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Ecological studies of tree vegetation of Jiyavan forest of Singrauli District (M.P.) India

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Abstract
Ecological studies are the measure of biodiversity status of any vegetation. Knowledge of ecological composition, diversity of tree species and dominant communities of the ecosystem is the basis of planning and implementation of biodiversity conservation management. To fulfil this requirement the study was carried out at Jiyavan forest of Singrauli District, Madhya Pradesh, India. The study provided the composition of tree communities and the status of biodiversity of these trees. The article mainly focused on the diversity and ecology of the tree vegetation of the forest range. A total of 21 established tree species belonging to 17 families were recorded. The present studies were made to evaluate the Frequency, Density, Basal Area and Importance Value Index along with some community indices.

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

Introduction
Forests are the greatest resources among the ecosystems that support life throughout the globe. The forest ecosystems are the richest terrestrial ecosystems which are characterized by the high species diversity and species richness. These ecosystems are distinguished from all other terrestrial ecosystems by a very high level of biodiversity. Now a days biodiversity is declining seriously on a global scale, which also reveals the importance of conservation planning. Except protected areas and reserve forests, scientific studies on biodiversity of special habitats in India are meager like the other areas of the world. Furthermore, extensive surveys of biodiversity have been conducted only for a few taxonomic groups and ecosystem types. The situation is the same in Jiyavan range of Singrauli district. Only preliminary information on the biodiversity patterns of plant groups are available in this forest range. Such a lack of study significantly hinders the assessment of the value of existing species, their current status and threats which might facilitate their long term conservation (Lohbeck *et al.* 2014) [1]. As a result, a considerable number of species may currently be under threat of local extinction. From the ecological point of view, eliminating or decreasing forest ecosystem has severe negative effect on other ecosystems (Palit *et al.* 2012) [2]. The present investigation has been conducted to assess the status of biodiversity of tree species in Jiyavan Forest Range.
For the evaluation of the status several phytosociological and quantitative parameters were determined. Such quantitative description of plant patterns provides a clear view to look at the interaction between the plants as well as between the plant and environment. It can also provide a clearcut evidence about the status of biodiversity (Chase and Leibold, 2003) [3].

Materials and Methods
Description of Study Site
Jiyawan is a forest in Deosar Tehsil in Singrauli District of Madhya Pradesh State, India. It belongs to Rewa Division. It is located 46 km. towards west from District head quarters Singrauli.

Methodology
For phytosociological studies in Jiyavan forest range, 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 overall 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 overall 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

All the phytosociological data collected from different sources were tabulated and analysed individually. The data collected were used to compute some community indices like.

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 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 (3.80) 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 30.48. It is also noted that some other tree species had a good IVI value. These include *Wrightia tomentosa* Roem and Schult. (23.39), *Lagerstromia perviflora* Roxb. (17.92) and *Butea monosperma* Taub. (17.04). However maximum relative basal growth is recorded for *Shorea robusta* Gaertn. f. and it is 4.34. Relative basal growth is not so good in other tree species of this forest including *Adina cordifolia* Hook.f. (4.34), *Wrightia tomentosa* Roem. and Schult (3.63) and *Butea monosperma* Taub. (0.92). 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.

To assess the overall status of biodiversity in Jiyavan Forest Range, eight diversity indices were used. Shannon and Weiner (1963) [12] index represents entropy. It is a diversity index that consider the number of individual species as well as the number of taxa. It ranges from zero to higher value. The communities with only single taxa has the value of zero. Increase of the value of diversity index reveal higher number of taxa in the community. Simpson's dominance Index was also found much less than 1, which showed that the sites were not dominated by single species (Huston, 1994) [18]. On the contrary a few species dominate the forest. The primary conclusion is that there is low grazing pressure and moderate human impact on normal distribution of tree species which may cause reduction in tree community in next few decades in the forest ecosystem. Both the Menhinick's Index and Margalef's Index measure richness of species in the ecosystem.

Table 1: Value for the different phytosociological parameters measured for different tree species of Jiyavan forest range

Name of the Plant	Family	A	D	Fr (%)	BA	RD	RF	RBA	IVI
Shorea robusta Gaertn. f.	Dipterocarpaceae	2.81	2.80	100	4825.83	12.5	10.2	25.96	48.66
Adina cordifolia Hook.f.	Rubiaceae	4.22	3.80	90	810.29	16.96	9.18	4.34	30.48
Wrightia tomentosa Roem.& Schult.	Apocynaceae	3.25	2.60	80	676.20	11.6	8.16	3.63	23.39
Lagerstromia perviflora Roxb.	Lythraceae	2.00	1.20	60	1199.73	5.35	6.12	6.45	17.92
Amoora walichii King.	Meliaceae	1.80	1.00	50	1391.95	4.46	5.1	7.48	17.04
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	1.75	0.70	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	0.92	7.67
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
Syzygium cumini (Linn.) Skeels	Myrtaceae	1.33	0.40	10	392.53	1.78	1.02	2.11	4.91
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 Jiyavan forest range

Sl. No.	Name of the Plant	Shannon Index (H)	Species dominance	Evenness	A/F index
1	*Shorea robusta* Gaertn. f.	0.2947	0.2946	0.2229	0.027
2	*Adina cordifolia* Hook.f.	0.2332	0.0115	0.1764	0.046
3	*Wrightia tomentosa* Roem.& Schult.	0.1989	0.0060	0.1989	0.040
4	*Lagerstromia perviflora* Roxb.	0.1683	0.0035	0.1272	0.034
5	*Amoora walichii* King.	0.1630	0.0032	0.1232	0.037
6	*Terminalia tomentosa* Roth.	0.1596	0.0030	0.1206	0.021
7	*Dillenia pentagyna* Roxb.	0.1583	0.0029	0.1197	0.024
8	*Bischofia javanica* Blume	0.1550	0.0027	0.1172	0.044
9	*Sterculia villosa* Roxb.	0.1497	0.0025	0.1132	0.200
10	*Careya arborea* Roxb.	0.1363	0.0019	0.1031	0.036
11	*Terminalia bellerica* (Gaetn.) Roxb.	0.1359	0.0018	0.1028	0.044
12	*Toona ciliata* Roem.	0.1331	0.0017	0.1006	0.050
13	*Terminalia alata* Heyne ex Roth.	0.1233	0.0014	0.0932	0.056
14	*Aegle marmelos* Correa	0.1196	0.0012	0.0904	0.043
15	*Madhuca indica* Gmel.	0.0968	0.0007	0.0731	0.050
16	*Butea monosperma* (Lamk.) Taub	0.0942	0.0006	0.0713	0.037
17	*Tectona grandis* Linn.	0.0895	0.0005	0.0624	0.031
18	*Anthocephalus cadamba* Miq.	0.0756	0.0003	0.0571	0.050
19	*Syzygium cumini* (Linn.) Skeels	0.0670	0.0002	0.0506	0.133
20	*Lagerstromia speciosa* (L.) Pers.	0.0343	0.00004	0.0259	0.200
21	*Albizia procera* (Roxb.) Benth. gum	0.0305	0.00003	0.0231	0.101

Table 3: Value for different community indices for Jiyavan Forest Range

Community indices	Value
Species diversity (H')	2.8256
Species dominance (Cd)	0.3383
Equitability of evenness (e)	2.1274
Species richness (d)	3.6832
Menhinick's index (D_{mm})	0.0947
Equitability Index	0.923
Berger-Parker Dominance Index	0.1771

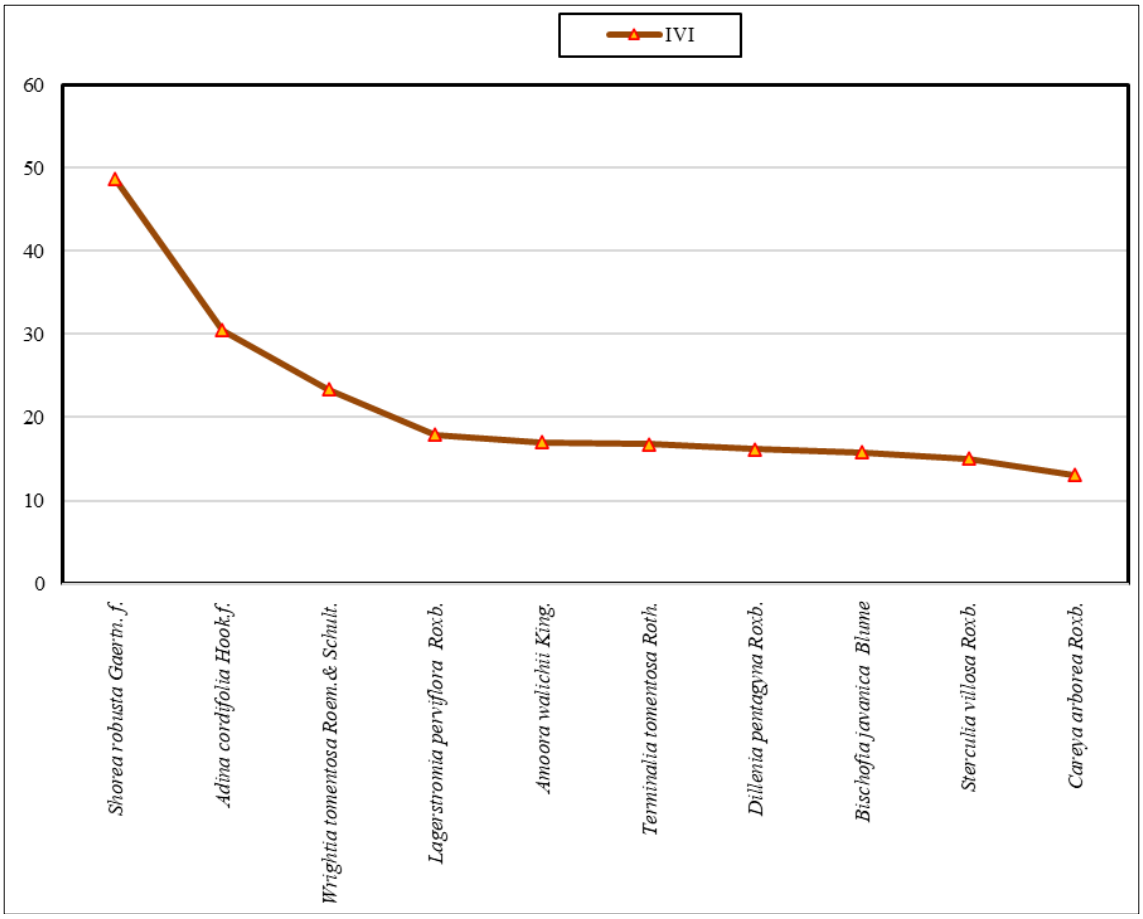

Fig 1: Graph analysis of top ten IVI of tree species in Jiyavan forest.

Conclusion

The paper reflects the phytosociological characters of tree vegetation of Jiyavan forest range in Singrauli forest division, Madhya Pradesh, India. This study implies the variety of tree species, their distribution and the status of dominance. The vegetation of the Jiyavan forest range is composed of mosses, ferns, native grasses, sedges, climbers, shrubs and trees. It is also rich in faunal diversity. Here Diversity index of tree species was found as 2.8256, whereas dominance index (Cd) was observed as 0.3383. Both the indices reflect that the forest patch is rich in tree vegetation and tree diversity. The present investigation also revealed some interesting phytosociological findings about the tree vegetation of the forest. The findings have illustrated that most abundant plant species i.e., *Adina cordifolia* Hook. f. Lack proper growth (growth of basal area), whereas 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.

Therefore, the study recommends further research to be carried out to study succession pattern including tree species loss more specifically (*i.e.* effects of specific species in specific ecosystems such as in forest, grassland and bush-land ecosystems) regeneration ability of the previously disturbed species in this forest range.

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