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Study of Chir Pine (*Pinus roxburghii* Sarg.) Community along an Altitudinal Gradient in Garhwal Himalaya of Uttarakhand

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Abstract

Present study reports vegetational analysis of a forest dominated by Pinus roxburghii at different slopes. Competition was observed in shrub layer between Berberis aristata and Rhus parviflora, Rubus ellipticus and Pyrus pashia, and Pyrus pashia and Berberis aristata. Community diversity, beta-diversity and concentration of dominance ranged from 1.31 to 2.87; 2.0 to 2.96; and 0.09 to 0.207, respectively. Community diversity was highest (2.87) on the upper slope and was directly related to the number of shrub species. The concentration of dominance followed the opposite trend of diversity index at all the slopes.

Key Words: *Chir-Pine community, Diversity, Dominance, Vegetation analysis*

Introduction

Himalaya has along an altitudinal gradient, from montane to alpine, diversified vegetation which ranges from forests through savana open grazing land. The forests also vary with altitude ranging from *Shorea robusta* in the montane zone to *Quercus semicarpifolia* near timberline and *Quercus leucotrichophora* and *Pinus roxburghii* in the montane zone. It is interesting that in the subalpine zone the north facing slopes bear timberline at lower altitude and on south facing slopes the *Quercus semicarpifolia* wood reaches to higher altitudes than on north facing slopes. Though the preliminary data on submontane and montane forests of Garhwal Himalaya are available (Tiwari *et. al.,* 1989), studies along altitudinal gradients are meager (Joshi and Tiwari 1990). The present study reports on the structure of the forest vegetation along an altitudinal gradient in montane zone of Garhwal Himalaya.

Material and Methods

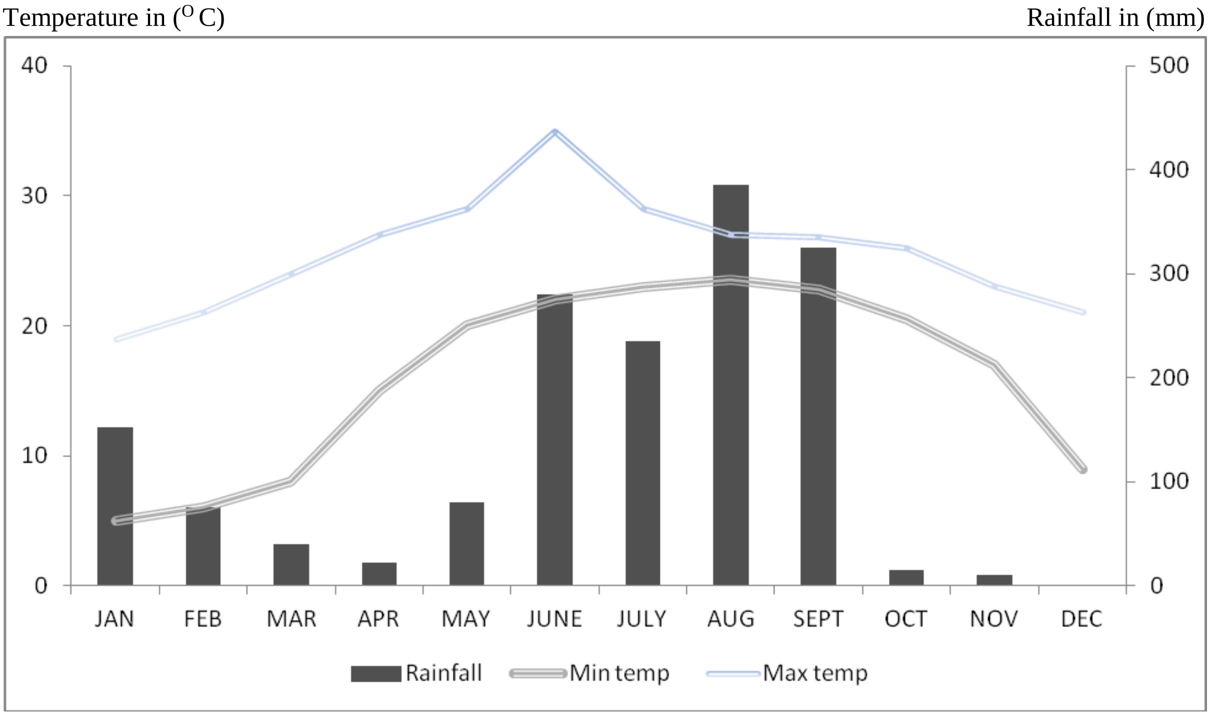
The study was carried out from July to September, 2016 on a mountain flank of Jakhni, Tehri Garhwal (1400-1800 m above MSL), located between 78°53'30" E Longitude and 30"23'30" N Latitude, on the right limb of River Mandakini. The flank dominated by *Pinus roxburghii* covers an area of about 12 km^2 and was divided into lower, middle and upper slopes for convenience (Table1). Each slope was surveyed for species composition, plant density, mean and total basal cover, dominance, species diversity and related parameters.
The climate is subtropical montane type with distinct summer, rainy (monsoon) and winter seasons (Figure 1).

Table 1. Site characteristics in the study area at Jakhni, Tehri Garhwal

Location	Altitude (M)	Slope(o)	Forest type	Aspect
Lower slope	1400	48	*Pinus roxburghii*	South East

Middle slope	1600	50	*Pinus roxburghii*	South East
Upper slope	1800	62	*Pinus roxburghii*	South East

Figure1.Climatic data for Jakhni, Jakholi Block, Tehri Garhwal, 2017



Forest vegetation was analysed by 10x10 m quadrats (Misra 1968) on each slope. The parameters like frequency, abundance, abundance to frequency ratio, density, basal area and Importance Value Index (IVI) were calculated for each species of each slope (Curtis and McIntosh 1950). The ratio of abundance to frequency indicates the distribution pattern of the species (Whitford 1949). It is regular if <0.025, random (between 0.025-0.05) and contagious if >0.05 (Curtis and Cottam 1956). Circumference at breast height (CBH) of trees (1.37 m) was calculated. Plants with CBH more than 31.5 cm were considered trees and those with 10.5-31.4 cm were considered as saplings or shrubs and individuals with Cbh < 10.5 cm were considered as seedlings.

Species diversity (H) was determined with Shannon-Wiener information function (Shannon-Wiener 1963). Concentration of dominance (C) was calculated by Simpson Index (Simpson 1949). Following Whittaker (1975), beta-diversity (β) was computed to measure the rate of species change across the stands.

Results and Discussion

Pinus roxburghii was the dominant species in all the three strata viz., tree, sapling and seedling on each slope. The IVI was maximum (142.8) for the tree stratum and minimum (20.5) for the seedling stratum on middle slope. In the sapling stratum *Alnus nepalensis* also showed its presence (IVI = 9.7) on lower slope. In the seedling stratum, *Lyonia ovalifolia* shared the dominance on the middle and lower slopes. Though the dominance was identical on each slope, yet species composition varied due to difference in slope and altitude. All the strata, except shrubs, on each slope were dominated by *Pinus roxburghii* indicating that if identical environmental conditions continue, the slope would remain dominated by this species. On the slopes *Berberis aristata*, *Rubus ellipticus* and *Pyrus pashia* were the dominant species and were competing with *Rhus parviflora*, *Pyrus pashia* and *Berberis aristata*, respectively, on upper, middle and lower slopes. It shows that owing to competition the shrub layer might be dominated by the competiting species. The competition in the shrub stratum is due to deep shade in the under canopy environment, as the canopy cover exceeded the values reported for low elevation forests of Central Himalaya (Singh and Singh 1987). The highest shrub density (2960) of *Berberis aristata* on the upper slope depicts the progressive secondary succession to achieve disclimax stage irrespective of existing biotic activities.

Devlal and Sharma (2007) studied the altitudinal changes in dominance diversity and species richness of tree species in a temperate forest of Garhwal Himalaya. Raturi (2012) studied the forest community structure along the altitudinal gradient of District Rudraprayag of Garhwal Himalaya.

Alnus nepalensis (nitrogen fixing species) was recorded only from lower slope in the sapling stratum. Pine (*Pinus roxburghii)* is a light demanding, fire-adapted but fire promoting species. The surface fires averaging, once every two or three years cause substantial nitrogen losses in pine forests (Singh *et. al.*, 1984, Bhandari 1996). According to Mohan and Puri (1954) the *Alnus* community seems to be an early seral stage, and due to the fact that these areas become nitrogen depleted, *Alnus* is the only species to grow and establish itself due to its ability to fix nitrogen (Sharma and Ambasht 1988).

The total basal area across the stands ranged from 24.76 -56.54 m2 ha^{-1} and the total tree density varied between 680 and 1220 ha^{-1} (Table 2). In earlier studies, total basal area and density were reported in the range of 27-84 m2 ha^{-1} and 350-1640 ha^{-1} respectively, for various forest types in a part of *Kumaun* Himalaya (Saxena and Singh 1982, Singh and Singh 1987). The values of density for the present study fall in this range. The values of basal cover are slightly lower suggesting that the present forest stands are younger than the forests of *Kumaun* Himalaya.

Hussain *et.al.*, (2008) reported the species composition and community structure of forest stands in Kumaun Himalaya.

Table2. Density (D), total basal cover (TBC) and Importance Value Index (IVI) of woody species at different altitudes along slopes at Jakhni, Tehri Garhwal

Species	D (Plants ha^{-1})	TBC ($m^2 ha^{-1}$)	IVI
Upper Slope Trees: *Pinus roxburghii*	1220	24.76	106.3
Saplings *Pinus roxburghii*	1710	6.99	55.8
Seedling *Pinus roxburghii*	4710	0.23	59.5
Shrubs *Berberis aristata*	2960	0.35	40.6

Symplocos paniculata	70	0.007	4.7
Pyrus pashia	40	0.006	4.4
Rubus ellipticus	10	0.002	2.7
Rhus parviflora	1540	0.25	5.6
Middle slope Trees: *Pinus roxburghii*	1150	31.05	142.8
Saplings *Pinus roxburghii*	690	2.594	45.3
Seedlings *Pinus roxburghii*	10020	0.003	20.5
Lyonia ovaliolia	220	0.047	13.5
Shrubs *Pyrus pashia*	300	0.029	21.1
Rhus parviflora	440	0.055	16.5
Rosa brunoii	180	0.021	15.8
Rubus ellipticus	350	0.049	24.2
Lower Slope Trees: *Pinus roxburghii*	680	56.54	126.6
Saplings *Pinus roxburghii*	590	2.16	33.9
Alnus nepalensis	90	0.43	9.7
Seedlings *Pinus roxburghii*	12250	0.089	44.8
Lyonia ovalifolia	920	0.148	30.6
Shrubs *Berberis aristata*	320	0.063	14.0
Cotinus spp	140	0.023	6.6
Pyrus pashia	440	0.013	23.5
Rhus parviflora	200	0.024	9.6

Distribution of the species exhibits an interesting pattern due the dominance of a single tree, sapling and seedling species in all strata. All the species were contagiously distributed. Regular and random distribution was not recorded from the study sites. Joshi and Tiwari (1990) and Bhandari *et. al.*, (1995) also reported identical distribution pattern of woody vegetation in different parts of Garhwal Himalaya. Singh *et. al.*, (2009) studied the distribution pattern of Oak and Pine along altitudinal gradients in Garhwal Himalaya. Odum (197l) also stated that in the natural conditions, the contagious distribution is most common.

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Diversity and Related Parameters

The total diversity was highest (2.87) on the upper slope while it was 1.50 and 1.31, for middle and lower slopes, respectively (Table 3). These values are comparable with those generally reported for temperate forests (Monk 1967, Singh and Singh 1987). The lower diversity in temperate and subtropical vegetation could be due to lower rate of evaluation and classification of communities and severity in the environment. Singh and Saxena (1982) reported the diversity index value from 0 to 1.44 for trees +saplings, and 0 to 0.94 for shrubs + seedlings in the pine (*Pinus roxburghii*) forest of Kumaun Himalaya.

Table 3. Species diversity (H), beta diversity *(β)*, and concentration of dominance (C) of woody species calculated on community basis

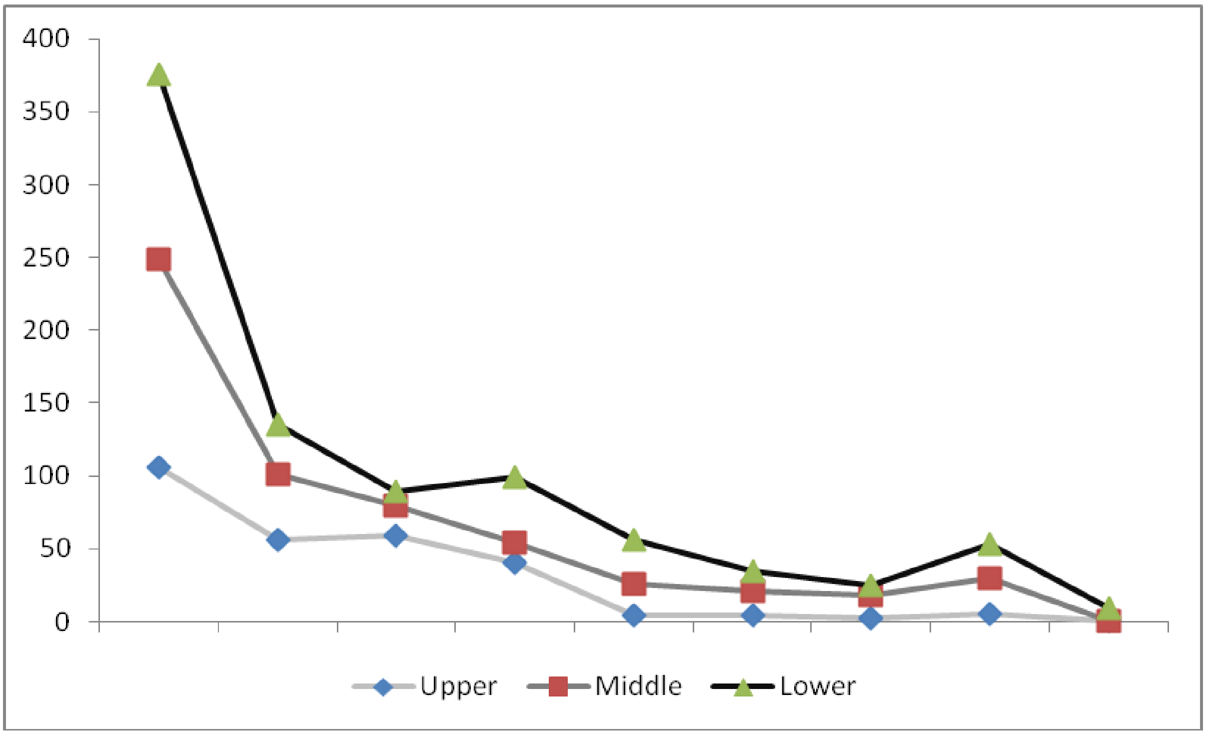
Component	H	B	C
Upper Slope			
Trees	0.331		0.006
Saplings	0.111		0.015
Seedlings	0.407	2.96	0.043
Shrubs	2.025		0.125
Community diversity	2.874		0.190
Middle Slope			
Trees	0.528		0.112
Saplings	0.465		0.040
Seedlings	0.201	2.0	0.045
Shrubs	0.311		0.009
Community diversity	1.506		0.207
Lower Slope			
Trees	0.406		0.022
Saplings	0.244		0.008
Seedlings	0.426	2.58	0.056
Shrubs	0.234		0.004
Community diversity	1.311		0.090

The concentration of dominance (C) (0.19-upper, 0.21- middle and 0.09-lower slope) is more or less similar to that reported by Whittaker (1965) and Risser and Rice (1971) for certain temperate vegetation. Saxena and Singh (1982) reported the values to be 0.13 to 1.00 for woody species, and Tiwari and Singh (1985) observed C values in the range of 0.11 to 0.93 for tree layer in different forests of *Kumaon* Himalaya.

Beta diversity (β) was 2.96, 2.00 and 2.58 respectively, for upper , middle and lower slopes. Small differences in the beta-diversity indicate that the growth forms in the stands respond similarly (Adhikari *et. al*,. 1991). These values are much lower than those reported for oak forests of *Kumaon* Himalaya (Tewari and Singh 1985). Low values of beta diversity (β) show that the species composition does not vary significantly across the slopes. Rawat and Chandra (2014) studied vegetational diversity analysis along different habitats in Garhwal Himalaya.

The dominance diversity (d-d) curve approached a geometric series along all altitudinal gradients (Figure 2). The geometric form is often shown by vascular plant communities with low diversity (Whittaker 1972).

Figure 2. Dominance Diversity Curve For Woody Species at Different Altitudinal Gradients



It is evident that the total actual area occupied by woody plants (trees + seedlings + saplings) was 126.11 m^2 (1.26%). It is obvious to conclude that the mountain flank has an open plant community and there is no chance of invasion by new species and the beginning of secondary succession if suitable management practices are implemented well in time.

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