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Quantitative analysis, distributional pattern and species diversity of woody plant species of Lamberi Forest Range, Rajouri, J&K, India

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Abstract: Quantitative analysis, distributional pattern and species diversity of woody plant species of Lamberi Range of Rajouri Forest division, J&K, has been carried out by laying 50 quadrats (10m X 10m size) for trees and 100 quadrats (5m X 5m size) for shrubs. Various phytosociological parameters like frequency, density, abundance, importance value index IVI and diversity indices for trees and shrubs has been used to reveal the plant community structure of the area. The abundance to frequency ratio (A/F) for different species was determined to assess the distribution pattern of the species (regular <0.025, random 0.025-0.05 and contagious >0.05) which indicated the contagious distribution for all the species. Survey of the area revealed presence of 63 woody plant species from the study area comprising of 43 trees and 20 shrubs. *Pinus roxburghii* (IVI 49.7, Abundance 81.1) and *Carissa opaca* (IVI 81.12 abundance 7.05) have been recorded as the dominant tree and shrub, respectively, of the area. The computation of diversity indices showed that species richness and evenness i.e Shannon- Weiner's, Margalef's and Menhinick's remained high for trees and low for shrubs. Simpson's index of dominance was also high for trees. Species which needs priorities for conservation and protection and also required to be monitored have also been highlighted.

Keywords: Distributional pattern, Lamberi forest range, Phytosociology, Species diversity, Woody vegetation

INTRODUCTION

The prime objective of the quantitative analysis of vegetation, also known as phytosociology, is to describe the vegetation, explain or predict its pattern and classify it in a meaningful way (Ilorkar and Khatri, 2003). It indicates species diversity which determines the distribution of individuals among the species in a particular habitat. The species diversity and distribution pattern are useful for the evaluation of ecological significance of an ecosystems (Ardakani, 2004; Reddy and Ugle, 2008). The structure and composition, most significant ecological attributes of an ecosystem, exhibit variations in response to environmental as well as anthropogenic variables (Timilsina *et al.,* 2007; Gairola *et al*., 2008; Shaheen *et al.,* 2012). Various diversity indices, used as indicators of the degree of complexity of the communities, provide information on the homeostatic capacity of the system to unforeseen environmental changes (Magurran, 1988).

Vegetation of Himalaya is diverse and distributed over a wide range of climatic and topographical variation (Dhaulkhandi *et al.,* 2008). Several workers have studied the phytosociological parameters and population structure of forests in Himalayan subtropical regions (Ahmed *et al*., 2006; Kharkwal, 2009; Rawat and Chandhok, 2009; Kharkwal and Rawat, 2010; Gurarni *et al.,*2010; Gairola *et al.*,2011; Shaheen *et al*.,2011). In Jammu region of J & K state, studies on phytosociological investigation, phytodiversity assessment and distribution pattern has also been carried out by the workers like Kour (2001) in Trikuta hills; Sudan (2007) in Mahamaya catchment; Sharma *et al.,* (2008) in Birhun watershed; Dangwal *et al.* (2012) in Nowshera and Sharma and Raina (2013) in Jammu, however the work on this aspect in the Lamberi Forest Range of district Rajouri has not been done so far. Therefore, the present work has been carried out to document the species diversity and dominance in Lamberi Forest Range which falls under inner Shiwaliks region in Nowshera Forest Division of district Rajouri, J&K, India.

MATERIALS AND METHODS

Vegetation analysis: Lamberi Forest Range falls under inner Shiwaliks region in Nowshera Forest Division ($33^0 06'$ N to $33^0 13'$ N and $74^0 08'$ E to $74^0 18'$ E) of district Rajouri, J&K, India. It covers an altitudinal range of 600 m to 1200 m above sea level .s.l and falls mostly in sub-tropical zone with an average maximum and minimum temperature of 37.4^0 C to 7.42^0 C, respectively. Average annual rainfall is 500 mm, most of which occurs during monsoon season.

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Thorough field visits have been conducted from May 2011 to June 2012 to survey all the possible habitats for recording the data. For the purpose of identification of the plants, various local, regional and National flora has been used besides consulting taxonomic experts of the region.. Data on Phytosociological attributes of plant species has been collected by randomly laying 50 quadrats of 10m x 10m size for trees and 100 quadrats of 5m x 5m size for shrubs in forest area.

Data analysis: The recorded data was quantitatively analysed for density, frequency and abundance following Curtis and McIntosh (1950). In order to have a overall picture of ecological importance of species with respect to the community structure, the percentage values of the relative frequency, relative density and relative dominance have been determined as Phillips (1959) which have been added together to get the Importance Value Index(I.V.I) of individual species (Curtis, 1959). In each quadrat, all plants having cbh ≥ 30 cm were treated as trees and individually measured at breast height, *i.e*. 1.37 m from the ground.

The basal area was calculated by using following formula.

$$\frac{(Cbh)^2}{(4\pi)} \quad \ldots (i)$$

Where, cbh= circumference at breast height(meters)

The ratio of abundance to frequency (A/F) for different species was determined to assess the distribution pattern (Curtis and Cotton, 1956). Species diversity and concentration of dominance was computed by using Shannon-Weiner index (Shannon and Weiner, 1949) and Simpson index (Simpson,1949), respectively. Species richness was calculated by using Menhinick's Index (Menhinick, 1964) and Margalef's Index (Margalef,1968).

RESULTS AND DISCUSSION

The perusal of tables 1 and 2 depicting the phytosociological analysis of trees and shrubs revealed the presence of 43 trees and 20 shrub species in the area belonging to 41 families and 52 genera. However, the studies carried out in the nearby regions by Dangwal *et al.*(2012) and Ahmed and Sharma (2014) have reported 41 woody plants (29 trees and 12 shrubs) and 72 woody plants (46 trees and 26 shrubs), respectively. This variation in number of species may depend upon several factor which include the local conditions with respect to micro-climate, edaphic factors, topography, sampling area, latitude/longitude, altitude and anthropogenic disturbances.

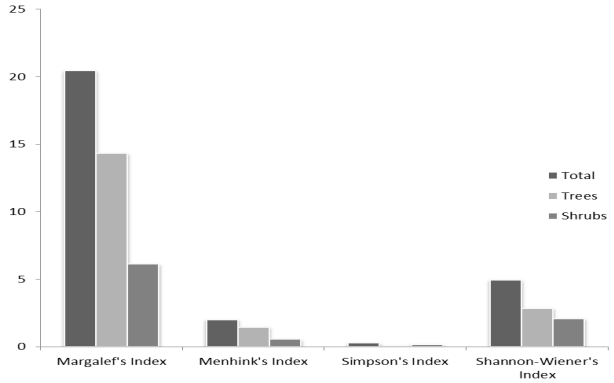

Fig. 1. *Diversity indices for Trees and Shrubs in Lamberi forest range, Rajouri, J&K.*

Phytosociological analysis: The phytosociological analysis carried out in the study revealed that Importance value indices (IVI) of the tree species ranged from 49.75 to 0.58 with *Pinus roxburghii* being the most dominant tree species while for shrubs it ranges between 18.36 to 3.014 with *Carrisa opaca* being the most dominant shrub species. (Table 1). The IVI, an aggregate index that summarises the density, abundance and distribution of a species, measures the overall importance of a species and gives an indication of the ecological success of a species in a particular area (Muthuramkumar and Parthasarathy, 2000). Thus IVI of a species is a function of its abundance (the number of plants within the quadrats), its dominance (influence on the other species through its shading, competition, or aggressiveness) and its frequency (contribution to the community through its distribution) (Okiror *et al*., 2012). *Pinus roxburghii* has also been reported as the dominated tree species in the Rajouri district and other adjoining areas with similar conditions (Dangwal *et al*., 2012 ; Nizami *et al.,* 2009; Shaheen *et al.,* 2011; Muhammad *et al.,* 2012 and Kumar and Sharma, 2014) while *Carrisa opaca* has been reported as most dominant (Shrub) species by Dangwal *et al*., (2012) and Sharma and Kant (2014) in block Nowshera of district Rajouri and Kandi Shivaliks of Jammu, respectively. Almost similar trend has been reported by Sharma (2003) and Sudan (2007) for Jammu district and Mahamaya catchment, respectively.

It has also been observed that species present in and around the present study area viz. *Ficus, Aegle, Psidium, Cordia, Syzygium, Zizyphus, Morus* etc. and serve as source of food for the wild animals are less dominant as is reflected by their IVI values. These species are required to be prioritized for conservation and protection. Also the species which at present dominate the Chir forest viz. *Pinus, Accacia, Mallotus, Dalbergia, Carissa, Justicia, Gymnosporia, Dodonaea* etc.needs constant monitoring so as to conserve the structure and composition of the area.

Distribution pattern: Abundance to frequency ratio (A/F) has been calculated to assess the distribution pattern of species and depending upon the ratios, distribution may be regular (<0.025), random (0.025-0.05) and contagious (>0.05). In natural conditions, contagious distribution is most common type of distribution due to significant variation in environmental conditions (Odum, 1971). Studies conducted by several workers have also reported that majority of species

Table 1. Phytosociological analysis of Tree species of Lamberi Forest Range, Rajouri, J&K

S.N.	Species	BA (m^2/ha)	F (%)	D (tree/ha)	A	A/F	IVI (%)
1.	*Pinus roxburghii* Sarg.	20.12	18	6.76	18.77	1.04	49.75
2.	*Acacia modesta* (Wall.) P.J.H. Hurter	12.1	62	7.16	5.77	0.09	49.38
3.	*Mallotus phillipensis* (Lam.) Muell. Arg.	6.24	36	3.36	4.67	0.13	25.32
4.	*Dalbergia sissoo* Roxb.	4.6	44	2.16	2.45	0.05	21.30
5.	*Lannea coromandelica* (Houtt.) Merr.	3.66	26	1.48	2.85	0.12	14.42
6.	*Flacourtia indica* (Burm.f.) Merr	2.4	20	1.16	2.90	0.14	10.61
7.	*Ziziphus maurtiana* Lam.	1.32	24	1.28	2.67	0.11	10.36
8.	*Melia azedarach* Linn.	1.38	20	0.96	1.70	0.5	8.55
9.	*Toona ciliata* M.Roemer.	1.9	16	0.68	1.87	0.08	7.32
10.	*Cassia fistula* Linn.	1.76	12	0.6	2.50	0.12	6.03
11.	*Grewia optiva* J.R Drumm.	1.34	6	0.44	3.0	0.22	5.83
12.	*Bombax ceiba* Linn.	0.98	14	0.6	1.57	0.3	5.53
13.	*Celtis australis* Linn.	1.4	12	0.6	1.57	0.23	5.46
14.	*Bauhinia variegata* Linn.	1.14	10	0.52	22.0	0.18	5.08
15.	*Phoenix sylvestris*(Linn.) Roxb.	1.06	10	0.44	3.0	0.11	5.07
16.	*Phyllanthus emblica* Linn.	1.12	10	0.52	26.0	0.26	5.02
17.	*Morus alba* Linn.	0.94	12	0.44	1.83	0.15	4.96
18.	*Albizia lebbeck* (L.) Benth.	0.8	10	0.52	26.0	0.26	4.60
19.	*Acacia nilotica* (L.) Delie.	0.56	12	0.36	1.5	0.12	4.23
20.	*Acacia catechu / Senegalia catechu* (L.f.) P.J.H. Hurter & Mabb	0.62	10	0.4	2	0.2	4.02
21.	*Ficus bengalensis* L.s	2.32	2	0.04	1	0.5	3.57
22	*Zanthoxylam armatum DC.*	0.3	10	0.32	1.6	0.16	3.37
23	*Morus serrata* Roxb.	0.46	10	0.24	1.2	0.12	3.34
24	*Olea cuspidata* Wall. ex G. Don	0.42	10	0.2	1	0.1	3.17
25	*Pyrus pashia* Buch-Ham. ex D Don.	0.56	6	0.36	3	0.5	3.01
26	*Ficus auriculata* Lour.	1.74	4	0.04	5.5	0.5	2.81
27	*Ficus religiosa* Linn	0.54	2	0.44	1	1.37	2.80
28	*Ficus palmata* Forssk.	0.54	6	0.24	2	0.33	2.63
29	*Ziziphus oxyphylla*	0.32	6	0.2	1.25	0.27	2.23
30	*Ficus racemosa* Roxb.	0.24	6	0.16	1.33	0.22	2.00
31	*Cordia myxa* Linn.	0.48	4	0.16	2	0.5	1.91
32	*Ficus carica* Linn.	0.42	4	0.16	2	0.5	1.83
33	*Ficus hispida* L.f.	0.36	4	0.16	2	0.5	1.75
34	*Populous ciliata* Wall ex Royle.	0.32	4	0.16	2	0.5	1.70
35	*Aegle marmelos* Corr.	0.3	4	0.16	2	0.5	1.67
36	*Azadirachta indica* A.Juss.	0.28	4	0.16	2	0.5	1.65
37	*Lagerstroemia parviflora* Roxb.	0.26	4	0.16	2	0.5	1.62
38	*Eucalyptus tereticornis* Sm.	0.08	4	0.08	2	0.25	1.59
39	*Psidium guajava* Linn.	0.38	4	0.08	1	1	1.15
40	*Mangifera indica* Linn.	0.24	2	0.16	2	0.5	1.14
41	*Sapindus mukorossi* Gaertn.	0.14	2	0.08	2	1	0.82
42	*Syzygium cumini* (L.) Skeels	0.1	2	0.08	2	1	0.77
43	*Prunus persica* (L.)	0.04	2	0.04	1	0.5	0.58
	Total	**76.28**	**490**	**34.32**			**300**

BA= Basal area; F= Frequency; D= Density; A= Abundance; A/F= Abundance to Frequency Ratio; IVI= Importance Value Index.

exhibit contagious pattern of distribution in natural vegetation and negligible species have regular distribution (Sudan, 2007; Chen *et al.,* 2008; Bahuguna *et al.,* 2010; Dangwal *et al.,* 2012; Kour and Sharma, 2014, Gazal, 2015).

In the present study all the species of both trees and shrubs have been found to be contagiously distributed.

Diversity analysis: Species diversity is an index that incorporates the number of species in an area and also their relative abundance. It has been calculated on the basis of total number of individuals of species and total number of species. Typically the value of the index ranges from 1.5 (low species richness and evenness) to 3.5 (high species evenness and richness), though values beyond these limits may also be encountered. Margalef's index (Margalef, 1968) and Menhinick's Index (Menhinick, 1964) were used as a simple measures of species richness. All the indices were calculated for trees and shrubs in the study area and have been represented in Fig.1. The value of Shanon- Weiner index was found to be 3.08 for all species, with trees exhibiting 2.85 and shrubs 2.09. Whereas, the species rich-

Table 2. Phytosociological analysis of Shrubs species of Lamberi Forest Range, Rajouri, J&K

S. N.	Species	BA (m^2/ha)	F (%)	D (shrub/ ha)	A	A/F	IVI (%)
1.	*Carissa opaca* Stapf.	1.92	59	16.64	7.051	0.119	81.12
2.	*Justicia adhatoda* Nees.	0.336	36	12.8	8.89	0.25	45.06
3.	*Ziziphus oxyphylla* Edgew.	1.52	17	2.2	3.235	0.190	29.44
4.	*Gymnosporia royleana* Wall. ex M.A. Lawson.	0.896	21	4.48	5.333	0.254	28.47
5.	*Mimosa rubicaulis* Lamk.	1.512	12	1.32	2.75	0.229	25.41
6.	*Dodonaea viscosa* Jacq.	0.72	16	1.52	2.375	0.15	18.36
7.	*Woodfordia fruticosa* (L.) kurz.	0.092	8	3.64	11.37	1.422	11.79
8.	*Solanum erianthum* D. Don	0.58	5	0.2	1	0.2	9.313
9.	*Parthenium hysterophorus* Linn.	0.064	8	1.76	5.5	0.687	7.734
10.	*Calotropis procera* (Aiton) Dryand	0.076	8	1	3.125	0.390	6.363
11.	*Indigofera pulchella* Roxb	0.0392	7	1.16	4.143	0.592	5.817
12.	*Punica granatum* Linn.	0.292	4	0.28	1.75	0.437	5.692
13.	*Vitex negundo* Linn.	0.192	6	0.36	1.5	0.25	5.564
14.	*Ipomoea carnea* Jacq.	0.024	5	0.76	3.8	0.76	3.972
15.	*Euphorbia royleana* Boiss.	0.14932	3	0.28	2.333	0.78	3.599
16.	*Lantana camara* var. *aculeata* (L.)Moldenke	0.0304	3	0.76	6.333	2.111	3.173
17.	*Ricinus communis* Linn.	0.0852	3	0.36	3	1	3.014
18.	*Colebrookea oppositifolia* Smith	0.0276	3	0.4	3.333	1.111	2.425
19.	*Rosa multiflora* Lindl.	0.0484	3	0.24	2	0.667	2.349
20.	*Nerium indicum* Mill.	0.0116	2	0.16	2	1	1.326
	Total	**8.61**	**229**	**50.32**			**300**

BA= Basal area; F= Frequency; D= Density; A= Abundance; A/F= Abundance to Frequency Ratio; IVI= Important Value Index.

ness values for Margalef's and Menhinick's indices are found in the range between 18.64 and 1.36 for all the species, with trees exhibiting 14.33 and 1.44 and shrubs 6.13 and 0.56, respectively. Simpson's index of diversity for all species comes out to be 0.083 with a value of 0.10 for tree species and 0.19 for shrubs. Fig.1 clearly depicts that values of ShannonWeiner's , Margalef's, Menhinick'sand Simpson's indices were higher for trees and lower for shrubs in this forest. The tree diversity index analyzed for the study area was lower than that reported by the earlier workers like Sharma (2003) in Northern dry mixed deciduous forest of Jammu; Sharma (2008) in Birbhum watershed; Mishra *et al.* (2011) in Simplipal Biosphere reserve; Singh (2002) in Kalakote region of Rajouri and Dangwal *et al.* (2012) in Chirpine forest of Nowshera and higher than the values calculated by Rai (2007) in Mansar –Surinsar Wildlife Sanctuary, Kumar and Raina (2012) in Ratle hydro-electric project, Kishtwar and Ahmed and Sharma (2014) in Ponda watershed, Rajouri, J&K.

Conclusion

The phytosociological studies conducted in the study area revealed the predominance of tree species like *Pinus roxburghii, Acacia modesta, Mallotus philippensis, Dalbergia sissoo* along with under storey species of shrubby vegetation like *Carissa opaca*, *Justicia adhatoda*, *Ziziphus nummularia*. The results of the secondary analysis of data revealed that species diversity exhibited higher values for trees and lower values for shrubs. Based on the present investigations that helped to decide on conservation priorities of both species and habitat, it is suggested that species with lower IVIs be given priority for protection and those with higher IVIs be monitored to maintain diversity. Thus, baseline information generated in the present study will help for the conservation and management of the Lamberi forest range and will also be helpful in taking future research activities for its management.

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