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Vegetational diversity of shrub across different habitat in Garhwal Himalaya

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Abstract

Shrub species richness, shrub density, shrubs diversity, shrub canopy cover and distribution pattern were investigation in low disturbance stands of temperate forest of West Pinder region of Garhwal Himalaya. Four sites were selected viz- stream bank site, dry site, ridge site and moist site. The shrubs density was higher on moist habitat (12847 ind/ha). The maximum species richness was higher on investigated site and minimum on moist habitat. *Arundinaria falcata* was the most dominant species in terms of IVI *(*52.15%) reported on moist site. Total canopy cover percent was maximum on moist site (73.09±2.35%) and least on ridge site (39.07±7.94%). Species diversity was higher on stream bank (3.95) and least on moist habitat (3.53) and concentration of dominance ranged from 0.081 to 0.118.

INTRODUCTION

In the last decade, scientists have turned their attention towards biodiversity with its heterogeneous distribution across the earth [1]. According to [2] the dispersal limitation is an important ecological factor for controlling species distribution pattern and some focusses has been given to local biotic and abiotic ecological interactions to explain the distribution pattern of species. Qualitative descriptions of the Himalaya are given by various researchers [3-5]. Inaccessibility has hindered the quantitative studies at high altitudes [6]. Conservation biologists warn that 25% of all species could become extinct during the next twenty to thirty year, the main cause for the extinction of species is the loss and fragmentation of natural habitats. In the Himalayan region, the chronic form of disturbances are found in which people remove only a small fraction of forest biomass in the form grazing, lopping, surface burning and litter removal at a given time [7].

The present study deals with quantitative analysis of Shrub vegetation on elevations ranging from 1900-2200m in the Garhwal Himalaya.

MATERIAL AND METHODS

The selected sites are located in the western Pindar region of Badrinath Forest Division in Chamoli district of Uttarakhand (30°2'43" N and 30°3'27" N latitude and 79°24'43" and 79°26'46"). The elevation ranged between 1900m to 2200m. The shrubs layer vegetation data was analyzed in thirty quadrats of 5x5 m^2 placed randomly on four different habitats or sites (Stream bank, Dry, Ridge and Moist site). The size and number of samples was determined following [8]. The vegetational data were quantitatively analyzed for density, frequency and abundance [9]. The distribution pattern of different species was studied using the ratio of abundance to frequency [10]. Species diversity index was computed using Shannon-Wiener information index [11] as:

$$H = \sum (\frac{ni}{n}) \log 2 (\frac{ni}{n})$$

Where, ni = total number of individual of a species, n= total number of individual of all species

Concentration of Dominance (CD) was calculated by Simpson's index [12] as:

$$CD = \sum (\frac{ni}{n})^2$$

where, ni and n were the same as for Shannon-Wiener index. Percent crown cover was determined by line transect method [13]. T-test was determined follwing [14].

RESULTS

Stream bank site

A total of 20 shrub species were present at stream bank. The total shrub density recorded at this site was 9213 ind/ha. The highest shrub density was that of *Indigofera dosua (*1553 ind/ha, Table 1) and minimum for *Elsholtzia flava (66 ind/ha.). Berberis asiatica* was the dominant shrub species in terms of IVI (41.49%) followed by *Indigofera dousa* (IVI=30.52%), D*esmodium gangenticum* (IVI=24.06%), *Viburnum coriaceum* (22.67%) and *Eupatorium adenophorum* (18.73%). Other shrub species had IVI below 15.97%. Total canopy cover percent was 50.47±4.06%. The maximum canopy cover percent was recorded for *Berberis asiatica* (6.97±0.92%) and minimum for *Elsholtzia flava* (0.37±0.00%).

Dry site

A total of 21 shrub species were recorded on dry site. The total shrub density recorded at this site was 7166 ind/ha. The highest shrub density was that of *Berberis asiatica (*1160 ind/ha) and minimum for *Desmodium elegans (*26 ind/ha, Table 2). *Berberis asiatica* was the dominant shrub species in terms of IVI (47.03%) followed by *Viburnum coriaceum* (IVI=31.62%). Other species had an IVI below 28.43%. *Desmodium elegans* was least dominant species (IVI =1.38%). Total canopy cover percent was 58.05±5.65%. The maximum canopy cover percent was recorded for *Berberis asiatica* (10.04±2.84%) and minimum for *Sarcococca hookeriana* (0.28±0.00%).

Ridge site

A total of 23 shrub species were recorded on this site. The total shrub density recorded at this site was 9926 ind/ha. The highest

Table 1. Vegetational parameters for shrub layer at Stream bank site

S.No	Species	Density (ind/ha)	A/F	Canopy cover %	IVI
1-	*Achne cordifolia*	373	0.14	2.36±0.62	13.01
2-	*Berberis asiatica*	1200	0.07	6.97±0.92	41.49
3-	*Berberis chitria*	386	0.05	3.61±1.91	15.97
4-	*Cotoneaster acuminate*	453	0.06	2.60±1.45	15.44
5-	*Daphne cannabina*	386	0.15	2.71±0.60	13.23
6-	*Desmodium gangenticum*	906	0.30	2.40±0.45	24.06
7-	*Elsholtzia flava*	66	0.17	0.37±0.00	1.82
8-	*Eupatorium adenophorum*	653	0.10	3.50±2.39	18.73
9-	*Indigofera dosua*	1533	0.11	3.02±1.58	30.52
10-	*Inula cappa*	213	0.06	1.59±1.32	6.52
11-	*Jasminum humile*	226	0.14	1.13±0.79	6.99
12-	*Leptodermis lanceolata*	586	0.05	2.45±1.27	18.59
13-	*Myrsine africana*	333	0.13	1.90±0.50	11.91
14-	*Pyracantha crenulata*	253	0.11	2.70±0.33	11.92
15-	*Randia tetrasperma*	253	0.05	1.85±1.19	9.71
16-	*Rhus cotinus*	133	0.02	0.97±0.00	6.47
17-	*Rubus ellipticus*	306	0.06	3.07±1.27	14.85
18-	*Salix tetrasperma*	120	0.03	0.95±0.00	4.65
19-	*Viburnum coriaceum*	560	0.06	3.65±1.84	22.67
20-	*Viburnum cotinifolium*	266	0.26	2.67±0.27	11.38
	TOTAL	**9213**		**50.47±4.06**	

shrub density was that of *Viburnum coriaceum (*1466 ind/ha) and minimum for *Cynanchum glaucum (*53 ind/ha, Table 2). *Viburnum coriaceum* was the most dominant species (IVI=46.95%) followed by *Berberis chitria* (IVI=43.03%) and *Desmodium gangenticum* (IVI=31.65%). Other species had an IVI below 22.95%.

Total canopy cover percent was 39.07±7.94%. The maximum canopy cover percent was recorded for *Viburnum coriaceum* (6.65±1.25%) and minimum for *Cynanchum glaucum* (0.14±0.00%).

Moist site

A total of 19 shrub species were present on moist site. The total shrub density recorded at this site was 12847 ind/ha. The highest shrub density was that of *Arundinaria falcata (*2773 ind/ha) and minimum for *Boehmaria regulosa (*26 ind/ha, Table 2). *Arundinaria falcata* was the most dominant shrub species in terms of IVI (52.15%) followed by *Plectranthus japonicus* (IVI=37.03%), *Desmodium elegans* (IVI=36.64%) and *Daphne canabina* (IVI=21.03%) and the remaining species had an IVI below 20.37%. Total canopy cover percent was 73.09±2.35%.

Table 2. Vegetational parameters for shrub layer at Dry site

S.No	Species	Density (ind/ha)	A/F	Canopy cover %	IVI
1.	*Achne cordifolia*	253	0.08	0.65±0.34	9.74
2.	*Berberis asiatica*	1160	0.08	10.04±2.84	47.03
3.	*Berberis chitria*	626	0.03	8.84±0.22	35.87
4.	*Cotoneaster acuminata*	706	0.05	5.13±1.96	28.32
5.	*Cotoneaster microphylla*	66	0.04	0.67±0.00	2.75
6.	*Desmodium elegans*	26	0.07	0.38±0.00	1.38
7.	*Elsholtzia flava*	120	0.08	1.59±0.00	4.40
8.	*Eupatorium adenophorum*	546	0.16	2.47±1.69	17.86
9.	*Hypericum lysimachioides*	213	0.03	1.13±0.00	7.79
10.	*Leptodermis lanceolata*	400	0.02	3.85±1.94	15.86
11.	*Lonicera quinquelocularis*	120	0.01	0.45±0.00	6.90
12.	*Mahonia nepalensis*	53	0.03	1.15±0.00	3.17
13.	*Maesa indica*	53	0.13	0.32±0.00	2.03
14.	*Myrsine africana*	826	0.07	4.25±0.57	28.43
15.	*Plectranthus japonicus*	173	0.03	1.13±0.00	6.61
16.	*Pyracanthus crenulata*	213	0.07	2.04±1.56	10.83
17.	*Randia tetrasperma*	53	0.02	0.44±0.00	3.52
18.	*Sarcococca hookeriana*	40	0.10	0.28±0.00	1.62
19.	*Strobilanthes alatus*	293	0.03	1.25±0.00	8.49
20.	*Viburnum coriaceum*	746	0.06	7.04±2.98	31.62
21.	*Viburnum cotinifolium*	480	0.026	4.95±2.52	25.68
	TOTAL	**7166**		**58.05±5.65**	

The maximum canopy cover percent was recorded for *Arundinaria falcata* (12.88±2.39%) and minimum for *Cotoneaster acuminata* (0.33±0.00%).

Diversity indices

Species diversity was higher on stream bank site (3.95) and least on moist site (3.53) while, the concentration of dominance ranged from 0.081 at moist site to 0.118 at stream bank site. Dominance diversity covers of shrubs layer showed a log normal sequence. The correlation between shrub species density and species richness and shrub cover percent were significant at $p<0.01$ as indicated by correlation coefficient values (Fig. 2 and 3).

DISSCUSSION

Species richness, relative abundance, heterogeneity, spatial or temporal distribution in an area are the central subjects of community ecology [15]. The density value of shrubs in the present study was maximum on moist site (12847 ind/ha) and minimum on dry site (7166 ind/ha). The moist site was covered by *Arundinaria falcata* species. *Arundinaria falcata* was maximum

Table 3. Vegetational parameters for shrub layer at Ridge site

S.No	Species	Density (ind/ha)	A/F	Canopy cover %	IVI
1.	*Achne cordifolia*	80	0.20	0.21±0.00	1.71
2.	*Berberis asiatica*	640	0.07	2.17±1.49	22.95
3.	*Berberis chitria*	1226	0.06	5.44±0.79	43.03
4.	*Boehmaria regulosa*	120	0.08	0.55±0.30	3.69
5.	*Cotoneaster acuminata*	533	0.16	1.79±1.14	15.13
6.	*Cynanchum glaucum*	53	0.13	0.14±0.00	1.54
7.	*Daphne cannabina*	173	0.02	0.64±0.00	6.28
8.	*Desmodium elegans*	200	0.29	1.55±0.72	6.68
9.	*Desmodium gangenticum*	1440	0.34	2.38±1.97	31.65
10.	*Eupatorium adenophorum*	293	0.17	0.55±0.40	7.45
11.	*Hypericum oblongifolium*	66	0.04	0.23±0.00	2.31
12.	*Indigofera dosua*	386	0.11	1.33±0.69	10.92
13.	*Leptodermis lanceolata*	693	0.16	2.11±0.84	19.79
14.	*Myrsine Africana*	866	0.23	1.51±0.49	20.98
15.	*Plectranthus japonicus*	133	0.08	0.63±0.00	3.67
16.	*Pyracanthus crenulata*	226	0.04	1.19±0.00	7.55
17.	*Rendia tetrasperma*	146	0.07	0.56±0.28	5.11
18.	*Rhus cotinus*	80	0.02	0.62±0.00	3.94
19.	*Rubus lasiocarpus*	80	0.02	1.23±0.00	4.36
20.	*Rumex hastatus*	106	0.03	0.31±0.00	3.51
21.	*Salix tetrasperma*	400	0.13	1.59±0.91	10.34
22.	*Viburnum coriaceum*	1466	0.09	6.65±1.25	46.95
23.	*Viburnum cotinifolium*	520	0.19	5.69±2.89	20.30
	TOTAL	**9926**		**39.07±7.94**	

Table 4. Vegetational parameters for shrub layer at Moist site

S.No	Species	Density (ind/ha)	A/F	Canopy cover %	IVI
1.	*Arundinaria falcata*	2773	0.13	12.88±2.39	52.15
2.	*Berberis asiatica*	53	0.03	0.66±0.00	2.03
3.	*Berberis chitria*	93	0.06	0.80±0.00	2.55
4.	*Boehmaria regulosa*	26	0.05	0.61±0.32	6.91
5.	*Cotoneaster acuminata*	53	0.03	0.33±0.00	2.02
6.	*Daphne cannabina*	920	0.07	4.12±1.87	21.03
7.	*Desmodium elegans*	1573	0.08	6.58±2.14	36.64
8.	*Desmodium gangenticum*	400	0.08	1.49±0.75	9.24
9.	*Hypericum lysimachioides*	546	0.13	2.26±1.24	14.89
10.	*Leptodermis lnceolata*	573	0.11	3.51±1.76	14.60
11.	*Lonicera quinquelocularis*	680	0.15	4.88±1.24	20.19
12.	*Maesa indica*	280	0.16	2.61±1.03	8.64
13.	*Myrsine africana*	813	0.12	3.26±0.72	17.77
14.	*Plectranthus japonicus*	2400	0.19	6.27±1.28	37.03
15.	*Rhus cotinus*	146	0.01	2.15±0.00	5.99
16.	*Rubus ellipticus*	186	0.05	4.84±3.34	9.14
17.	*Rubus lasiocarpus*	106	0.03	1.87±0.00	3.95
18.	*Rubus paniculatus*	626	0.12	8.40±3.98	20.37
19.	*Viburnum coriaceum*	400	0.09	5.57±2.13	14.74
	TOTAL	**12847**		**73.09±2.35**	

Table 5. Species Diversity and Concentration of Dominance for Different habitat

Habitat	Species richness	Species Diversity	Concentration of Dominance
Stream bank	20	3.95	0.081
Dry	21	3.81	0.087
Ridge	23	3.92	0.087
Moist	19	3.53	0.118

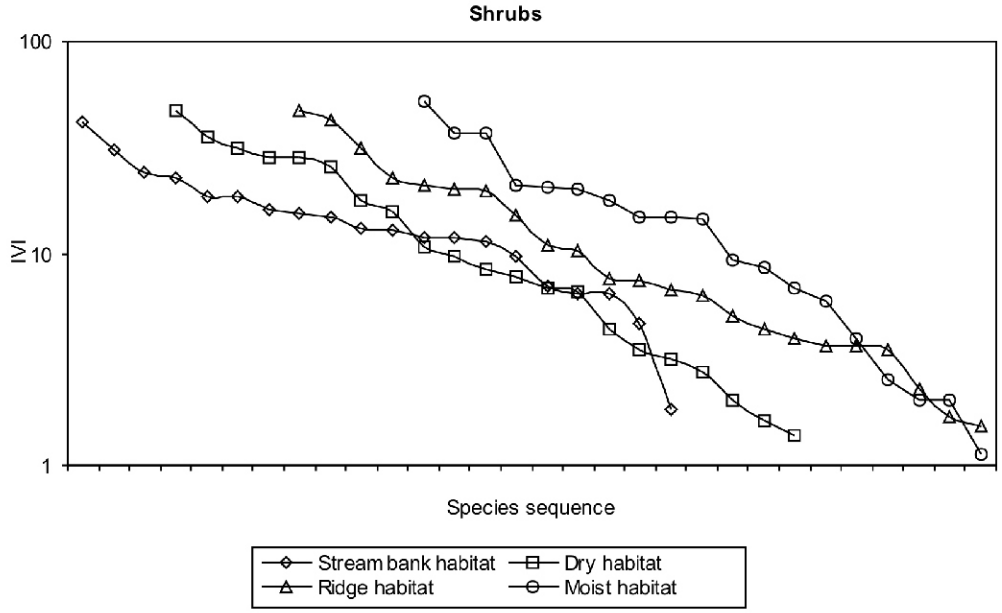

Fig. 1. Dominance diversity curves of different habitats

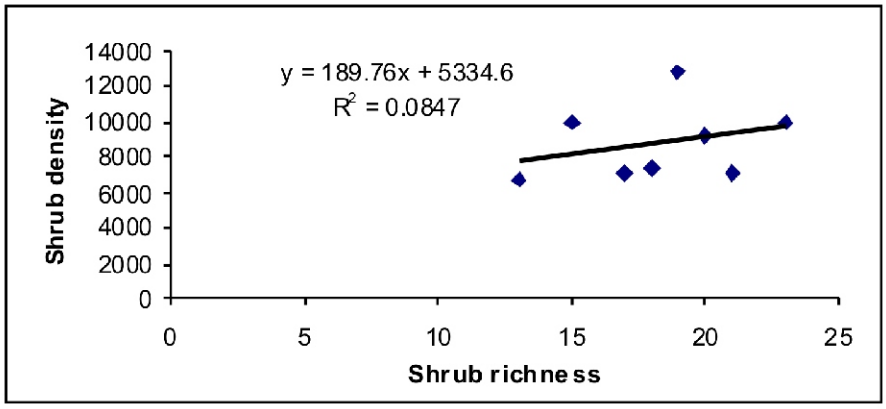

Fig. 2. Relationship between density (ind/ha) and species richness.

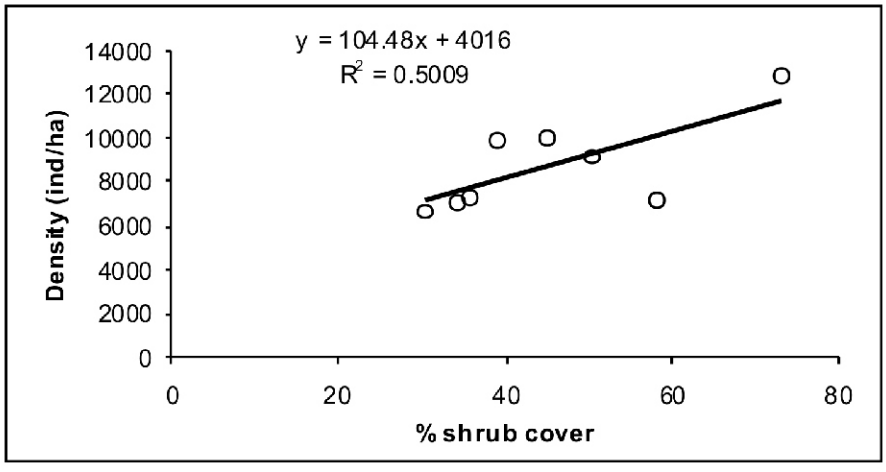

Fig. 3. Relationships between cover and density.

growing on high moisture and higher humidity. [16] reported shrubs density ranging between 676.4- 1760.0 ind/ha and [17] reported 2480 ind/ha to 7920 ind/ha for the Central Himalayan forests. The shrub diversity was lower in moist site and higher in stream bank site. The values of shrub diversity were similar (upto 3.90) to those reported earlier by various workers [16, 18-20].

The species richness ranged from 19 (moist habitat) to 23 (ridge habitat, oak-chirpine dominant forest). [19] reported the same pattern of species richness in banj-oak dominant forest in central Himalaya. The maximum shrubs richness recorded on Ridge habitat was due to low moisture content and higher disturbance. The species richness of shrubs did not increased significantly with increase in density (Fig 1). Total cover of shrubs was recorded between 39.07±7.94% and 73.09±2.35%. The canopy cover of shrubs was maximum on moist habitat. However, the minimum shrubs cover was recorded at ridge habitat. Generally, the shrubs cover was higher in moist habitats and lower in ridge habitats.

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