *Shorea robusta* forest and degraded mixed moist forest of Achanakmar- Amarkantak Biosphere Reserve.Based on the repeated reconnaissance of the area, three representative sites of size 1 hac. in pure sal forest was selected for two growth strata stages eg.upper story(trees)under story(,saplings and seedlings). The forest vegetation was analyzed using 10 randomly placed quadrate(each 10 *10m) within the representative sites. The vegetation data were quantitavely analyzed for frequency, density, abundance and Importance value index and various indices of alpha and beta diversity .The pure *Shorea robusta* forest showed high density and basal cover of trees (1233stem ha$^{-1,}$basal cover 36.36 m^{2} ha^{-1})and under story vegetation (density1575 stem ha^{-1} ,basal cover 1.85 m^{2} ha^{-1}). The degraded mixed moist deciduous forest sites represents the degraded stage having low density of trees and basal cover(633 stem ha$^{-1,}$basal cover 32.82 m^{2} ha^{-1})and under story vegetation (density 918 stem ha^{-1} ,basal cover 0.37 m^{2} ha^{-1}). The total number of species was high in pure *Shorea robusta* forest as compared to degraded mixed moist deciduous forest.
Similarly plant diversity was also high in pure *Shorea robusta* (sal) forest for trees and understory(2.82;2.92 Shanon index;4.76;2.32 richness index ,0.99;1.01 equitability ,0.21;0.22 concentration of dominance,5.78;8.82 beta diversity)respcectively than on degraded mixed moist deciduous forests for trees and understory(1.99;2.44 Shanon index;3.48 ;1.43richness index , 0.78;1.04 equitability index,0.39;0.26 concentration of dominance,8.20;11.93; beta diversity)respcectively..The climatic condition of the region supported the regeneration of *Shorea robusta* (sal) and its associates in the climax formation over a long successional process. The study focus the comparison and conservation implication of this biosphere reserve.

Key words: Bioshere Reseve,Composition, Floral diversity, Structure and Succession.

1. INTRODUCTION

While biodiversity loss is a global phenomenon, its impact may be greatest in the tropics where the majority a species are distributed. This long recognized pattern of increasing diversity towards the tropics is exemplified in tropical forest, which take up less than 2 percent a the earth's surface, but contain upwards a 50 percent of its biodiversity. (Howkins,2001) In order to effectively mitigate biodiversity loss, grater investment of conservation attention is required in tropical region where there is the more to lose. Broad-reaching global legislation may provide an impact for such investment. One important example is the convention on biological diversity (CBD), under which 190 signatory nations have ambitiously committed themselves to "achieve, by 2010 levels".(UNEP, 2002)Assessing - Progress towards this important goal requires data on the status and trend in biodiversity for a country or region.

Tree species diversity in the tropics varies dramatically from place to place (Pitmen et al. 2002) . Much attention has been give to tropical forests due to their species richness (whitmore,1984) high standing biomass (Bruening, 1983) and greater productivity (Jordon, 1983).

2. MATERIAL AND METHOD

STUDY AREA

The Achanakmar-Amarkantak Biosphere Reserve is one of the premium biosphere reserve in India. The reserve covers a huge area of 3835.5189sq. km. and it falls in almost northern part of bio-geographic zone of 6 and Bio-geographic province 6a (Deccan peninsula, Central highlands). About 68.10% out of the total area of this reserves lies in the Bilaspur district in Chhattisgarh. The area of the Achanakmar-Amarkantak Biosphere Reserve is considered as one of the major watershed at peninsular India. It separates the rivers that drain in to the Arabian sea and Bay of Bengal. The reserve is also unique on being the source of there major river systems like Narmada, Johilla and Sone of the Ganga basin.

Study area is described in detail by (EPCO,1999) . The Achanakmar - Amarkantak Biosphere Reserve is located between 22'15' to 22'58' N latitude and 81'25'to 82'5' E longitude. The land use analysis made by RSAC, Bhopal indicates that 63. 19% of the area is occupied by the forest. It can be classified in to Northern tropical moist deciduous and southern dry mixed deciduous forest. The Reserve is highly rich in biodiversity, both flora and fauna and is also endowed with several rare and endangered species. It has rich diversity of medicinal and aromatic plant. However, Increased biotic interference during the last two decades has eroded the structure and diversity of these forest. Major problems in the area are illicit grazing by cattle, expansion of agriculture , increased mining, over exploitation of NTFP's and medicinal plants. The present study focuses on the relationship of environment to the composition, structure and diversity of forest communities of the Achanakmar- Amarkanantak Biosphere Reserve.

MAP OF ACHANAKMAR –AMARKANTAK BIOSPHERE RESERVE

The climate of the reserve is tropical and the year is distinctly divisible in to winter (November-February) , summer (April-June) and a warm rainy season (July-September) , Mean monthly minimum temperature within the annual cycle ranges from 10.9^{o} to 25.6 ^{o} C and mean monthly maximum temperature from 24.1to 42.^{o} C. The annual rainfall average is 1322mm. (mean monthly range is 6.63 mm to 359. 88 mm) of which about 85% occurs during the period mid June to September.

The soil of the study area that varies greatly depending upon the parent rocks and topography is red lateritic, nutrient poor (lacking N and P) and characterized by excessive amounts of iron oxide (Prakash, 1992)

SURVEY

Based on repeated reconnaissance of the area, representative sites of pure sal forest and miscellaneous moist deciduous forest were selected for the present study. In each forest type the observations were recorded on three experimental plots, each 100m x 100m in area .The pure sal forest represents the climax, dense and reserve forest types whereas miscellaneous moist forest represents the degraded forest.

The forest vegetation was analyzed using 10 randomly placed quadrates (each 10 x 10 m in size) within the representative 1 ha plot on each of the three plots. The size and number of quadrates needed were determined using the species area curve(Misra 1968) and the running mean method (Kershaw 1973) . In each quadrate, dbh of each mature individual (>9.6 cm dbh) was measured in the center of each 10 x 10 m quadrate, a 2 x 2 m area was marked for enumeration of saplings (individuals 3.2cm to < 9.6 cm dbh) and seedlings (individuals < 3.2 cm diameter but < 30 cm height) . In the present study the saplings and seedlings are pooled under the category of undestroyed vegetation. Stem diameter of mature and saplings individuals were measured at 1.37 m from the ground and for seedlings it was measured at 10 cm above the ground . The vegetation data were quantitatively analyzed for frequency, density and abundance. (Curtis & Mclntosh 1950) . An importance value inbox (IVI) was calculated as the sum total of relative frequency, relative density and relative dominance (Phillips 1959)

The alpha diversity and its components, i.e. species richness (Margalef index) and evenness (Whittaker index) were calculated for each plot. Beta diversity was calculated for each plot to represent the degree of habitat heterogeneity. These indices were calculated following Sagar and Singh (1999).Shanon-Wiener ,1963 information function was used for species diversity

H' = pi log pi where Pi is the proportion of basal cover/ density of the species (ni) in the total of the community (N) . We used a factor of 3.3219 to convert $\log_{10}$ to $\log_2$ (Smith 1974).

Concentration of dominance was measured by Simpson's index (Simpson 1949)

Cd = (Ni/N)2 where Ni and N are same as above.

Equitability (e) was calculated following pielou (1966) , as:

E = H'/ S where H' = Shannon index and S = number of species.

Species richness (d) was calculated following Marglef (1958) as:

D = (S-1)/ N where S = total number of species and N - total basal cover/total density of all species.

Beta diversity was calculated according to the formula given by Whittaker (1972):

Bd = Sc/S

where Sc = total number of species in the two sites (i.e. pure sal forest site and degraded moist deciduous forest site) and

S = average member of species per site.

3. RESULT AND DISCUSSION

SPECIES DIVERSITY

A total of 101 species that belongs to 46 families were recorded from study area. The result showed that the greater number of species were recorded in the pure sal forest (26 families and 66 spp) than the degraded moist deciduous forest (20 families, 41 species) .

The top canopy of the vegetation in the pure sal forests dominated by *Shorea robusta, Pterocarpus marsupium,Terminalia tomentosa, Woodfordia fruiticosa and Diospyros melanoxylon***.** The second layer was dominated by the *Miliusa tomentosa* and in the third layer

the saplings of *Diospyros melanoxylon* and *Shorea robusta* were predominant .Degraded moist deciduous forest site is dominated by *shorea robusta, Terminalia tomentosa and Diospyros melanoxylon* on sal dominated patches. However, in mixed forest site sal is absent and the forest is dominated by *Terminalia tomentosa and Anogeissus latifolia***.** . The second storey is dominanted by species was *miliusa tomentosa*, where as in the third layer *Diospyros melanoxylon* was less pronounced. However, the density and cover of the under storey vegetation was very poor as compared to pure sal forest.

The density, basal cover and IVI for trees and under story layer are given in Table1 and 2 respectively. The total basal cover of trees and Under story was 36.36 m^2ha^{-1} ,1.85 m^2ha^{-1}respectively in pure sal forest and 32.37 m^2ha^{-1} ,0.37 m^2ha^{-1} in degraded forest.

The dominant trees in pure sal forest were *Shorea robusta, Terminalia tomentosa and Diospyros melanoxylon*(mean IVI 84.97, 37.43 and 24.84 respectively). *In* Understory the dominant species were *Miliusa tomentosa,Embelua robusta, Diospyros melanoxylon and Shorea robusta with* mean IVI of 47.72, 46.93, 45.39 and 38.09 respectively.

In degraded forest were *Shorea robusta, Terminalia tomentosa and Miliusa tomentosa* (mean IVI 104.23, 67.90 and 31.76 respectively). In Understory the dominant species were *Miliusa tomentosa,Embelua robusta, Diospyros melanoxylon and Shorea robusta with* mean IVI of 112.8,67.5 and 25.01 respectively.

The complexicity index is product of stem density, canopy height, number of species and basal cover(Holdrige et al.1971).For the present study the mean complexcity index was 13.44 for pure sal forest as compared to5-45 for tropical dry forest and 180-405 for tropical wet forest(Murphy and Lugo1986).This is in conformity to the report of Murphy and Lugo(1986)that dry tropical forest are less complex floristically and structurally then wet tropical forest.

Tree basal cover in the present study varied from 32.37-36.36 m^2ha- for both pure sal forest and degraded moist deciduous sites. These basal cover values were higher than that of the values reported for the several dry tropical forest communities in Vindhyan region by (Jha and Sing 1990) between 6.58-23.21m2ha-1 and by (Singh and Singh 1991) The trotal basal cover in the present study is 32.82-36.36 m^2ha for pure sal forest and degraded moist deciduous sites . These values are in comparision with 17-40 m2 ha-1 for dry tropical. forest and 20-75 m2ha-1 for wet forest (Murphy and Lugo 1986) .

In the present study tree density ranged from 1040-1250 stems ha 1 for pure sal forest .Density values in other ranges of Amarkantak regions were 845-980trees m2 ha-1 for Karangia range,1074-1527 tress m2 ha-1 for Lamni range,1912 tress m2 ha-1 for Lormi range,934-1912 tress m2 ha-1for Kota range ,823-853 tress m2 ha-1 for Khudia range,588-1159 tress m2 ha-1 for Pendra range,782-1051 tress m2 ha-1for Belgahna range,964-1201 tress m2 ha-1 for Khodri rangeand 1269-1354 tress m2 ha-1 for Amarkantak range(EPCO,1999).

PLANT DIVERSITY

Plant diversity parameters are summarized in Table-3. The higher concentration of dominance and rich diversity on pure sal forest could be related to uneven show of dominance i.e. case of *Shorea robusta, , Terminalia tomentosa* show in dominance was maximum as compared to other species. Murphy and lugo (1986) have argued that because of difference in sample size, in the taxonomic group included and in plant size. Comparisons of species diversity among different tropical forests are difficult to make. Among the two sites, the shanon-wiener index, the species richness and equitability for tree and shrub layer were higher for pure sal forest

site while the concentration of dominance was higher for degraded moist deciduous sites. The higher concentration of dominance and lower diversity on open forest could be related to uneven show of dominance i.e. case of shorea robusta, show in dominance was maximum as compared to other species. The shanon-wiener index for the tree and shrubs in the prasent study was low 2.66-2.925 , (in pure sal forest) and 1.42-2.36, (in degraded moist deciduous sites)as compared to tropical rainforest of silent valley (3.8-4.8; singh et al 1984). For the pure sal forest site ,the species diversity (Shanon-wiener index)for tree layer was 2.82,and for under story layer it was 2.93compared to Dry Dipterocarp Forest of Thailand(3.75-4.49,Krratiprayon et al.1995),tropical rain forest of Silent Valley,India3.8-4.8(Singh et al.1984).

Diversity parameters in the tropical pure sal forest communities i.e.trees and under story vegetation 2.82,2.92(shanon-wiener index), 0.99,1.01 (equatability) 4.76,2.32 (species richness) ,0.21,0.22(Concentration of Dominance)and 5.78,8.82 (Beta diversity) respectively .Diversity parameters in tropical forest of the Vindhyan hill as reported by Singh and Singh (1991) had ranged between 1.93-2.82 (Shanon-wienar index), 0.83-1.04 (equitability) and 0.18-0.39 (simpson's index) o.88-1.4 (species richness).Sager et al(2003)reported Shanon-wienar index between 1.398-2.629 for dry tropical forest located along the disturbance gradient.

Diversity parameters in the degraded moist deciduous sites communities i.e.trees and under story vegetation are 1.99,2.44(shanon-wiener index), 0.78,1.04 (equatability) 3.48,1.43 (species richness) ,0.39,0.26(Concentration of Dominance)and 8.20,11.93. (Beta diversity) respecively.

Thus from the study of diversity and species composition of sal dominated tropical moist deciduous forest it is evident that the sal dominated forests site is highly diverse than miscellaneous degraded moist deciduous forest in all aspect. This indicates that the climatic condition of Chhattisgarh region would have favorable sal and its associates in the climax formation over a long successional process and have favored highly diverse forest of sal. Therefore, the management plan for this forest should focus on sal and its associates in order to safeguard the overall diversity of this area.

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Table 3. Diversity parameters of sal dominated and degraded moist deciduous forest

Parameters		Sal Dominated Forest	Degraded Moist Deciduous Forest
Species richness (d)	a) b)		

Table 1: Species structure of the tropical moist deciduous forest (tree layer)

Species	Sal Forest			Degraded Forest		
	Density (stems ha^{-1})	Basal cover (m^2 ha^{-1})	IVI	Density (stems ha^{-1})	Basal cover (m^2ha^{-1})	IVI
Shorea robusta Gaertn f. Dipterocarpacear	350	14.24	84.97	233	15.66	104.23
Terminalia tomentosa Wt & Agn. Combretaceae	140	4.98	37.43	133	7.96	67.9
Diospyros melanoxylon Roxb. Ebenaceae	117	2.0	24.84	27.0	3.23	19.11
Embelia robusta C.B. Clarke non Roxb. Myrsinaceae	143.0	1.59	21.43	-	-	-
Miliusa tomentosa (Roxb.) J. Sinclair, Annonaceae	107.0	0.73	20.52	90.0	0.64	31.76
Pterocarpus marsupium Roxb. Fabaceae	40.0	3.31	18.78	7.0	0.12	3.54
Buchanania lanan Spreng, Anacardiaceae	80.0	1.32	17.97	27.0	0.47	11.58
Anogeissus latifolia Wall.ex Bedd, Combretaceae	27.0	1.10	10.45	20.0	1.74	13.46
Woodfordia fruticosa Lythraceae	10.0	1.73	6.17	-	-	-
Eugenia cumini Druce, Myrtaceae	17.0	0.80	6.10	-	-	-
Ougeinia oojeinensis (Roxb.) Hochr. Fabaceae	23.0	0.44	5.61	10.0	0.22	4.31
Lannea grandis Engl. Anacardeaceae	13.0	0.9	5.45	7.0	0.14	3.60
Emblica officinalis Gaertn, Euphorbiaceae	27.0	0.19	5.26	7.0	0.28	4.31
Dendrocalamus strictus Nees Poaceae	17.0	0.32	4.79	-	-	-
Grewia tiliacfolia Vahl., Tiliaceae	20.0	0.36	4.57	-	-	-
Radermachera xylocarpa Roxb. K. Schum Bignoniaceae	10.0	0.50	4.12	7.0	0.27	3.99
Careya arborea Roxb. Lecythidaceae	7.0	0.62	2.86	7.0	0.16	2.48
Zizyphus xylopyra Willd, Rhamnaceae	7.0	0.26	2.64	3.0	0.02	1.41
Bridelia squamosa Gehrm, Euphorbiaceae	7.0	0.12	2.26	3.0	0.36	2.44
Lagerstroemia parviflora Roxb.	7.0	0.09	2.18	3.0	0.05	1.5
Bauhinia malabarica Roxb. Caesalpiniaceae	7.0	0.07	2.12	3.0	0.07	1.56
Terminalia chebula Retz. Combretaceae	3	0.31	1.69	-	-	-
Mitragyna parvifolia (Roxb.) Korth, Rubiaceae	3.00	0.14	1.21	-	-	-
Cordial dichotoma Forst. F. Boraginaceae	3.00	0.06	0.99	-	-	-
Ficus religiosa Linn. Moraceae	3.00	0.06	0.99	-	-	-
Semecarpus anacardium Linn. F. Anacardiaceae	3.0	0.04	0.94	-	-	-
Adina cordifolica Benth & Hok. F. Rubiaceae	3.0	0.03	0.91	10.0	0.57	6.26
Bauhinia vahlii Wight & Arn. Caesalpiniaceae	3.0	0.02	0.88	-	-	-
Cassia fistula Linn. Caesalpiniaceae	3.00	0.02	0.88	-	-	-
Kydia calycina Roxb. Malvacea	3.00	0.01	0.87	10.0	0.17	2.98
Tectona grandis Linn. F. Verbenaceae	-	-	-	13.0	0.21	6.51
Madhuca indica J.F.Gmel. Sapotaceae	-	-	-	7.0	0.18	3.72
Dalbergia paniculata Roxb. Fabaceae	-	-	-	3.0	0.02	1.41
Burseraceae	-	-	-	3.0	0.28	2.20
Total	**1203**	**36.36**		**633**	**32.82**	

Note: All data are average of three plots

Table 2; Species structure of the tropical moist deciduous forest (unerstorey layer)

Species	Sal Dominated Forest			Degraded Moist Deciduous Forest		
	Density (stems ha^{-1})	Basal cover (m^2 ha^{-1})	IVI	Density (stems ha^{-1})	Basal cover (m^2 ha^{-1})	IVI
Maliusa tomentosa	230.0	0.33	47.72	317.0	0.19	112.81
Embelia robusta	397.0	0.24	46.93	53.0	0.01	15.59
Diospyros melanoxylon	187.0	0.39	45.39	277.0	0.5	67.51
Shorea robusta	247.0	0.16	38.09	87.0	0.02	25.11
Ventillago calyculata Tul. Rhamnaceae	30.0	0.39	25.82	10.0	0.01	4.72
Eugenia cumini	157.0	0.08	20.85	23.0	0.01	8.3
Emblica officinalis	23.0	0.05	8.52	7.0	0.01	4.39
Grewia tiliaefolia	40.0	0.05	8.07	-	-	-
Bauhinia vahlaii	33.0	0.004	6.67	-	-	-
Schleichera oleosa (Lour.) Oken, Sapindaceae	27.0	0.008	5.90	17.0	0.002	7.56
Heretic laevis Roxb. Boraginaceae	23.0	0.01	4.83	-	-	-
Buchanania lanzan	20.0	0.02	3.88	17.0	0.02	11.27
Terminalia tomentosa	10.0	0.03	3.79	3.0	0.0003	2.07
Cassia fistula	17.0	0.004	3.48	7.0	0.001	3.2
Lagerstoemia parviflora	10.0	0.01	3.36	10.0	0.005	3.37
Ptcrocarpus marsupium	7.0	0.02	3.06	-	-	-
Radcrmachera xylocarpa	7.0	0.02	3.06	-	-	-
Adina cordifolia	17.0	0.007	2.99	-	-	-
Grevia hirsute vah. Tiliaceae	17.0	0.0004	2.63	-	-	-
Madhuca indica	1.0	0.0004	2.19	7.0	0.0001	2.96
Smilex macrophylla Roxb. Liliaceae	7.0	0.0007	2.02	-	-	-
Helicteres isora Linn. Sterculiaceae	13.0	0.0003	1.50	-	-	-
Terminalia chebula	7.0		1.48	-	-	-
Indigofera pulchella Roxb. Fabaceae	10.0	0.003	1.45	-	-	-
Semecarpus anacardium	30.0	0.007	1.22	-	-	-
Ziziphus xylopyra	30.0	0.007	1.22	-	-	-
Anogeissus latifolia	7.0	0.001	1.15	-	-	-
Randia uliginosa Dc. Ribiaceae	7.0	0.00007	1.10	-	-	-
Dillenia aurea Sm. Dilleniaceae	3.0	0.0002	0.86	-	-	-
Gardenia turgida Roxb. Rubiaceae	3.0	0.0003	0.86	-	-	-
Tectona grandis	-	-	-	30.0	0.02	11.77
Aegle marmelos Correa ex. Roxb. Rutaceae	-	-	-	30.0	0.007	7.33
Ziziphus ocnoplia Mill. Rhamnaceae	-	-	-	10.0	0.0007	3.45
Garuga pinnata	-	-	-	3.0	0.007	3.15
Boswellia serrata Roxb. Burseracae	-	-	-	7.0	0.0001	2.96
Wendlandia exserta Dc. Rubiaceae	-	-	-	3.0	0.0007	1.45
Total	**1572**	**1.85**		**918**	**0.37**	