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Full Length Research Paper

Group association, biological dispersion and differing qualities of trees and Shrubs in Selected ranges of Branwar Forest of Kashmir Himalaya

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Periodic studies were conducted in four selected sites of Branwar foresfiet area of Kashmir Himalaya in the year 2010 to 2011 for assessing ecological distribution and diversity of trees and shrubs. The Plant Community Organizational features, ecological distribution and diversity of different study sites in the Branwar Forest during 2010 to 2011 are markedly variable with regard to the life-forms namely, trees and shrubs. A total of five tree species belonging to four families were recorded at the different study sites. Near village (NS) site (I) had five species and riparian forest (RS) site (II) had three tree species, while dam forest (DS) site (III) and protected forest (PS) site (IV) had two species each. Among the trees *Abies pindrow* and *Pinus wallichiana* were present at all the study sites. The shrub species present at the study sites ranged from 03 for protected forest (PS) site and 06 for near village (NS) site. The number of shrub species present at near village (NS) site was 06, at riparian forest (RS) site, 05 species were present; while, at dam forest (DS) site and protected forest (PS) site, 04 and 03 species of shrubs were present, respectively. Among the shrub species *Indigofera heterantha* was present at all the study sites. In the present study, low tree species diversity index was found at the unprotected sites of near village site and riparian site compared to the protected sites of dam forest site and protected forest site. With increasing disturbance in the forests the plant species diversity, richness and evenness are significantly reduced. The increase in shrub diversity and evenness at near village (NS) site and riparian forest (RS) site may be due to less competition and availability of more space due to less vegetation.

Key Words: Richness, Species Diversity, community, Habitat, dispersal, Vegetation

INTRODUCTION

The mainstream approach in community ecology has been to search for deterministic processes explaining the organization of species assemblages, for example by looking for the particular adaptations of each species to abiotic factors or the complexity of species interactions. In this way, community ecologists have been successful to demonstrate that each species is restricted to a more or less wide range of habitats, so that habitat heterogeneity is a main factor determining the geographical distribution of species. However, even within an apparently homogenous habitat, species spatial distribution is often non-random. This may result from our inability to detect finer details of habitat heterogeneity, but also from the fact that individuals tend to aggregate under limited

dispersal.

Organization of communities is the outcome of the habitat, environmental conditions and existing vegetation types. Community structure provides data about recognition and definition of different vegetation types; their mapping and the study of relationship between plant species distribution and environmental controls. Community structure analyzes and interprets the plants at different exposures and provides first hand information about the vegetation and basis for prediction of likely future changes (Mueller Dum-bois and Ellenberg, 1974). Margalef (1963) reported high species diversity as an indication of maturity of an ecosystem. The values of diversity index and concentration of dominance in the coniferous forests of the Himalaya as reported by Ralhan et al. (1982) (0.0 - 1.93 and 1.0 - 0.31); Singhal et al. (1986) (0.0 - 1.65 and 1.0 - 0.74); Singh et al., (1991b) (0.86 - 2.84 and 0.15 - 0.57) and Devlal and Sharma (2008) (1.0 - 2.07 and 0.13 - 0.40) falls in the range of values as described for other temperate forests.

Risser and Rice (1971) reported tree species diversity index between 1.69 and 3.40 and concentration of dominance in the range of 0.10 - 0.99 for temperate forests. The lower value of diversity and consequently greater concentration of dominance have been attributed by Simpson (1964) to the lower rate of evolution and diversification of communities, while Connel and Orias (1964) related the lower value of diversity to severity in environment. Whittakar (1972) stated that the dominance of one stratum might affect the diversity of another stratum. Javied (1971) gave a detailed account of history of plant exploration in Kashmir.

The phytogeographical analysis revealed that the flora of Kashmir Himalaya contained Cosmopolitan/sub-Cosmopolitan Eurasian, Euro-Siberian, Pan Tropical, Mediterranean, Central Asian, Sino-Japanese, temperate and localized (restricted) floristic elements. A number of workers have reported the floristic diversity of the Kashmir Himalaya. Rau (1975) reported 790 species of flowering plants in 260 genera belonging to 59 families. Bhat (1984) while working on the flora of Gulmarg which is a small part of Pir Panjal Range recorded 475 species out of which 466 species belonging to angiosperms, 4 to gymnosperms and five to other vascular plants and Kaul (1986) reported 410 species belonging to 251 genera in only 56 families of angiosperms growing as weeds in Kashmir Himalaya.

Singh and Kachroo (1994) reported a total of 526 species of vascular plants of which 507 species belonged to angiosperms, seven species to gymnosperms and pteridophytes were represented by 12 species. On the basis of their own field study as well as earlier reports, Dar and Naqshi (2002) listed a total of 2104 species of vascular plants, belonging to 750 genera in 150 families and 2000 species of flowering plants to 710 genera and 132 families, from the Kashmir region. About 36.5% of the alpine/subalpine floral taxa of Kashmir Himalaya (Poaceae excluded) have been reported to be endemic, of which about 40% are said to be endangered (Dhar and Kachroo, 1983). According to Dar and Naqshi (2001) 40 taxa are endangered, 55 are rare, 150 are vulnerable and 110 are in intermediate category.

Study area

The present study is being carried out for assessing the plant (trees and shrubs) community organization, distribution and diversity in Branwar Forests of Kashmir Himalaya. The present study area that is, Branwar forest range lies over and above famous tourist area of Yus Marg on one side and Neel Nag forest lake on the other side. It forms the main hydrologic catchment for the famous fresh water stream of Dudhganga in the Pir Panjal forest division.

The Branwar Forest Area is an important area of Dudhganga forest division and is about 40 km away from Srinagar city encompassing an area of about 5148.50 ha which include a sizeable portion of alpine scrub and pasture land. Branwar forest region form a compact and linear strip like area, running from south east to north-west in length and from north-east to south-west in breadth. For the last two decades, human activities have been on an increase in this part of the Dudhganga catchment.

Besides being used as a heavily grazed range and pasture area it is being utilized for a dam construction and power generation. As such ecological monitoring of the area becomes imperative. Four sites were selected in the Branwar forest area in order to study the plant (trees and shrubs) community organization, distribution and diversity. The main features for comparison of the study sites are given in Table 1 and are as stated below:

Site I (Near Village Site) (NS) 2146 masl: This site is located near the main entrance to the forest area and is the nearest to the village Branwar.

Site II (Riparian Site) (RS) 2181 masl: This is located on the right side of Nalla Dudhganga deep in the forest. This site adjoins newly constructed and operative small scale hydal power project.

Site III (Dense forest Site and/or Dam forest site) (DS) 2383 masl: This site is located in the Protected Dense forest near the newly constructed water storage dam for the operation of small scale mini power project.

Site IV (Protected Forest Site) (PS) 2318 masl: This site is located in the protected forest area.

MATERIALS AND METHODS

The plant (trees and shrubs) community organization, distribution and diversity studies were conducted by stratified sampling technique using quadrats of different convinces as sampling units of

Table 1. Characteristics of selected study sites.

S. No.	Site	Latitude	Longitude	Altitude (masl)	Tree density (10 m^2)	Soil type	Dominant tree species
01.	NS (I)	33°52' 11.3"N	74°39' 22.2"E	2146	2.2	SiL	*Pinus wallichiana*
02.	RS (II)	33°51' 45.0"N	74°39' 20.6"E	2181	14.0	ScL	*Abies pindrow*
03.	DS (III)	33°50' 36.0"N	74°38' 52.3"E	2383	21.8	CL	*Pinus wallichiana*
04.	PS (IV)	33°51' 28.2"N	74°38' 54.6"E	2318	86.9	CL	*Pinus wallichiana*

SiL= Silty loam; ScL= sand clay loam; CL= clay loam.

different vegetational strata (trees and shrubs strata). For tree canopy it was 10 × 10 m and for shrubs it was 5 m × 5 m. In the present study, trees in seedling or sapling stages at each quadrat were also counted as trees. The vegetation data were further computed for frequency, density and abundance following Curtis and McIntosh (1950).

The relative values of frequency, density and dominance were determined as per Phillips (1959). These values were summed to represent IVI (Importance Value Index) of individual species in order to express the dominance and ecological success of the species (Curtis, 1959).

The ratio of abundance to frequency (A/F ratio) for different species was calculated to elicit the distributional pattern of the species (Whitford, 1949). This ratio indicates regular (0.025), random (0.025 - 0.05) and contagious (>0.05) distributions, thus for this Curtis and Cottam (1956) was fallowed.

Species diversity was computed by using Shannon and Weiner's information index (Shannon-Weiner, 1963). Index of dominance (C) was calculated according to Simpson (1949). Index of richness or the variety component (R) was determined using Menhinick Index (Menhinick, 1964). Index of evenness or the equitability component (E) was determined after Pielou (1975). Index of similarity (S) was calculated following Sorensen (1948) to compare the forest of two stands as: Where, A and B represent the number of species in forest stand A and B, respectively, and C is the number of species common to both stands (Table 2).

Table 2. Similarity between different sites based on Sorensen's Similarity Index.

Plant group	Sites	NS(I)	RS(II)	DS(III)	PS(IV)
Trees	NS		75.0	57.1	57.1
	RS			80.0	80.0
	DS	57.1	80.0		100.0
	PS	57.1	80.0	100.0	
Shrubs	NS		90.90	60.00	44.44
	RS			66.66	25.00
	DS	60.00			57.14
	PS	44.44	25.00	57.14	

RESULTS AND DISCUSSION

The plant community organizational features, ecological distribution and diversity of different study sites in the Branwar Forest during 2010 - 2011 are markedly variable with regard to all the three life-forms namely, trees, shrubs and herbs. A total of 5 tree species belonging to 4 families were recorded at the different study sites. Near village (NS) site had five species and riparian forest (RS) site had three tree species, while dam forest (DS) site and protected forest (PS) site had 2 species each. Among the trees *Abies pindrow* and *Pinus wallichiana* were present at all the study sites.

The shrub species present at the study sites ranged from 03 for protected forest (PS) site and 06 for near village (NS) site. The number of shrub species present at near village (NS) site was 06, at riparian forest (RS) site 05 species were present and at dam forest (DS) site and protected forest (PS) site, 04 and 03 species of shrubs were present, respectively.

Among the shrub species *Indigofera heterantha* was present at all the study sites. Perusal of the data reveals that on the basis of tree species only highest similarity was observed between dam forest (DS) site and protected forest (PS) site (100%) followed by riparian forest (RS) site and protected forest (PS) site, dam forest (DS) site and riparian forest (RS) site and protected forest (PS) site and riparian forest (RS) site having the similarity index of 80% between them and near village (NS) site and riparian forest (RS) site having similarity index of 75% and the lowest of 57.10% was observed between near village (NS) site and dam forest (DS) site and near village (NS) site and protected forest (PS) site. Similarly, on the basis of shrubs, highest similarity index of 90.90% was between near village (NS) site and riparian forest (RS) site, while as the lowest similarity index of 25% riparian forest (RS) site and protected forest (PS) site.

Frequency, density and abundance

The density of trees ranged from a minimum of 0.05 trees/10 m^2 at near village (NS) site to a maximum of 83 trees/10 m^2 at site protected forest (PS) site which is a protected site. Among the tree species *Pinus wallichiana* had the highest density at all the sites except at riparian forest (RS) site, where *Abies pindrow* had the highest

Table 3. Vegetational characteristics of different tree and herb species at the study sites of Branwar forest.

S. No.	Vegetational characteristic				
01	**Dominant plant composition**	**Site I**	**Site II**	**Site III**	**Site IV**
	Tree	*Pinus Wallichiana*	*Abies pindrow*	*Pinus Wallichiana*	*Pinus Wallichiana*
	Shrub	*Indigofera heterantha*	*Indigofera heterantha*	*Vibernum foeteuns*	*Vibernum grandiflorum*
02	**Density**				
	Trees	2.29	14.05	21.8	86.9
	Shrubs	7.1	6.4	5.3	2.8
03	A/F	>0.05	>0.05	>0.05	>0.05
04	**Diversity (H)**				
	Trees	1.190	0.844	0.564	0.161
	Shrubs	1.115	0.875	0.823	0.559
05	**Dominance (C)**				
	Trees	0.285	0.435	0.563	0.749
	Shrubs	0.360	0.350	0.366	0.560
18	**Richness (R)**				
	Trees	1.044	0.253	0.135	0.067
	Shrubs	0.216	0.625	0.549	0.567
19	**Evenness (E)**				
	Trees	1.190	1.085	0.936	0.267
	Shrubs	1.033	0.875	0.911	0.718

density, frequency and abundance fallowed by *Pinus wallichiana*. The lowest density (0.05 trees/10 m^2), frequency (2.5%) and abundance (1.0) were observed for *Ulmus villosa* at near village (NS) site.

The density and abundance of tree species at different study sites was in the order of NS<RS<DS<PS, while frequency was in the order of NS<PS<DS<RS. The density of shrub species ranged from a minimum of 0.1 shrubs/5 m^2 at II, III and IV sites to a maximum of 4.8 shrubs/5 m^2 at near village (NS) site and riparian forest (RS) site. The lowest shrub density (0.1 shrubs/5 m^2) values were observed at II(RS), III(DS) and IV (PS) sites for three different herb species, *Rosa webbiana* (site II), *Cotaneaster rosea* (site II) and *Parrotiopsis jacquemontaina* (site IV) , while the highest shrub density (4.8 shrubs/5 m^2) was recorded at site I (NS) and site II (RS) for *Indigofera heterantha*.

Indigofera heterantha had the highest density (4.8 shrubs/5 m^2), frequency (55%) and abundance (8.7) except at site III (DS) and site IV (PS), at these sites *Vibernum grandiflorum* had the highest density (3.8 and 2.3 shrubs/5 m^2) frequency (45 and 40%) and abundance (8.4 and 5.3) respectively. The lowest value for density, frequency and abundance were observed for *Rosa webbiana* (site II), *Cotaneaster rosea* (site III) and *Parrotiopsis jacquemontaina* (site IV).

Diversity and dominance indices

Values of species diversity index, dominance index, species richness and evenness for different plant groups at all the study sites are presented in Table 3. The values of Shannon-Wiener's diversity index (H') at the study sites varied. For the tree species Shannon-Wiener's diversity index (H') was highest of 1.190 for near forest (NS) site followed by 0.844 for riparian forest (RS) site, 0.564 for dam forest (DS) site and lowest of 0.161 was recorded for protected forest (PS) site.

The diversity index (H') for shrubs varied from a highest of 1.115 for near village (NS) site followed by 0.875 for riparian forest (RS) site, 0.823 for dam forest (DS) site and a least of 0.559 for protected forest (PS) site. The concentration of dominance (C) at the study sites ranged between 0.749 for tree community at protected forest (PS) site. For the tree species dominance index (C) was highest of 0.749 for protected forest (PS) site followed by 0.563 for dam forest (DS) site, 0.435 for riparian forest (RS) site and lowest of 0.285 was recorded for near village (NS) site.

The dominance index (C) for shrubs varied from a highest of 0.560 for protected forest (PS) site followed by 0.366 for dam forest (DS) site, 0.360 for near village (NS) site and a least of 0.350 for riparian forest (RS) site. The Species Richness Index (R) for trees had the maximum value of 1.0449 for near village (NS) site, followed by 0.253 for riparian forest (RS) site, 0.135 for dam forest (DS) site and a minimum of 0.067 for site IV (PS). Similarly, the values of species richness (R) for shrubs varied between 0.625 for riparian forest (RS) site, followed by 0.567 for protected forest (PS) site, 0.549 for dam forest (DS) site and 0.216 for near village (NS) site.

The equitability index (E) for tree species ranged between 1.190 for near village (NS) site, followed by 1.085 for riparian forest (RS) site, 0.936 for dam forest (DS) site and 0.067 for protected forest (PS) site. The values of equitability index (E) for shrubs varied between 1.033 for near village (NS) site, followed by 0.911 for dam forest (DS) site, 0.875 for riparian forest (RS) site and 0.718 for protected forest (PS) site. Similarly, the values of equitability index ranged between 1.080 for protected forest (PS) site and 0.706 for dam forest (DS) site.

Conclusions

In the present study low tree species diversity index was found at the unprotected sites of near village site and riparian site compared to the protected sites of dam forest site and protected forest site. With increasing disturbance in the forests the plant species diversity, richness and evenness are significantly reduced. The increase in shrub diversity and evenness at near village (NS) site and riparian forest (RS) site may be due to less competition and availability of more space due to less vegetation. The pattern of the percentage frequency values evaluated for the study sites appeared to be not exactly in tune with the normal law of frequency by Raunkiaer (1938).

The proportion of species belonging to class A (having frequency of <20%) was maximum. Thus, the frequency distribution was quite aberrant. These findings clearly indicate that at all the sites the plant species were irregularly distributed that is, these are heterogeneous. Similar results were also obtained by Pande and Shukla (2005). Importance The analysis of distribution pattern (A/F ratio) in the present study revealed that the plant forms (trees and shrubs) observed contagion distribution at all the study sites except two shrub species (*Berberis lycium* and *Rosa webbiana*) at near village (NS) site where they showed regular distribution. In general, contagious distribution in natural vegetation has been reported by several workers (Ralhan et al., 1982; Singh et al., 1991). Odum (1971) stressed that contagious (clumped) distribution is the commonest pattern in nature and it is due to small significant variations in the environment. Regular distribution occurs were severe competition between the individuals exists. Most Ecologist are convinced that species diversity is important for the stability and proper functioning of ecosystems (Schlapfer et al., 1999; Tilman, 1997), however, with increasing disturbance in the forests the plant species diversity, richness and evenness are significantly reduced (Dar and Kaul, 1987; Rad et al., 2009). Species diversity refers to the variation that exists among the different forms. Diversity is considered to be an outcome of the co-evolution of species in a biogeographic region. It is often considered to be a synthetic measure of the structure, complexity, stability and proper functioning of ecosystems (Schlapfer et al., 1999).

In the present study low tree species diversity index was found at all the sites as compared to diversity indices reported for temperate forests. The concentration of dominance (C) followed almost inverse relation to species diversity. Whittakar (1965) and Risser and Rice (1971) have reported values of concentration of dominance in the range of 0.10 to 0.99 and 2 to 3 as the highest range of diversity index for certain temperate forests. Extreme coniferous have been reported to contain lower species diversity and high concentration of dominance than evergreen or deciduous broad leaved forests (Wangda and Ohsawa, 2006).

The decrease in Shannon-Wiener diversity index seems mainly due to equitability. The Shannon-Wiener diversity index is more sensitive to equitability than to richness after a fairly large number of species has accumulated. Even if species numbers (richness) remain the same in later stages of succession, it is unclear what will happen to equitability (Reiners, 1992). The increase in shrub diversity and evenness at near village (NS) site and riparian forest (RS) site may be due to less competition and availability of more space due to less vegetation (Bahera and Mishra, 2006). The results also indicate that the richness and evenness values can be sometimes misleading when lower number of tree species is present and dominance is shared by single species.

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