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Ecological studies of tree vegetation of Chhatarpur district (M.P.) India

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Abstract
Ecological studies evaluate any vegetation's level of biodiversity. Designing and implementing biodiversity conservation management requires a thorough understanding of the ecosystem's biological makeup, tree species variety, and dominating communities. To fulfill this need, the study was carried out in the Chhatarpur District of Madhya Pradesh, India. The makeup of arboreal groups and the degree of biodiversity among these trees were presented in the study. The diversity and ecology of the forest's tree vegetation were the main topics of the paper. There were 20 known tree species in all, belonging to 16 families. In addition to other community indices, the current studies sought to evaluate the important value index, density, frequency, and basal area.

Keywords: Biodiversity, quadrate, phytosociology, dominance, co-ordinance, basal area, IVI

Introduction
The most important resources in ecosystems that support life on a global scale are forests. Because of their enormous species richness and diversity, forest ecosystems are the most prosperous terrestrial ecosystems. These habitats are distinct from all other terrestrial ecosystems due to their very high levels of biodiversity. Global biodiversity is currently declining significantly, which emphasizes the need for conservation planning. Like other parts of the world, India has little scientific research on the biodiversity of its distinct ecosystems outside of protected areas and reserve forests. Furthermore, only a small number of taxonomic groups and ecological types have had extensive biodiversity assessments conducted. In the district of Chhatarpur, nothing has changed. There is little preliminary information available about the patterns of plant group biodiversity in this forest range. The lack of study makes it very difficult to assess the value of living species, their current state, and the threats that could allow for their long-term preservation (Lohbeck *et al.* 2014) [1]. As a result, several species are currently in risk of local extinction. From an ecological standpoint, other ecosystems suffer when forest ecosystems are eliminated or reduced (Palit *et al.* 2012) [2]. This study aims to evaluate the biodiversity status of tree species in Chhatarpur district.
To evaluate the state, a number of quantitative and phytosociological markers were evaluated. This quantitative description of plant patterns provides a clear understanding of how plants interact with one another and with their surroundings. Additionally, it can provide clear proof of the state of biodiversity (Chase and Leibold, 2003) [3].

Materials and Methods
Description of Study Site: The Ecological studies of tree vegetation of Chhatarpur district, Madhya Pradesh state of India during the year 2024. Chattarpur district located at 24.06° & 25.20°N 78.59° & 80.26° E respectively. The district has an area of 8,687 km². Chhatarpur District is bounded by Uttar Pradesh state to the north, and the Madhya Pradesh districts of Panna to the east, Damoh to the south, Sagar to the southwest, and Tikamgarh to the west. Chhatarpur District is part of Sagar Division. The district has extensive forests. About 42% of the total area is covered by forests only.

Methodology: For phytosociological studies in Chhatarpur district, the quadrate methods were used. In each forest beat five quadrates laid down for trees. The sizes of quadrates for trees were 10 m.sq. Basal area was calculated from the perimeter which was measured at a breast height (Phillips, 1959) [6].

Data Analysis Techniques: To analyses the level of diversity in tree vegetation several phytosociological parameters like frequency, Relative frequency, density and Relative density etc., were calculated (Phillips, 1959; Chaubey *et al.* 1988 and Misra, 1968) [6-8]. Then IVI of trees were made to determine the dominant species of the forest. Dominance is a significant indicator of species composition in a forest ecosystem (Burak *et al.* 2011; Sahu *et al.* 2008) [9, 10]. The dominance of any species refers to its relative value or importance in its habitat (Chase and Leibold, 2003) [3]. Or in other language it is the measure of the degree of influence of the species on the ecosystem. To assess the over all impact of a species Importance Value Index was determined by adding Relative frequency, Relative density and Relative Basal Area (Misra, 1968 and Priya *et al.* 2005) [8, 11].

Frequency (%): Frequency refers to the degree of dispersion of individual species in an area and usually expressed in terms of percentage. It is calculated by the equation:

$$\text{Frequency (\%)} = \frac{\text{No. of plot in which the species is present}}{\text{Total No. of plots sampled}} \times 100$$

Density: Density refers to the expression of the numerical strength of a species. It is calculated by the equation:

$$\text{Density} = \frac{\text{No. individuals of the species}}{\text{Total No. of plots sampled}}$$

Relative Frequency (%): Relative Frequency is the degree of dispersion of individual species in an area in relation to the number of all the species occurred.

$$\text{Relative Frequency (\%)} = \frac{\text{Frequency of the species}}{\text{Frequency of all the species}} \times 100$$

Relative Density (%): Relative Density is the measure of numerical strength of a speies in respect to the total number of individual of all the species. It can be determined by the equation.

$$\text{Relative Density} = \frac{\text{Density of the species}}{\text{Density of all the species}}$$

Relative Dominance (%): Dominance is the parameter which is determined by the value of basal area. For the comparative analysis Relative dominance is determined. It is the coverage value of a species with respect to the sum of coverage of the rest of the species in the area.

$$\text{Basal area} = \frac{(\text{Circumference at breast height})^2}{12.56}$$

$$\text{Relative dominance or Relative Basal Area} = \frac{\text{Basal Area of the species}}{\text{Basal area of all teh species}}$$

Importance Value Index: Importance Value Index is used to determine the over all impact of each species in the community structure. It is calculated by the addition of the percentage values of the relative frequency, relative density and relative dominance (Relative Basal Area).

IVI = Relative Frequency + Relative Density + Relative

Data Processing and Phytosociological Analysis: Every phytosociological data set gathered from various sources was tallied and subjected to separate analysis. Some community indicators were calculated using the collected data.

Species diversity (H'): Species diversity was determined by the Shannon-Weiner Index (Shannon and Wiener, 1963) [12]. It was calculated by the equation,

$$(H') = - \sum [(ni / N). \ln (ni / N)]$$

Where
ni = IVI of individual speciesf
N = total IVI of all the species (Shannon and Wiener, 1963) [12].

Species dominance (Cd): Species dominance was calculated by the Simpson Index (Simpson, 1949) [13]: $Cd = \Sigma (ni/N)^2$,

Where
ni = IVI of individual species
N = total IVI of all the species.

Equitability of evenness (e): Equitability of evenness is the measure of the degree of relative dominance of each species in the habitat. It was determined according to Pielou (1966) [14] as:

Evenness (e) = H'/log S

Where:
H' = Shannon index
S = number of species

Species richness (D): Species richness was calculated by Margalef (1968) [15] Index as:

D=(S-1)/ln N.

Where
S = number of species
N= total number of individuals

Menhinick's index (D_{mm}): Menhinick's index (Whittaker and Levin, 1977) [16] is expressed as

$D_{mm}=S/\sqrt{N}$,

Where
N = Number of individuals in the sample
S = Number of species

Equitability Index: The Shannon's equitability Index (Simpson, 1949) [13] is expressed as

(EH) = H'/Hmax = H'/ln S

Berger-Parker Dominance Index: The Berger-Parker
Dominance Index is the measure of numerical importance of the most abundant species. It is determined by the equation

$d = N_{max}/N$.

Where:
$N_{max=}$ Number of individuals of the most abundant species
N= Total number of individuals in the site.

Results and Discussion

Observation of this study indicates that *Adina cordifolia* Hook.f. had highest density (3.79) and *Shorea robusta* Gaertn. f. had maximum IVI (48.66). Density of *Shorea robusta* Gaertn. f. was recorded as 2.81. *Adina cordifolia* Hook.f. had IVI value as 30.47. It is also noted that some other tree species had a good IVI value. These include *Wrightia tomentosa* Roem and Schult. (23.38), *Lagerstromia perviflora* Roxb. (17.94) and *Butea monosperma* Taub. (17.06). However maximum relative basal growth is recorded for *Shorea robusta* Gaertn. f. and it is 25.96. Relative basal growth is not so good in other tree species of this forest including *Adina cordifolia* Hook.f. (4.33), *Wrightia tomentosa* Roem. and Schult (3.62) and *Butea monosperma* Taub. (0.91). Relative basal area is also found good for *Sterculia villosa* Roxb. (13.11). In this survey it is also recorded that few species had very low IVI and Relative basal area *Albizia procera* has minimum IVI value of 1.81 and relative basal area of 0.35.

Eight diversity indices were used to evaluate the district of Chhatarpur's overall biodiversity status. Shannon and Weiner (1963) [12] index represents entropy. It is a diversity measure that takes into account both the number of taxa and the number of individual species. It goes from 0 to a greater value. Communities with a single taxonomic group have a value of zero. A greater diversity index value indicates that there are more taxa in the community. Additionally, Simpson's dominance index was significantly below 1, indicating that no single species dominated the sites (Huston, 1994) [18]. Conversely, the forest is dominated by a small number of species. The main finding is that there is little grazing pressure and a moderate human influence on the typical distribution of tree species, which could lead to a decline in the tree community within the forest ecosystem over the coming decades. The ecosystem's species richness is measured by both the Menhinick's Index and the Margalef's Index.

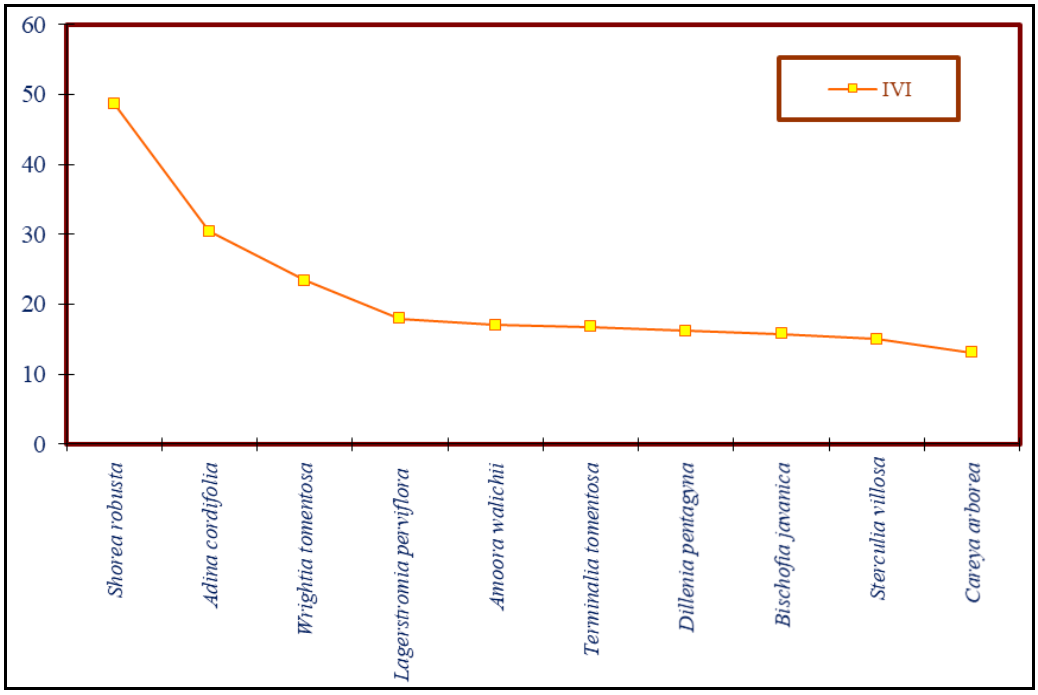

Fig 1: Graph analysis of Top ten IVI

Table 1: Value for the different phytosociological parameters measured for different tree species of Chhatarpur district.

Name of the Plant	Family	A	D	Fr (%)	BA	RD	RF	RBA	IVI
Shorea robusta Gaertn. f.	Dipterocarpaceae	2.81	2.81	100	4825.83	12.50	10.20	25.96	48.66
Adina cordifolia Hook.f.	Rubiaceae	4.21	3.79	90	810.29	16.97	9.17	4.33	30.47
Wrightia tomentosa Roem.& Schult.	Apocynaceae	3.25	2.60	80	676.20	11.60	8.16	3.62	23.38
Lagerstromia perviflora Roxb.	Lythraceae	2.00	1.20	60	1199.73	5.36	6.12	6.46	17.94
Amoora walichii King.	Meliaceae	1.80	1.00	50	1391.95	4.47	5.11	7.48	17.06
Terminalia tomentosa Roth.	Combretaceae	1.75	1.40	80	435.62	6.25	8.16	2.34	16.75
Dillenia pentagyna Roxb.	Dilleniaceae	1.71	1.20	70	684.91	5.35	7.14	3.68	16.17
Bischofia javanica Blume	Phyllanthaceae	2.66	1.60	60	473.49	7.14	6.12	2.54	15.8
Sterculia villosa Roxb.	Sterculiaceae	2.00	0.20	10	2436.30	0.89	1.02	13.11	15.02
Careya arborea Roxb.	Lecythidaceae	2.16	1.30	60	210.32	5.8	6.12	1.13	13.05
Terminalia bellerica (Gaetn.) Roxb.	Combretaceae	2.20	1.10	50	554.26	4.91	5.1	2.98	12.99
Toona ciliata Roem.	Meliaceae	1.00	0.20	20	1819.78	0.89	2.04	9.78	12.71
Terminalia alata Heyne ex Roth.	Combretaceae	2.25	0.90	40	595.39	4.01	4.08	3.2	11.29
Aegle marmelos Correa	Rutaceae	1.74	0.71	40	718.55	3.12	4.08	3.86	11.06
Madhuca indica Gmel.	Sapotaceae	1.50	0.03	30	678.76	1.33	3.06	3.65	8.04
Butea monosperma (Lamk.) Taub	Fabaceae	1.50	0.60	40	171.14	2.67	4.08	0.91	7.66
Tectona grandis Linn.	Verbenaceae	1.25	0.50	40	170.15	2.23	4.08	0.91	7.22
Anthocephalus cadamba Miq.	Rubiaceae	1.50	0.30	30	247.72	1.33	3.06	1.33	5.72
Lagerstromia speciosa (L.) Pers.	Lythraceae	2.00	0.20	10	33.16	0.89	1.02	0.17	2.08
Albizia procera (Roxb.) Benth. gum	Fabaceae	1.00	0.10	10	64.66	0.44	1.02	0.35	1.81

Table 2: Value for the different community index parameters, measured for different tree species of Chhatarpur district

Name of the Plant	Shannon Index (H)	Species dominance	Evenness	A/F index
Shorea robusta Gaertn. f.	0.2947	0.2948	0.2228	0.028
Adina cordifolia Hook.f.	0.2329	0.0101	0.1760	0.045
Wrightia tomentosa Roem. & Schult.	0.1987	0.0062	0.1989	0.043
Lagerstromia perviflora Roxb.	0.1681	0.0035	0.1272	0.033
Amoora walichii King.	0.1629	0.0031	0.1233	0.035
Terminalia tomentosa Roth.	0.1595	0.0031	0.1206	0.021
Dillenia pentagyna Roxb.	0.15823	0.0026	0.1194	0.021
Bischofia javanica Blume	0.1551	0.0026	0.1171	0.044
Sterculia villosa Roxb.	0.1497	0.0024	0.1132	0.200
Careya arborea Roxb.	0.1363	0.0018	0.1031	0.035
Terminalia bellerica (Gaetn.) Roxb.	0.1359	0.0018	0.1026	0.044
Toona ciliata Roem.	0.1331	0.0017	0.1006	0.050
Terminalia alata Heyne ex Roth.	0.1233	0.0014	0.0932	0.057
Aegle marmelos Correa	0.1195	0.0012	0.0903	0.041
Madhuca indica Gmel.	0.0969	0.0007	0.0730	0.050
Butea monosperma (Lamk.) Taub	0.0942	0.0005	0.0714	0.038
Tectona grandis Linn.	0.0894	0.0005	0.0623	0.031
Anthocephalus cadamba Miq.	0.0754	0.0004	0.0573	0.050
Lagerstromia speciosa (L.) Pers.	0.0343	0.00002	0.0259	0.201
Albizia procera (Roxb.) Benth. gum	0.0307	0.00003	0.0230	0.101

Table 3: Value for different community indices for Chhatarpur district

Community indices	Value
Species diversity (H')	2.832
Species dominance (Cd)	0.3382
Equitability of evenness (e)	2.125
Species richness (d)	3.697
Menhinick's index (D_{mm})	0.0935
Equitability Index	0.921
Berger-Parker Dominance Index	0.173

Conclusion

The phytosociological characteristics of the tree vegetation in the Chhatarpur district of Madhya Pradesh, India, are reflected in the study. The range of tree species, their distribution, and their dominance status are all implied by this study. In the Chhatarpur district, mosses, ferns, native grasses, sedges, climbers, shrubs, and trees make up the vegetation. It has a diverse fauna as well. In this case, the tree species' diversity index was 2.832, whereas the dominance index (Cd) was 0.3382. The woodland patch is rich in tree vegetation and tree diversity, as indicated by both indices. The current study also produced some intriguing phytosociological results on the forest's tree vegetation. The findings have illustrated that most abundant plant species i.e., *Adina cordifolia* Hook.f. Lack proper growth (growth of basal area), where as species having highest basal growth i.e., *Adina cordifolia* Hook.f. are comparatively less abundant. In addition another two species, *Wrightia tomentosa* Roem. and Schult and *Bischofia javanica* Blume are also abundant. Another noticeable fact is that IVI of *Wrightia tomentosa* Roem. and Schult is more than the IVI of *Shorea robusta* Gaertn. f. Thus more than one species are dominant in this forest. This finding supports theories of co-dominant succession.

As a result, the study suggests that more research be done to examine the succession pattern, including the loss of tree species, more precisely the effects of particular species in particular ecosystems, such as forests, grasslands, and bushlands, and the capacity of the previously disturbed species in this area to regenerate.

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