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Variation in Species Distribution Pattern and Dominance with Altitude and Aspect of Garhwal Himalayan Oak Forest

Vikaspal Singh[1*], D.S. Chauhan[2] and S. Dasgupta[3]

[1]Department of Forestry, Dolphin PG Institute of Biomedical and Natural Sciences, Dehradun, 248007, Uttarakhand, India; [2]Department of Forestry and Natural Resources, HNBGU, Srinagar Garhwal, Uttarakhand, 246174, India; [3]Department of Forestry and Biodiversity, Tripura University, Suryamaninagar, Tripura (West), PIN: 799022, India

*E-mail: vikaspals@gmail.com

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ABSTRACT

An investigation was conducted in an Oak forest of Garhwal Himalaya in relation to aspect and altitude. Major dominant tree, shrub and herb species were compared for density, A/F ratio and IVI values. *Quercus leucotrichophora*, *Rhododendron arboreum*, *Lyonia ovalifolia*, *Myrica esculanta*, *Pinus roxburghii*, *Pyrus pashia*, *Benthamedia capitata* and *Lindera pulcherrima* were most dominant tree species among all studied altitudes. *Q. leucotrochophora* showed contagious pattern in the north facing aspect and changed to random pattern in the south facing aspect at upper and middle altitudes. *R. arboreum* and *M. esculanata* also showed same changes in their distribution at middle and lower altitudes. In the shrub layer, the contagious pattern was changed to random pattern from north facing aspect to south facing aspect and vice versa. Herb species were mostly recorded in contagious pattern and the change of distribution was found for few species.

Key Words:

Altitude, Dominant, Distribution pattern, North facing aspect, South facing aspect

INTRODUCTION

Forest can be described by their composition, function and structure. Composition is the assemblage of organisms (living and non-living) that exists within the forest. Function refers to types and rates of processes (*e.g.* carbon production) and interactions among both biotic and abiotic forest components. Conversely, structure deals with the physical arrangement and characteristics of the forest and is a highly visible and described component (Franklin et al. 1981). Vegetation in a mountain area is affected by several factors of which altitude, aspect, slope, soil, canopy cover and microclimate are predominant as they modify regimes of moisture and exposure to Sun (Giri et al. 2008).

Quercus leucotrichophora is a moderate size or large evergreen tree which is found in western Himalaya region from Kashmir to Nepal at an altitude of 1,000 – 2,400 m. above men sea level (amsl). It plays subsistence role in the economy of rural population, being mainly used as fodder, fuelwood and for manufacturing agricultural implements (Gautam and Bhandari 2006).

MATERIAL AND METHODS

Study area location

The study was conducted in Chandrabadani Oak forest. The Chandrabadani Oak forest forms a moist-temperate area falling in the jurisdiction of Tehri district of Uttarakhand State. The most of oak forest area faces north and south aspects and has an altitudinal range of 1500 m – 2350 m amsl. Various land use categories such as cultivated land, village common land locally called "Panchayat Bhumi" (community land) under forest, scrub, barren land, isolated patches under fruit trees and government reserve forest, are available within and in adjoining area of forest.

Methodology

Vegetation study was conducted in both north-facing and south-facing aspects. Sampling was done in stratified random manner along the altitudinal transects. A total of six transects were laid down along altitudinal gradient (03 each in north-facing and south-facing aspects). Transects were spatially distributed so as to minimize the autocorrelation among the vegetation. Quadrats were laid down along each transect in stratified random manner and placed at an interval of 100m. Species area curve was used to determine minimal sample area which is based on quantitative variation of the vegetation in terms of species number. The adequacy of sample size was estimated by stopping sampling at the point at which additional quadrat did not significantly affect the mean of species.

Quadrats of 10 m x 10 m were used for tree layer, 2 m x 5 m for shrubs and 1 m x 1 m for herb species. About 5% of total forest area was sampled. The whole study area on each aspect was divided into three altitudinal ranges *viz*. upper altitudinal range (>1900 m amsl), middle altitudinal range (1700 to 1900 m amsl) and lower altitudinal range (<1700 m amsl). Phytosociological status was determined as per Muller-Dombios and Ellenberg (1974) and Mishra (1968). The Important Value Index (IVI) for different species was calculated as sum of relative frequency, relative density and relative dominance of each species. The distribution pattern of species was calculated as per method suggested by Curtis and Cottam (1956).

RESULTS

Density, A/F and IVI of major tree, shrub and herb species is presents in Table 1 – 3. In tree layer of both aspects, most of species were contagiously distributed among all studied altitudes. In the upper altitude four species were found under random distribution pattern while rest of tree species was contagiously distributed in both aspects collectively. The middle altitude concerned with 12 and 10 tree species in north and south facing aspect respectively. On the basis of density, 7 species were recorded as most dominant in this altitude in both aspects. *Lyonia ovalifolia, Myrica esculanta* and *Rhododendron arboreum* were found in random distribution pattern in both the aspects. In the lower altitude, ten species were recorded in north and south-facing aspect collectively and among them six species were showed dominance by their density. It was found interesting that in the south-facing aspect all species were randomly distributed, while in the north-facing aspect two species were randomly distributed and rest were in contagious distribution. (Table 1).

In context of shrub layer of studied altitudes and aspects, all type of distribution pattern was observed. In both of aspects, 8 species of shrub were dominated collectively on their density basis. The recorded shrub species for north facing and south-facing aspects were 14 and 13 respectively. In upper altitude, regular distribution pattern was found in majority followed by random and contagious pattern. In north facing aspect, 4 species were found under regular pattern and 2 species in south-facing aspect. Random distribution was found for 2 and 4 species in north and south-facing aspects respectively. The middle altitude showed contagious distribution for most of shrub species. In the north facing aspect, 16 species were found and 17 were for the south facing aspect. Out of 7 shrub species 5 were found under contagious pattern while *Asparegus racemosus* showed random distribution pattern and *Rubus ellipticus* showed regular pattern. In the south facing aspect, out of 8 shrub species, 5 were recorded under contagious pattern and 3 were randomly distributed. At lower altitude, 22 and 19 shrub species were recorded in north and south facing aspect respectively. Dominance of 11 shrub species was found on the basis of density values. All species in the north facing aspect observed in contagious pattern of distribution while, in the south facing aspect mixture of contagious and random distribution pattern was found (Table 2).

For the herb layer, contagious pattern was found for most of species and random distribution pattern was found for few species. In the upper altitude, 16 herb species were found in the north facing aspect and 13 in south facing aspect. The major dominant species were 11 collectively recorded in both the aspects. *Viola biflora* is only herb species which was regularly distributed while rest of species was contagiously distributed. In the middle altitude 16 and 21 herb species were observed in north facing and south facing aspect respectively. Collectively there were 15 herb species were found dominant on density basis. Only contagious distribution pattern was found for all herb species in both of the aspects in the middle altitude. As far as the lower altitude was concerned, the north aspect showed 19 herb species and south facing aspect showed 15 species. Among these herb species 9 species were dominant by their density values. In the north facing aspect four species were contagiously distributed while, *Andropogon munroi* and *Viola canescens* were recorded under random pattern of distribution. In the south aspect out of 7 herb species one species was distributed randomly while rest of six herb species contagiously distributed (Table 3).

Table 1. Tree Density (trees/ 100 m^2), A/F and IVI of major species at different altitude and aspect of Chandrabadani Oak forest.

S.No.	Species	North upper altitude (11)			South upper altitude (11)		
		Density	A/F	I.V.I	Density	A/F	I.V.I
1	*Lindera pulcherrima*	-	-	-	0.50	0.056	13.2
2	*Lyonia ovalifolia*	1.40	0.029	31.2	2.20	0.138	30.8
3	*Myrica esculanta*	-	-	-	0.60	0.038	17.0
4	*Quercus leucotricophora*	5.60	0.056	163.7	4.90	0.049	140.7
5	*Rhododendron arboreum*	1.90	0.023	42.6	1.90	0.053	35.0
		North middle altitude (12)			South middle altitude (10)		
1	*Lindera pulcherrima*	-	-	-	0.60	0.067	16.3
2	*Lyonia ovalifolia*	1.10	0.044	21.6	1.20	0.048	33.9
3	*Myrica esculanta*	1.00	0.040	20	1.30	0.052	42.8
4	*Pinus roxburghii*	-	-	-	0.50	0.056	13.7
5	*Pyrus pashia*	-	-	-	0.50	0.056	15.4
6	*Quercus leucotricophora*	7.40	0.074	175.6	3.80	0.047	114.9
7	*Rhododendron arboreum*	1.80	0.050	29.4	1.10	0.031	33.4
		North Lower altitude (10)			South lower altitude (10)		
1	*Banthmidia capitata*	0.50	0.125	13.6	-	-	-
2	*Lyonia ovalifolia*	1.10	0.031	37.8	1.00	0.028	33.1
3	*Myrica esculanta*	0.80	0.050	26.3	1.20	0.024	44.2
4	*Pyrus pashia*	0.30	0.300	8.0	0.50	0.031	19.8
5	*Quercus leucotricophora*	3.10	0.048	129.0	2.90	0.029	123.4
6	*Rhododendron arboreum*	0.50	0.056	19.9	1.30	0.027	47.4

Table 2. Shrub Density (plants/ 10 m^2), A/F and IVI of major species at different altitude and aspect of Chandrabadani Oak forest.

		North upper altitude (14)			South upper altitude (13)		
SN	Species	Density	A/F	I.V.I	Density	A/F	I.V.I
1	*Berberis aristata*	1.9	0.019	29.3	2.20	0.022	30.8
2	*Berchemia edgeworthii*	0.6	0.024	11.8	-	-	-
3	*Caryopteris foetida*	0.7	0.078	9.8	0.90	0.036	14.0
4	*Colebrookia oppositifolia*	0.7	0.019	14.1	0.50	0.031	9.7
5	*Daphne papyracea*	1.1	0.031	17.3	0.80	0.032	13.3
6	*Eupatorium adenophorum*	3.2	0.050	36.9	4.90	0.049	49.7
7	*Myrisine africana*	0.7	0.028	12.6	1.10	0.069	13.8
8	*Rubus ellipticus*	0.8	0.016	16.3	1.40	0.017	23.6
		North middle altitude (16)			South middle altitude (17)		
1	*Asparegus racemosus*	0.7	0.031	6.8	1.20	0.048	12.4
2	*Berberis aristata*	1.9	0.151	54.3	1.80	0.037	17.9
3	*Caryopteris foetida*	0.7	0.063	8.2	1.40	0.056	13.3
4	*Eupatorium adenophorum*	0.6	0.224	39.2	5.00	0.050	37.1
5	*Myrisine africana*	0.6	0.081	9.0	1.60	0.044	15.6
6	*Rhus parviflora*	-	-	-	1.10	0.069	10.6
7	*Rosa macrophylla*	1.1	0.078	6.0	0.90	0.056	9.6
8	*Rubus ellipticus*	0.2	0.020	14.5	1.40	0.088	12.0
		North lower altitude (22)			South lower altitude (19)		
1	*Arachne cordifolia*	0.70	0.078	5.1	1.20	0.048	11.3
2	*Asparegus racemosus*	1.40	0.350	5.4	2.90	0.029	24.9
3	*Berberis aristata*	12.10	0.189	36.1	1.40	0.056	12.2
4	*Caryopteris foetida*	1.90	0.076	10.1	0.70	0.028	8.9
5	*Colebrookia oppositifolia*	0.60	0.067	4.9	2.00	0.056	16.1
6	*Daphne papyracea*	0.80	0.089	5.3	2.50	0.039	20.7
7	*Eupatorium adenophorum*	12.70	0.157	38.6	0.70	0.044	7.8
8	*Indigofera heterantha*	1.00	0.063	6.9	-	-	-
9	*Inula cappa*	2.10	0.084	10.5	1.60	0.064	13.1
10	*Rosa macrophylla*	1.80	0.113	8.7	1.70	0.027	17.0
11	*Rubus ellipticus*	3.00	0.120	12.5	0.90	0.100	7.6

Table 3. Herb Density (plants/ m^2), A/F and IVI of major species at different altitude and aspect of Chandrabadani Oak forest.

SN	Species	North upper altitude (16)			South upper altitude (13)		
		Density	A/F	I.V.I	Density	A/F	I.V.I
1	*Anaphalis busua*	0.52	0.090	7.97	0.76	0.059	16.6
2	*Andropogon munroi*	3.44	0.041	42.21	1.60	0.051	30.5
3	*Bergenia ciliata*	0.56	0.043	10.18	0.52	0.040	14.0
4	*Bidens pilosa*	0.52	0.040	9.85	-	-	-
5	*Chrysopogon gryllus*	1.92	0.030	28.06	1.80	0.044	34.5
6	*Fragaria nubicola*	0.52	0.027	11.11	0.68	0.043	16.6
7	*Herteropogon contortus*	0.88	0.038	14.64	-	-	-
8	*Micromaria biflora*	0.72	0.037	12.72	-	-	-
9	*Valeriana jatamansii*	-	-	-	0.56	0.071	12.6
10	*Vicia tenera*	-	-	-	0.76	0.059	16.6
11	*Viola biflora*	0.96	0.019	19.06			
		North middle altitude (16)			South middle altitude (21)		
1	*Anaphalis adnata*	0.92	0.160	9.5	0.32	0.080	6.6
2	*Andropogon munroi*	2.08	0.058	22.3	1.36	0.085	20.2
3	*Bergenia ciliata*	1.12	0.194	10.7	-	-	-
4	*Chrysopogon gryllus*	2.24	0.048	24.6	1.84	0.040	29.7
5	*Cynadon dactylon*	1.88	0.033	23.6	-	-	-
6	*Fragaria nubicola*	1.16	0.073	13.5	0.60	0.038	12.9
7	*Galium acutum*	1.04	0.054	13.4	-	-	-
8	*Gerbera gossypina*	0.68	0.043	10.5	-	-	-
9	*Leucas lanata*	-	-	-	0.56	0.071	10.3
10	*Micromaria biflora*	-	-	-	0.52	0.090	9.3
11	*Oxalis corniculata*	0.56	0.140	6.6	-	-	-
12	*Rumex hastatus*	0.56	0.035	9.8	-	-	-
13	*Valeriana jatamansii*	1.32	0.057	15.7	-	-	-
14	*Senecio nudicaulis*	-	-	-	1.12	0.041	20.0
15	*Viola canescens*	0.96	0.122	10.4	-	-	-
		North lower altitude (19)			South lower altitude (15)		
1	*Andropogon munroi*	1.68	0.026	34.1	1.92	0.042	34.0
2	*Bidens pilosa*	1.24	0.078	21.5	-	-	-
3	*Galium acutum*	0.28	0.036	8.5	1.00	0.052	19.5
4	*Gerbera maxima*	-	-	-	0.52	0.051	12.1
5	*Herteropogon contortus*	-	-	-	0.52	0.130	9.5
6	*Micromaria biflora*	0.72	0.056	14.9	0.60	0.077	12.1
7	*Oxalis corniculata*	0.56	0.043	13.1	0.44	0.056	10.4
8	*Valeriana jatamansii*	0.92	0.029	21.0	-	-	-
9	*Viola canescens*	-	-	-	0.64	0.111	11.6

DISCUSSION

Distribution pattern indicated that most of species were distributed in contagious pattern in all studied altitudes. A number of species found in Himalaya showed different pattern of their distribution. The extension of climate gradient enables several species to realize their fullest range of elevational adaptability (Sharma et al. 2009). In present study the higher number of dominance for tree, shrub and herb species was occurred at middle and lower altitudes as compare to higher altitude. The low elevation sites were relatively densely populated probably because human interference in these areas which facilitates the introduction and establishment of non-native species (Rawal and Pangtey 1994). *Quercus leucotrichophora, Rhododendron arboreum* and *Myrica esculanta* showed their dominance by their higher density and IVI values among all altitudes and aspects. The density and IVI values of these dominant species are more or less similar to earlier reported values by Singh et al. (2009), Sharma et al. (2010) and Khera et al. (2001) in different parts of Gahrwal Himalya.

Table 4. Species distribution pattern of dominant species along altitudes and aspect.

	North Upper altitude			North Middle altitude			North Lower altitude		
	Regular	Random	Contagious	Regular	Random	Contagious	Regular	Random	Contagious
Tree	1	-	2	-	2	2	-	3	3
Shrub	4	2	2	1	1	5	-	-	1
Herb	1	7	1	-	4	8	-	4	2
	South Upper altitude			South Middle altitude			South Lower altitude		
Tree	-	2	3	-	3	4	-	-	5
Shrub	2	4	1	-	3	5	-	6	4
Herb	-	3	4	-	3	4	-	1	6

The upper altitude of both the aspects touched almost all distribution pattern by tree, shrub and herb species and largely recorded for random species distribution (Table 4). Comparatively the south facing aspect achieved greater number of species under contagious and random pattern of distribution while, regular distribution was recorded for few species situated in the north facing aspect. Sharma et al. (2009) reported maximum tree species distribution by random pattern in a moist temperate forest of Garhwal Himlaya. According to Odum (1971), the clumped distribution is common in nature, while random distribution is found in uniform environments. Distribution pattern in present study showed effect of aspect also as south facing aspect exhibited with more contagious distribution which may attributed to poor and specific regeneration. The clumping of individuals of a species may be due to insufficient mode of seed dispersal (Richards 1996) or when death of trees creates a large gap encouraging recruitment and growth of numerous saplings (Armesto et al. 1986).

In present study the recorded dominant tree, shrub, and herb species showed changed dispersal with respect of altitude and aspect. *Quercus leucotrochophora* showed contagious pattern in the north facing aspect and changed to random pattern in the south facing aspect at upper and middle altitudes. *Rhododendron arboreum* and *Myrica esculanata* also showed same changes in their distribution at middle and lower altitudes.

In the shrub layer also the contagious pattern was changed to random pattern from north facing aspect to south facing aspect and vice versa. Herb species were mostly recorded in contagious pattern and the change of distribution was found for few species. Sagar et al. (2003) observed that half of species changed dispersion behavior from clumped to uniform distribution and for some species it was changed uniform to clumped distribution. They concluded the changed species dispersion due to result of disturbance.

CONCLUSION

Present study revealed that species distribution pattern was directly influenced by the aspect as well as altitudes. The changes in species dispersion may be due to limit extent of some species for a particular aspect and altitude range and some disturbance occurred by forest surrounding villagers in form of fuel wood and fodder collection. Other factors may also be attributed for change in distribution pattern and density of species in form of uncontrolled grazing/ browsing and forest fires which arrest the regeneration in the forests. There should be a conservative approach by the villagers as well as concerning departments to promote the regeneration of major forest species.

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