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Ecological studies of tree vegetation of Semariya forest range of Rewa district (M.P.) India

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Abstract
Ecological studies aim to assess the biodiversity levels within vegetation, offering insights crucial for effective conservation management. Designing and implementing such strategies demands an in-depth understanding of the ecosystem's biological composition, diversity among tree species, and the predominant plant communities. Addressing these requirements, research was conducted in the Semariya forest range of Rewa District, Madhya Pradesh, India. The study focused on analyzing the structure of arboreal groups and measuring the biodiversity present among the tree species. It emphasized the ecological characteristics and variety of tree vegetation within the forest. Findings revealed a total of 20 tree species distributed across 14 families. Moreover, the research examined key community metrics such as the importance value index, density, frequency, and basal area, alongside other relevant indices.

Keywords: Biodiversity, Quadrate, Phytosociology, Dominance, Co-ordinance, Basal area, IVI

Introduction
Forests are among the most crucial resources in ecosystems, sustaining life on a global scale. Thanks to their phenomenal richness and diversity, forest ecosystems stand out as the most flourishing terrestrial systems. Their exceptionally high levels of biodiversity set them apart from all other terrestrial habitats. However, the ongoing decline of global biodiversity highlights an urgent need for effective conservation planning. In India, like in many other regions, scientific research on biodiversity outside protected areas and reserve forests remains sparse. Biodiversity assessments have predominantly focused on a limited range of taxonomic groups and ecological types, leaving many unique ecosystems unstudied. The Semariya forest range in Rewa District is no exception to this neglect. Detailed insights into the patterns of plant group biodiversity in this region are scarce, with little preliminary data available. This lack of research hinders effective evaluation of the ecological importance of species, their current status, and potential threats to their long-term survival (Lohbeck *et al*., 2014) [1]. Consequently, several species face the risk of local extinction. Additionally, the degradation or loss of forest ecosystems causes ripple effects, negatively impacting other ecological systems (Palit *et al.*, 2012) [2]. This study is aimed at assessing the biodiversity status of tree species within the Semariya forest range in Rewa District, contributing valuable information to conservation efforts in this vital ecosystem.
A series of quantitative and phytosociological markers were assessed to evaluate the state. This detailed examination of plant distribution patterns offers valuable insights into the interactions between plants and their environment. Furthermore, it serves as tangible evidence of the current state of biodiversity, as highlighted by Chase and Leibold (2003) [3].

Materials and Methods
Description of Study Site: The Ecological studies of tree vegetation of Semariya forest range of Rewa District, Madhya Pradesh state of India during the year 2024. Semariya forest range of Rewa district located at 24°47′42″ North and 81°9′8″ East. Around Semariya, there are some forest areas, like the "Open Mix Jungle, " which is very close, just about 1.9 kilometers to the northeast, and the Ranipur wildlife sanctuary, which is about 3.7 kilometers away. These forests show that there are wooded places nearby where animals and trees live, making Semaria a town surrounded by nature.

Methodology: For phytosociological studies in Semariya forest range of Rewa 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:

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

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

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

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.

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

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

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

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.

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

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

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 species and 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 and 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/ 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 (1970) [17]
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
The study highlights that *Haldina cordifolia* (Roxb.) Ridsd demonstrated the highest tree density (3.79), while *Buchanania lanzan* Spreng. exhibited the maximum Importance Value Index (IVI) at 48.66. Additionally, the density recorded for *Buchanania lanzan* Spreng. was 2.81, with an IVI of 30.47 reported for *Haldina cordifolia* (Roxb.) Ridsd. Several other tree species showed notable IVI values, including *Emblica officinalis* Gaertn. (23.38), *Lagerstroemia parviflora* Roxb. (17.94), and *Butea monosperma* Taub. (17.06).

Among the species studied, *Buchanania lanzan* Spreng. registered the highest relative basal growth at 25.96. Conversely, other tree species of this forest demonstrated relatively lower basal growth figures, with *Haldina cordifolia* (Roxb.) Ridsd at 4.33, *Emblica officinalis* Gaertn. at 3.62, and *Butea monosperma* Taub. at 0.91. *Sterculia urens* Roxb. stood out with a commendable relative basal area value of 13.11.

On the other hand, certain species displayed very low IVI and relative basal area indices. *Albizia procera* was found to have the minimum IVI value of 1.81 and a relative basal area of just 0.35, marking it as among the least significant in this survey.

Eight diversity indices were applied to assess the overall biodiversity status of the Semariya forest range in Rewa District. The Shannon-Weiner index (1963) [12] represents entropy and serves as a measure of diversity, accounting for both the number of taxa and the abundance of individual species. This index ranges from 0 upward, where a community consisting of a single taxonomic group scores zero. Higher diversity index values reflect a richer presence of taxa within the community. Furthermore, Simpson's dominance index was notably below 1, implying that no single species dominated the surveyed sites (Huston, 1994) [18]. However, the forest ecosystem is still characterized by dominance from a limited number of species.

The study highlights minimal grazing pressure alongside moderate human activity influences, which, over time, might result in a decline in tree community diversity within the forest ecosystem. Species richness within the ecosystem was evaluated using Menhinick's Index and Margalef's Index, providing further insight into the distribution and abundance of various species.

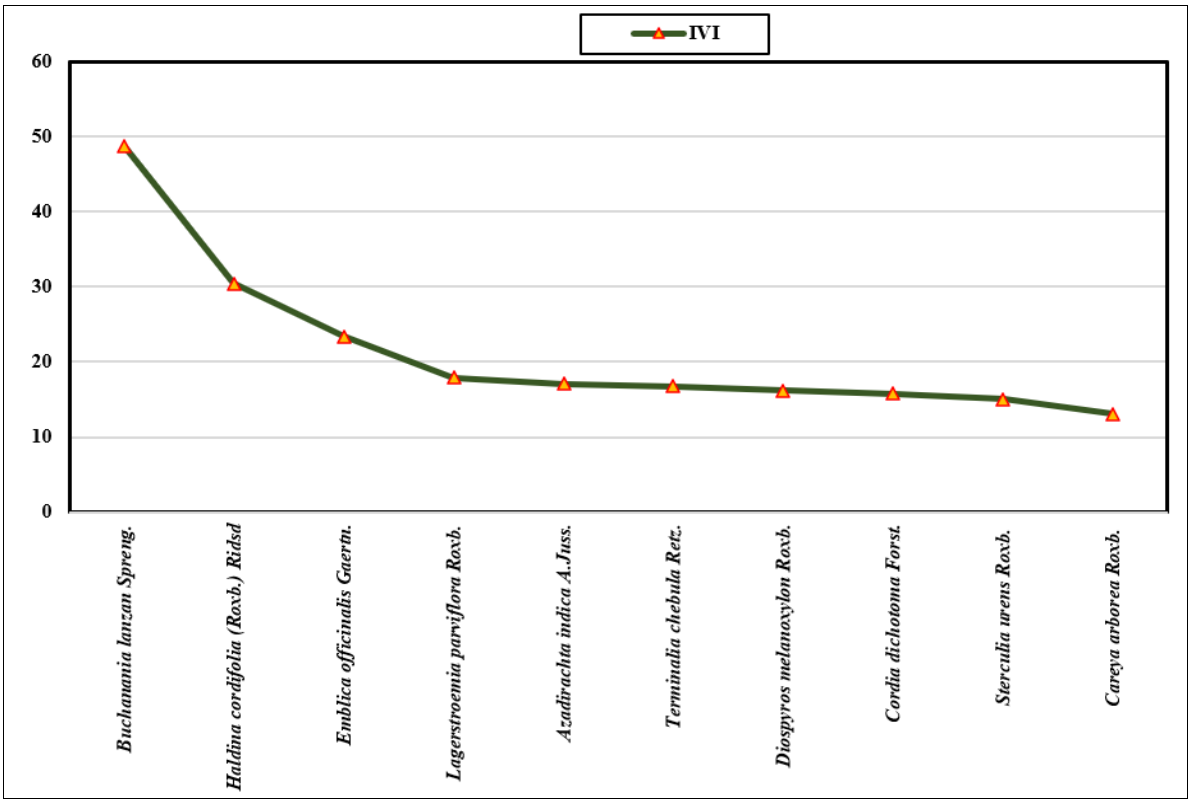

Fig 1: Graph analysis of top ten IVI of tree species in Semariya forest.

Table 1: Value for the different phytosociological parameters measured for different tree species of Semariya forest range of Rewa District.

Name of the Plant	Family	A	D	Fr (%)	BA	RD	RF	RBA	IVI
Aegle marmelos Correa	Rutaceae	1.74	0.71	40	718.55	3.12	4.08	3.86	11.06
Albizia procera (Roxb.) Benth.	Fabaceae	1.00	0.10	10	64.66	0.44	1.02	0.35	1.81
Anthocephalus chinensis (Lam.) A.Rich ex Walp.	Rubiaceae	1.50	0.30	30	247.72	1.33	3.06	1.33	5.72
Azadirachta indica A.Juss.	Meliaceae	1.80	1.00	50	1391.95	4.47	5.11	7.48	17.06
Buchanania lanzan Spreng.	Anacardiaceae	2.81	2.81	100	4825.83	12.50	10.20	25.96	48.66
Butea monosperma (Lamk.) Taub	Fabaceae	1.50	0.60	40	171.14	2.67	4.08	0.91	7.66
Careya arborea Roxb.	Lecythidaceae	2.16	1.30	60	210.32	5.8	6.12	1.13	13.05
Chloroxylon swietenia DC.	Rutaceae	2.00	0.20	10	33.16	0.89	1.02	0.17	2.08
Cordia dichotoma Forst.	Boraginaceae	2.66	1.60	60	473.49	7.14	6.12	2.54	15.8
Diospyros melanoxylon Roxb.	Ebenaceae	1.71	1.20	70	684.91	5.35	7.14	3.68	16.17
Emblica officinalis Gaertn.	Euphorbiaceae	3.25	2.60	80	676.20	11.60	8.16	3.62	23.38
Gmelina arborea Roxb.	Verbenaceae	1.00	0.20	20	1819.78	0.89	2.04	9.78	12.71
Haldina cordifolia (Roxb.) Ridsd	Rubiaceae	4.21	3.79	90	810.29	16.97	9.17	4.33	30.47
Lagerstroemia parviflora Roxb.	Lythraceae	2.00	1.20	60	1199.73	5.36	6.12	6.46	17.94
Madhuca longifolia (J. Koenig) Macbr.	Sapotaceae	1.50	0.03	30	678.76	1.33	3.06	3.65	8.04
Sterculia urens Roxb.	Sterculiaceae	2.00	0.20	10	2436.30	0.89	1.02	13.11	15.02
Tectona grandis L.f.	Verbenaceae	1.25	0.50	40	170.15	2.23	4.08	0.91	7.22
Terminalia alata Heyne ex Roth.	Combretaceae	2.25	0.90	40	595.39	4.01	4.08	3.2	11.29
Terminalia bellerica (Gaetn.) Roxb.	Combretaceae	2.20	1.10	50	554.26	4.91	5.1	2.98	12.99
Terminalia chebula Retz.	Combretaceae	1.75	1.40	80	435.62	6.25	8.16	2.34	16.75

Table 2: Value for the different community index parameters, measured for different tree species of Semariya forest range of Rewa District.

Name of the Plant	Shannon Index (H)	Species dominance	Evenness	A/F index
Aegle marmelos Correa	0.1195	0.0012	0.0903	0.041
Albizia procera (Roxb.) Benth.	0.0307	0.00003	0.0230	0.101
Anthocephalus chinensis (Lam.) A.Rich ex Walp.	0.0754	0.0004	0.0573	0.050
Azadirachta indica A.Juss.	0.1629	0.0031	0.1233	0.035
Buchanania lanzan Spreng.	0.2947	0.2948	0.2228	0.028
Butea monosperma (Lamk.) Taub	0.0942	0.0005	0.0714	0.038
Careya arborea Roxb.	0.1363	0.0018	0.1031	0.035
Chloroxylon swietenia DC.	0.0343	0.00002	0.0259	0.201
Cordia dichotoma Forst.	0.1551	0.0026	0.1171	0.044
Diospyros melanoxylon Roxb.	0.15823	0.0026	0.1194	0.021
Emblica officinalis Gaertn.	0.1987	0.0062	0.1989	0.043
Gmelina arborea Roxb.	0.1331	0.0017	0.1006	0.050
Haldina cordifolia (Roxb.) Ridsd	0.2329	0.0101	0.1760	0.045
Lagerstroemia parviflora Roxb.	0.1681	0.0035	0.1272	0.033
Madhuca longifolia (J. Koenig) Macbr.	0.0969	0.0007	0.0730	0.050
Sterculia urens Roxb.	0.1497	0.0024	0.1132	0.200
Tectona grandis L.f.	0.0894	0.0005	0.0623	0.031
Terminalia alata Heyne ex Roth.	0.1233	0.0014	0.0932	0.057
Terminalia bellerica (Gaetn.) Roxb.	0.1359	0.0018	0.1026	0.044
Terminalia chebula Retz.	0.1595	0.0031	0.1206	0.021

Table 3: Value for different community indices for Semariya forest range of Rewa District

Community indices	Value
Species diversity (H')	2.833
Species dominance (Cd)	0.339
Equitability of evenness (e)	2.126
Species richness (d)	3.698
Menhinick's index (D_{mm})	0.0936
Equitability Index	0.922
Berger-Parker Dominance Index	0.174

Conclusion

The study sheds light on the phytosociological characteristics of tree vegetation within the Semariya forest range, located in Rewa District, Madhya Pradesh, India. It highlights the diversity, distribution, and dominance of tree species in this region. Vegetation in the Semariya forest range comprises a rich composition involving mosses, ferns, native grasses, sedges, climbers, shrubs, and trees, alongside a varied fauna. According to the study, the tree species diversity index was recorded at 2.833, while the dominance index (Cd) stood at 0.339, reflecting a significant richness in tree vegetation and a noteworthy level of diversity within the woodland patch. Intriguing findings emerged regarding the growth patterns and abundance of tree species. *Haldina cordifolia* (Roxb.) Ridsd., identified as the most abundant species, exhibited insufficient basal growth, whereas trees with the highest basal area growth belonging to the same species were comparatively less plentiful. Furthermore, *Emblica officinalis* Gaertn. & Schult and Cordia dichotoma Forst. were found to be among the more abundant tree species within the ecosystem. A notable observation is the higher IVI (Importance Value Index) of *Emblica officinalis* Gaertn. & Schult compared to *Buchanania lanzan* Spreng., suggesting the dominance of multiple species in the forest, rather than a single dominant species. This aligns with theories of co-dominant succession.

Based on these findings, the study emphasizes the need for further research to investigate succession patterns more comprehensively. This includes studying tree species loss over time, assessing the ecological roles played by specific species within various systems like forests, grasslands, and bushlands, and exploring the ability of previously disturbed species in this region to regenerate effectively.

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