Altitudinal changes in dominance-diversity and species richness of tree species in a temperate forest of Garhwal Himalaya

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Abstract

In this study, we examined the species composition, diversity and concentration of dominance of tree species along an altitudinal gradient of Garhwal Himalaya. Vegetational analysis of tree species was analysed identifying four forest stands along an altitude of (1200 – 1800 m). *Quercus leucotrichophora* emerged as a dominant species on the Stand III (1600 m) and Stand IV (1800 m) with the highest importance value index values 138.79 & 74.49 respectively. The total density ranged from 1166 to 1828 trees/ha. Species diversity ranged from 1.00 to 2.07 maximum diversity reported for Stand IV (1800 m) and minimum diversity (1.00) recorded for Stand I (1200 m). [Life Science Journal. 2008; 5(2): 53 – 57] (ISSN: 1097 – 8135).

Keywords: altitude; diversity; species richness

1 Introduction

The temperate forests of Western and Central Himalaya are usually distributed between 1200 and 3000 m asl which are represented either by pure Oak or Oak- *Rhododendron* mixed forests. Puri (1960) considered that these forests represent climatic climax of one or other species of *Quercus* in upper altitudinal zones. The lower elevations of the temperate forest are occupied by Oak-Pine mixed forests and *Quercus semicarpifolia* with other coniferous at higher altitudes, normally form the climax vegetation. Other species of Oak are found above the Oak-Pine forests of Garhwal Himalaya (Osmaston, 1922). The oaks are the most preferred species in the entire region and used mainly for fuel, fodder and small timber. The forests also vary with altitude ranging from *Shorea robusta* in submontane zone to *Quercus semicarpifolia* near timberline and *Quercus leucotrichophora* and *Pinus roxburghii* in the montane zone (Bhandari *et al*, 1997). It is interesting that in the sub alpine zone to 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. The various changes in the Himalayan forests are appearing in their structure, density and composition due to global warming (Gaur, 1982), uncontrolled lopping and felling of trees for fuel wood, fodder and grazing (Bargali *et al,* 1998; Kumar *et al*, 2004).

Species diversity and its distribution along the altitudinal gradient had been a subject of ecosystem. Earlier Rahbek (1997) viewed that approximately half of the studies detected a mid altitude peak in species richness, in a critical literature review on species richness patterns in relation to altitude. Grytnes and Vetaas (2002) have also reviewed these aspects in Nepalese Himalaya. Though the plant community of a region is a function of time, nevertheless, altitude, slope, latitude, aspect, rainfall and humidity had played a role in the formation of community composition.

A lot of work has been done by various workers on submontane and montane forests of Western and Central Himalaya. The analytical and synthetic behavior of high altitude forests of Kumaun Himalaya study by Ralhan *et al* (1982), Saxena & Singh (1982), Singh & Singh (1986), Adhikari *et al* (1991).

Though several studies have been done on the plant communities of the Garhwal was done by Tiwari *et al (*1989), Joshi & Tiwari (1990), Bisht & Kusumlata (1993),

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Bhandari *et al* (1995 & 1997), and Kumar *et al* (2004). In the present study we try to understand the variation in tree species along the altitudinal gradient in a temperate forest for Garhwal Himalaya.

2 Materials and Methods

2.1 Study site

The present study was carried out along an altitudinal gradient in the temperate forest of Narayanbagar block of chamoli district. It lies in the Central Himalaya between the latitude 29º31'9" N and 31º26'5" N and longitude 77º33'5" E and 80º6'0" E with a total area of 29089 km^2. A total of four forest stands were selected at different altitudes (1200 m – 1800 m) to examine the changes on the tree vegetation (Table 1).

2.2 Climate

As the elevation of the district ranges from 800 m to 8000 m above sea level the climate of the district very largely depends on altitude. The winter season is from about mid November to March. As most of the region is situated on the southern slops of the outer Himalayas, monsoon currents can enter through the valley, the rainfall being heaviest in the monsoon from June to September.

2.3 Methods

Vegetational analysis of the selected forest stands along an altitudinal gradient was carried out in the year 2004 by using 10 × 10 m quadrates. The quadrates were laid out randomly for tree species throughout the selected forest stands. The size and the number of quadrates were determined following Misra (1968) and Kershaw (1973). In each quadrate, trees were recorded with > 31.5 cm cbh (Circumference at breast height i.e. 1.37 m above the ground) individually measured. The vegetational data were quantitatively analysed for abundance, density and frequency according to the formulae given by Curtis and McIntosh (1950) and Misra (1968). The relative values were summed up to represent importance value index (IVI) as Curtis (1959) reported. The diversity index (H') was computed by using Shannon-Wiener information Index (Shannon and Wiener, 1963). The concentration of dominance (CD) was computed by Simpson's Index (Simpson, 1949).

3 Results

The study showed that the total number of the tree species varied from 3 to 9 from Stand I (1200 m) to Stand IV (1800 m). The highest number of tree species was recorded from Stand IV (1800 m) due to relatively open habitat which provided congenial environment for the growth of different species. Figure 1 showed the total density of tree species ranged between 1166 trees/ha (Stand I) to 1826 trees/ha (Stand II, 1400 m). Meanwhile total density (1311 trees/ha) recorded for Stand III (1600 m) and 1698 trees/ha for Stand IV (1800 m) respectively.

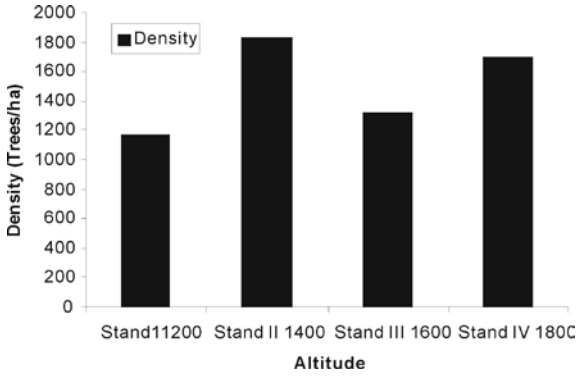

Figure 1. Altitude wise changes in total density (trees/ha) of study area

Altitudinal changes in density IVI and diversity were set in Tables 2, 3 and 4. On the basis of density, *Quercus leucotrichophora* was the dominated species on the Stand III (1025 trees/ha) and Stand IV (687 trees/ha). Meanwhile tree species *Pinus roxburghii* (783 trees/ha) dominated in Stand I (1200 m) and *Rhododendron arboretum* (514 trees/ha) in Stand II (1400 m) (Table 2). Dominance of tree species were observed by calculating the IVI and results were depicted in Table 3. Study revealed that *Quercus leucotricophora* is the most dominant species of Stand III (1600 m) and Stand IV (1800 m) with maximum IVI values (138.79 and 74.49) respectively.

Table 1. General characteristics of the study area

Forest stand	Altitude (m)	Aspect	Dominant spp.
I	1200	South-West	*Pinus roxburghii, Machilus duthi*
II	1400	East	*Rhododendron arboreum, Lyonia ovalifolia*
III	1600	East	*Quercus leucotrichophora, Lyonia ovalifolia*
IV	1800	East	*Quercus leucotrichophora, Rhododendron arboreum*

Table 2. Altitude wise variation in the values of density (trees/ha)

Tree species	Stand I (1200)	Stand II (1400)	Stand III (1600)	Stand IV (1800)
Ficus semicordata Buch -Ham.ex.J.E.Smith	183			
Lyonia ovalifolia (Wall) Drude		442	37	175
Machilus duthi King ex Hook.f.	200			
Myrica esculenta Buch-Ham ex. D.Don		257		175
Pinus roxburghii Sargent	783	200	87	
Pyrus pashia Buch-Ham ex.D.Don			50	50
Quercus floribunda Lindley ex Rehder				200
Quercus glauca Thunb.				25
Quercus. leucotrichophora A.Camus		371	1025	687
Rhododendron arboreum Smith.		514	75	312
Stranvaesia nussia Buch-Ham ex.D.Don				12
Symplocos paniculata (Thunb,) Miq		42	37	62

Table 3. Altitude wise changes in values of IVI

Tree species	Stand I (1200)	Stand II (1400)	Stand III (1600)	Stand IV (1800)
Ficus semicordata Buch -Ham.ex.J.E.Smith	63.84			
Lyonia ovalifolia (Wall) Drude		60.19	44.39	34.17
Machilus duthi King ex Hook.f.	72.12			
Myrica esculenta Buch-Ham ex. D.Don		51.02		32.36
Pinus roxburghii Sargent	164	54.45	39.23	
Pyrus pashia Buch-Ham ex.D.Don			17.42	15.5
Quercus floribunda Lindley ex Rehder				33.63
Quercus glauca Thunb.				16.90
Quercus. leucotrichophora A.Camus		54.82	138.79	74.49
Rhododendron arboreum Smith.		64.01	29.73	47.2
Stranvaesia nussia Buch-Ham ex.D.Don				28.98
Symplocos paniculata (Thunb,) Miq		15.51	30.43	16.76

Table 4. Altitude wise changes in species richness (R), diversity (H') and concentration of dominance (CD) for tree in selected forest stands

Altitude	R	H'	CD
Stand I (1200 m)	3	1.00	0.40
Stand II (1400 m)	6	1.72	0.18
Stand III (1600 m)	6	1.53	0.27
Stand IV (1800 m)	9	2.07	0.13

Species diversity (H') ranged from (1.00 – 2.07). Species diversity and concentration of dominance are generally inversely related. The values of species richness (R), species diversity (H') and CD were given in Table 4. Species richness and diversity of tree species along an altitudinal gradient ranged between (3 – 9) & (1.00 – 2.07) respectively. Maximum diversity (2.07) reported for Stand IV (1800 m) with the maximum number of species richness (9) whereas minimum diversity (1.00) recorded for Stand I (1200 m) with minimum number of tree species (3). Concentration of dominance showed reverse trend as compared to species diversity. In the present study the value of concentration of dominance ranged between 0.13 (Stand IV, 1800 m) to 0.40 (Stand I, 1200 m).

4 Discussion

The present study was conducted along an altitudinal gradient in a temperate forest of Garhwal Himalaya. The highest number of tree species (9) was recorded from Stand IV (1800 m) due to relatively open habitat which provided congenial environment for the growth of different species. Figure 1 showed the total density of tree species ranged between 1166 trees/ha (Stand I) to 1826 trees/ha (Stand II). The present values of density were higher as compared to those for submontane forest (Bhandari *et al*, 1997), suggesting that the present stands were much older than the submontane forests of Garhwal Himalaya. Study revealed that *Quercus leucotricophora* is the most dominant species of all stands. Oak (*Qurecus spp*) forests are most extensively distributed between the altitudes 1000 m to timberline and represent the climax stage, throughout the central Himalaya (Champion and Seth, 1968; Upreti *et al*; 1985). In these forests, one or other species of oak exhibits clear-cut dominance over other associated tree layer (Singh &Singh, 1986). Three oak species (Q*urecus floribunda, Quercus glauca* and *Quercus leucotrichophora*) were recorded in present forest stands but none of these attained a clear-cut dominance.

Species richness and diversity of tree species along an altitudinal gradient ranged between (3 – 9) and (1.00 – 2.07) respectively. CD showed reverse trend as compared to species diversity. In the present study the value of concentration of dominance ranged between 0.13 (Stand IV, 1800 m) to 0.40 (Stand I, 1200 m). These values are generally comparable with the values reported for temperate forests (Singh & Singh, 1986). Lower diversity in the temperate forests could be due to lower rate of evolution and diversification of community (Simpson, 1949) and severity in the environment (Conell and Oris, 1964). Species diversity and concentration of dominance are generally inversely related. The value of concentration of dominance ranged from 0.13 to 0.40. These findings supported the range reported by Risser and Rice (1971) for temperate forests. The data in Table 4 indicates that increasing diversity and reduced concentration of dominance is associated with increased stability (McNaughton, 1967). Pandey and Singh (1985) have also reported increasing species diversity in disturbed ecosystem of Kumaon Himalaya.

It is a well known fact that the altitude represents a complex gradient along which many environmental variables change concomitantly. Rahbek (1997) explain the patterns in species richness decrease with altitude. Highly diverse compositional pattern of forests characteristic of central Himalaya, has been explored by (Singh & Singh 1987). Besides the ecosystem functions the distribution and occurrence of species had been affected by human interventions (Singh & Singh, 1987). Among human influence, commercial exploitation, agricultural requirements, forest fire, and grazing pressure are the important source of disturbance (Singh & Singh, 1992).The result of present sturdy is pronounced that as well as the altitude is increase the tree diversity is also increase which is the result of above biotic disturbance and invasion by new species on these stands.

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