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 (1200-1800m). *Quercus leucotrichophora* emerged as a dominant species on the (Stand III, 1600m and Stand IV, 1800m) with the highest IVI 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, 1800m and minimum diversity (1.00) recorded for Stand I, 1200m. [The Journal of American Science. 2008;4(3):46-54]. (ISSN 1545-1003).

Key words: Altitude, Diversity, Species richness

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 (Osmoston, 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 a play 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, (1987) 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; Bhandari et al, 1995; & 1997; 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.

Material and Methods

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 $29^0$31'9"N and 31^0 26'5"N and longitude $77^0$33'5" E and $80^0$6'0" E with a total area of 29, 089 km^2. A total of four forest stands were selected at different altitudes (1200m –1800m) to examine the changes on the tree vegetation (Table: 1).

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.

Methods

Vegetational analysis of the selected forest stands along an altitudinal gradient was carried out in the year 2004 by using 10 X 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 quadrates, trees were recorded with >31.5 cm cbh (Circumference at breast height i.e. 1.37m above the ground) individually measured. The vegetational data were quantitatively analysed for abundance, density and frequency according to the formulae given by Curtis and Mc Intosh (1950) and Mishra (1968). The relative values were summed up to represent Importance Value Index (IVI) as per Curtis (1959). 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).

Results

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

Altitudinal changes in density Important value index and diversity are set in (Table 2, 3 and 4). On the basis of density *Quercus leucotrichophora* (1025 trees/ha and 687 trees/ha) was the dominated species on the (Stand I, 1200m) and (Stand IV, 1800m). Meanwhile Tree species *Pinus roxburghi*i (783 trees/ha) dominated in (Stand I, 1200m) and *Rhododendron arboretum* (54 trees/ha) in (Stand III, 1600m) Table 2. Dominance of tree species were observed by calculating the Important value index and result are depicted in Table 3. Study revealed that *Quercus leucotricophora* is the most dominant species of (Stand III, 1600m and Stand IV,1800m) with maximum IVI values (138.79 and 74.49) respectively.

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 concentration of dominance (cd) are 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, 1800m) with the maximum number of species richness (9) whereas minimum diversity (1.00) recorded for (Stand I, 1200m) with minimum number of tree species (3). Concentration of dominance (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 1800m) to 0.40 (Stand I, 1200 m).

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 arboretum Smith.		514	75	312
Stranvaesia nussia (Buch-Ham ex.D.Don)				12
Symplocos paniculata (Thunb,)Miq		42	37	62

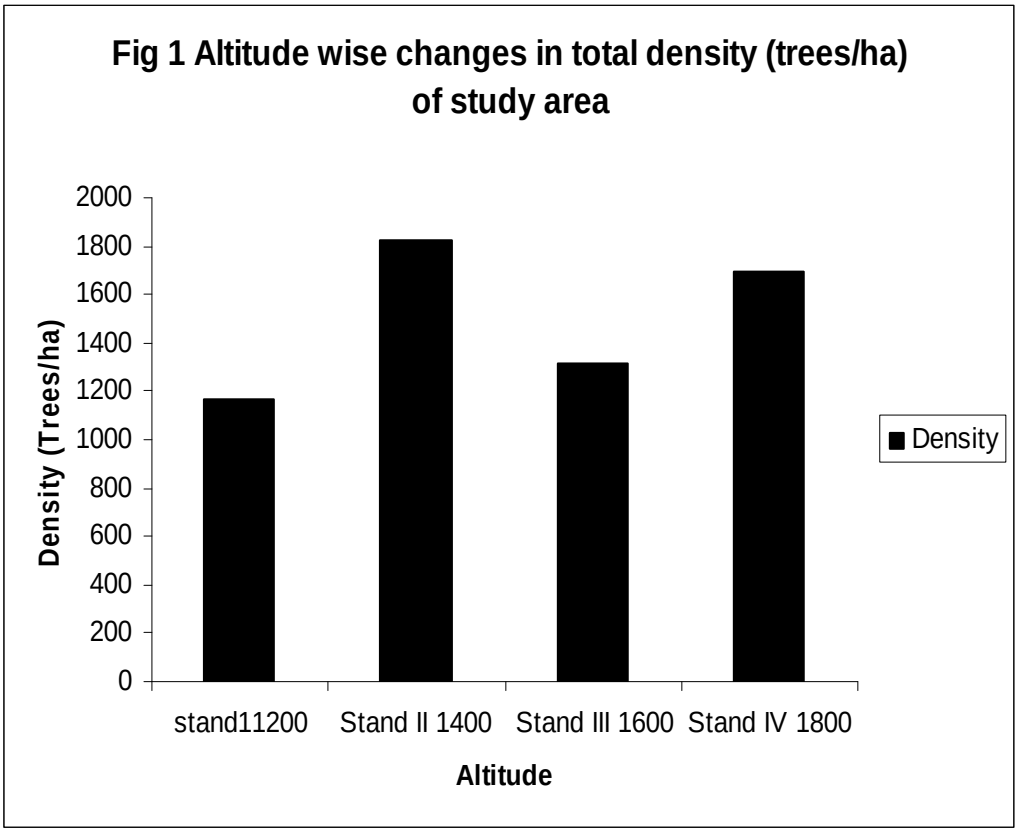
Table 3. Altitude wise changes in values of IVI (Important value Index)

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 arboretum 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 34 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 (1200m)	3	1.00	0.40
Stand II (1400m)	6	1.72	0.18
Stand III (1600m)	6	1.53	0.27
Stand IV (1800m)	9	2.07	0.13



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 1800m) due to relatively open habitat which provided congenial environment for the growth of different species. Fig 1 shows the total density of tree species ranged between (1166 trees/ha Stand I to 1826 trees/ha Stand II, 1400m). The

present values of density are higher as compared to those for submontane forest (Bhandari et al, 1997), suggesting that the present stands are 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 1000m 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 (*Qurecus floribunda, Quercus glauca and Quercus leucotrichophora*) were recorded in present forest stands but none of these attains a clear-cut dominance.

Species richness and diversity of tree species along an altitudinal gradient ranged between (3-9) & (1.00-2.07) respectively. Concentration of dominance (cd) showed reverse trend as compared to species diversity. In the present study the value of concentration of dominance ranged between 0.13 (Stands IV 1800m) to 0.40 (Stand I, 1200m). These values are generally comparable with the values reported for temperate forests (Singh & Singh, 1987). 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 support 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 (Mc Naughton, 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 et al, 1987). Among human influence, commercial exploitation, agricultural requirements, forest fire, and grazing pressure are the important source of disturbance (Singh et al, 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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References

Adhikari B.S, Rikhari, H.C, Rawat Y. S and Singh S.P. (1991) High altitude forest: Composition diversity and profile structure in a part of Kumaun Himalaya; *Trop Ecol*. **32**: 86-97.

Bargali, K., Usman and Joshi, M. (1998). Effect of forest covers on certain site and soil characteristics in Kumaun Himalayas. *Indian Journal of Forestry*, **21**(3): 224-227.

Bhandari, B. S (1995) Recovery of a submontane grazingland following summer burning; D.Phil Thesis; HNB Garhwal University Srinagar (Garhwal).

Bhandari, B.S., Mehta, J.P. Nautiyal, B.P. and Tiwari, S.C. (1997) Structure of a Chir Pine (*Pinus roxburghii* Sarg.) community along an altitudinal gradient in Garhwal Himalaya. *International Journal of Ecology and Environmental Science* **23**: 67-74

Bisht, N. S and Kusumlata (1973) Niche width and dominance diversity relations of woody species in a moist temperate forest of Garhwal Himalayas; *J. Hill. Res*. 6 107-113.

Champion, H. G and Seth, S.K (1968) *A Revised Survey of the Forests Types of India* (New Delhi: Govt. of India Publications) 404pp

Conell, J. H. and Oris, E. (1964). The ecological regulation of species diversity. *American Naturalist* **48**: 399-414.

Curtis, J. T. (1959) The Vegetation of Wisconsin. An ordination of plant communities, University Wisconsin press, Madison Wisconsin, 657pp.

Curtis, J. T. and M.C. Intosh, R.P. (1950) The interrelation of certain analytic and synthetic phytosociological characters. *Ecology* **31**: 434-455.

Gaur, R.D. (1982) Dynamics of vegetation of Garhwal Himalayas. *The vegetational Wealth of the Himalayas* (ed. G. S. Paliwal).pp. 12-25.

Grytnes, J.A. and Vetaas, O.R., (2002) Species richness and altitude: A composition between null models and interpolated plant species richness along the Himalayan altitudinal gradient, Nepal. Am. Nat. 159, 294-304

Joshi, N. K. and Tiwari, S. C. (1990) Phytosociological analysis of woody vegetation along an altitudinal gradient in Garhwal Himalya. *Indian Journal of Forestry* **13** (4): 322-328.

Kershaw, K. A.(1973) Quantitative and Dynamics Plant Ecology (2nd Edition), ELBSD & Edward Arnold, London.

Kumar, M., Sharma C.M. and Rajwar, G. S. (2004)A study on the community structure and diversity of a sub-tropical forest of Garhwal Himalayas. *Indian Forester* **130** (2): 207-214.

Mc Naughton, S. J. (1967). Relationship among functional properties of California grassland. *Nature* **216**: 168-169

Misra, R. (1968) Ecology Work Book. Oxford and IBH Publishing, New Delhi.

Odum, E. P. (1971) Fundamentals of Ecology 3rd ed (Philadelphia: WB Saunders Co.), 574pp

Osmaston, A. E., (1927) Forest flora of Kumaun, Govt. Press, United Provinces, Allahabad, p 605.

Osmaston, A. E. (1922) Notes on the forest communities of the Garhwal Himalaya. *Journal of Ecology* **10**: 129-187

Pandey, A. N. and Singh, J. S. (1985). Mechanism of ecosystem recovery: A case study of Kumaun Himalaya, *Recreation and Revegetation Research* **3:** 271-292.

Puri, G. S. (1960) Indian Forest Ecology 2 Vol. New Delhi.

Rahbek, C., (1997) The relationship among area, elevation and regional species richness in Neotropical birds. Am. Nat., 149, 875-902

Ralhan, P. K., Saxena, A.K. and Singh, J. S. (1982.) Analysis of forest vegetation at and around Nainital in Kumaun Himalaya. *Proc. Indian National Sciences Academy* **348**: 121-137.

Risser, P. G. and Rice, E. I. (1971). Diversity in tree species in Oklahoma upland forests. *Ecology* **52**: 876-880.

Rodhe, K., (1992) Latitudinal gradients in species diversity: The search for the primary cause. *Oikos* 65 514-527

Saxena, A.K. Singh, J.S. (1982) A Phytosociological analysis of woody species in forest communities of a part of Kumaun Himalaya. *Vegetatio* **50**:3-22.

Shannon, C. E. and Wiener, W. (1963). The Mathematical Theory of communication. University of lllinois press, Urbana. 117pp.

Simpson, E. H. (1949). The Measurement of Diversity. *Nature.* 163-688.

Singh, J. S and Singh S. P. (1987) Forest vegetation of the Himalaya; *Bot. Rev.* **52** 80-192.

Singh, S.P. & J. S. Singh. (1986). Structure and function of the Central Himalayan oak forests. *Proceeding Indian Academy of Science* (Plant Sci.) 96: 159-189.

Singh, J. S. and Singh, S.P., (1992) Forest of Himalaya: Structure, Functioning and impact of Man, Gyanodaya Prakashan, Nanital

Tiwari, S. C. Rawat, K. S., Semwal, R. L. and Joshi, N. K. (1989) Phytological investigation on some landscapes of Garhwal. Final Technical Report. Univ. Grants Commission, New Delhi. 86 Pages.

Upreti, N., J. C. Tewari and S.P. Singh. (1985). The oak forests of Kumaun Himalaya (India): Composition, Diversity, and regeneration. *Mountain Research and Development* **5**: 163-174