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Full Length Research Paper

Vegetational diversity along an altitudinal range in Garhwal Himalaya

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Four forest habitats varying in different vegetation were studied along an altitudinal range of 1900-2200 m called low elevation forests. These forests were close to human habitation with high disturbance. A total of 209 plant species were recorded out of which 29 were trees, 50 shrubs, 102 herbs, 11 climbers, 7 epiphytes, 4 pteridophytes, 3 bryophytes and 3 parasites. Maximum tree species were recorded on moist site (22) and minimum on ridge site (12). Maximum shrub species were present both on stream bank and dry site (31 at each site). Maximum herb and climber species were present on dry and moist site (62 and 8) respectively. Species relationship between the sites indicates that 11 trees, 20 shrubs, 41 herbs, 4 climbers, 2 pteridophytes, 1 bryophyte and 2 parasites were common in stream bank and dry site. The mean tree, shrub and herb species richness was maximum on stream bank (6.3 ± 0.2), moist (6.1 ± 0.3) and dry (10.3 ± 0.4) and minimum on ridge site (4.6 ± 0.3), (5.5 ± 0.4), (7.6 ± 0.5) respectively. Comparison similarity between the sites revealed maximum similarity among stream bank and moist sites (70%) for trees and minimum between ridge and moist site (32.43%) for herbs. The high similarity index between moist and stream bank site may be due to similar environmental conditions on both the sites.

Key words: Species richness, study sites, vegetation, Garhwal Himalaya.

INTRODUCTION

The Garhwal Himalaya is one of the hot spot of biodiversity situated in the western part of Central Himalaya. The unusually wide altitudinal range, rapid change in altitudinal gradient even at small distances and high endemism make it interesting for studies (Singh and Singh, 1992; Zobel and Singh, 1997). Conversion of forest land into non forest activity is one of the major threats to the ecosystem functioning and biodiversity depletion (Prentice and Parish, 1990). Ecologists worldwide are concerned about the habitats, which are fragmented by human activity, urgently need extensive study to preserve their ecology and biodiversity with prioritization of internationally collaborative research studies. The need for preservation lies in the value of the component of diversity, which includes the direct benefits arising from the conservation of those components viz., ecosystems services, biological resources and social benefits (Heywood, 1995). Diversity at all organization levels, ranging from genetic diversity within a population to the diversity of ecosystems in landscape, contributes to global biodiversity. The effects on functioning of ecosystems and species diversity influence the resilience and resistance of ecosystems to environmental changes (Chapin et al., 2000). Species diversity of a floristic community in an ecosystem represents and regulates the functioning of the ecosystem.

Garhwal Himalaya has been a source of knowledge for their unique vegetational wealth since time immemorial. The oak and oak mixed forest comprises the major forest types of Garhwal Himalaya and distributed at an elevations between 500 - 2000 and 1700 - 2800 m, respectively. The vegetation diversity of forest ecosystems of Himalaya is influenced by topography, soil, climate and geographical location of the region. There is a great diversity in the floristic pattern due to altitudinal variation, and rainfall (Arora, 1995). The biodiversity varies with change in latitude or altitude. As we move from high to low latitude (from pole to equator), the biological diversity increases. Similarly, a decrease in species diversity was noticed from lower to higher altitude on a mountain in

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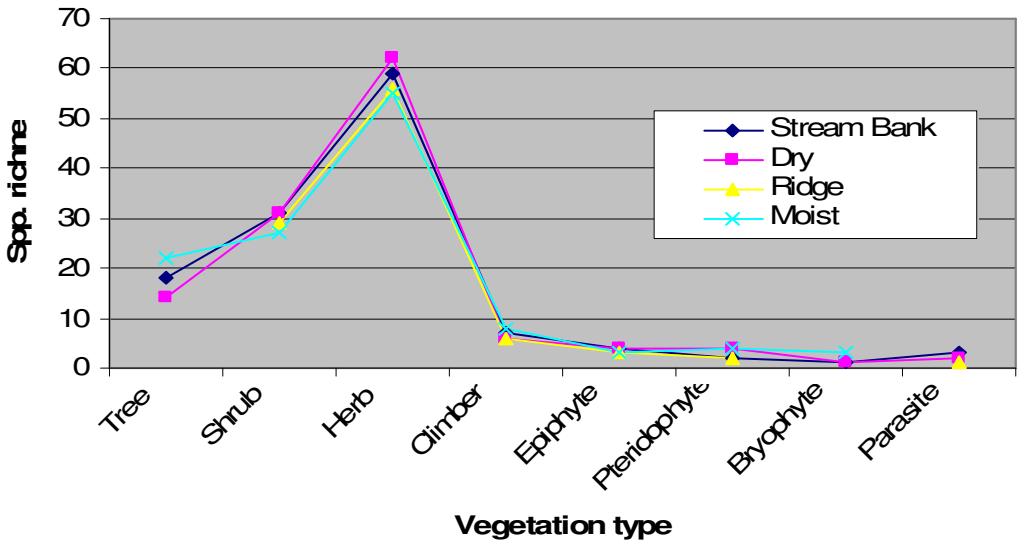

Figure 1. Species richness in different habitats.

on a mountain in terrestrial environment (Singh et al., 1994). The difference in micro- environment condition may also cause variation in plant diversity and species distribution. Various plant forms especially the climber, parasite and tree Trunk vegetation may respond to climate change. Species of lower growth forms like herbs, climbers, epiphytes, pteridophytes and bryophytes may respond more quickly compared to species of higher growth forms like tree and shrubs.

The present study deals with variations in species richness and species composition in different habitats along low elevation (1900 - 2200 m) forests of Garhwal Himalaya.

MATERIALS AND METHODS

The study area is located in between 30°2'43" N and 30°3'27" N latitude and 79°24'43" and 79°26'46" longitude between 1900 - 2500 masl in Garhwal Himalaya. The mean monthly maximum and minimum temperature was 25.5°C in June and 2.5°C in February respectively. The average monthly maximum rainfall was 510.8 mm in August, and minimum 10.4 mm in November. The meteorological data were collected from Krishi Vigyan Kendra Gwaldam (Uttarakhand) during year (2003 - 2004). Rocks are complex mixtures of mainly sedimentary, low grade metamorphosed and igneous type (Valdiya, 1980). The area is covered by oak mixed forest. The important species are *Lyonia ovalifolia, Quercus spp., Rhododendron arboreum*, *Myrica esculenta*, *Cedrus deodara, Cornus capitata* and *Aesculus indica*. The study area were selected on the basis of habitats which is divisible in to four sites (stream bank, dry, ridge and moist sites). These sites were situated near the settlement and have intermittent disturbances like grazing, lopping for fuel wood and fodder, litter removal and occasional fire. Phytosociological analysis in the area was done by placing randomly 10, 100 m^2 circular quadrats, the size and number of samples were determined following Saxena and Singh (1982). The vegetation data were calculated for density, frequency, abundance (Curtis and McIntosh, 1950). Species diversity was computed by using Shannon-Wiener index (1963). The plant species were collected annually and brought to the laboratory, preserved and mounted in a herbarium sheet and identified according to the flora of Chamoli (Naithani, 1984), Flora of Himalaya (Polunin and Stainton, 1984). The plant species collected was categorized as tree, shrub, herb, climber and tree trunk vegetation (epiphyte, pteridophyte, and parasite). Total species richness was the sum of all species present in a site considering all samples and mean species richness was determined following Whittaker (1972).The data were analyzed using SPSS Version 12. The variation in species richness in different sites was analyzed using GLM univariate analysis as 2 elevation × 4 habitat × 30 plots. Least Significance Difference (LSD) was also determined to differentiate richness among the sites (habitats) and between the elevations. T-test was applied to differentiate the species richness between elevations following Snedecor and Cochran (1967).

RESULTS

A total of 209 plant species were present at low elevation out of which 29 were trees, 50 shrubs, 102 herbs, 11 climbers, 7 epiphytes, 4 pteridophytes, 3 bryophytes and 3 parasites. Maximum tree species were recorded on moist site (22) and minimum on ridge site (12). Maximum shrub species were present both on stream bank and dry site (31 at each site) and minimum on moist site (27). Maximum herb and climber species were present on dry and moist site (62 and 8) respectively. 12 species each 4 of epiphytes, pteridophytes, bryophytes were present on stream bank site, dry and moist sites respectively (Figure 1). Species relationship between the four sites indicates that 11 trees, 20 shrubs, 41 herbs, 4 climbers, 2 pteridophytes, 1bryophytes and 2 parasites were common in stream bank and dry site. However 9 trees, 19 shrubs, 35 herbs, 4 climbers, 3 epiphytes, 2 pteridophytes and 1

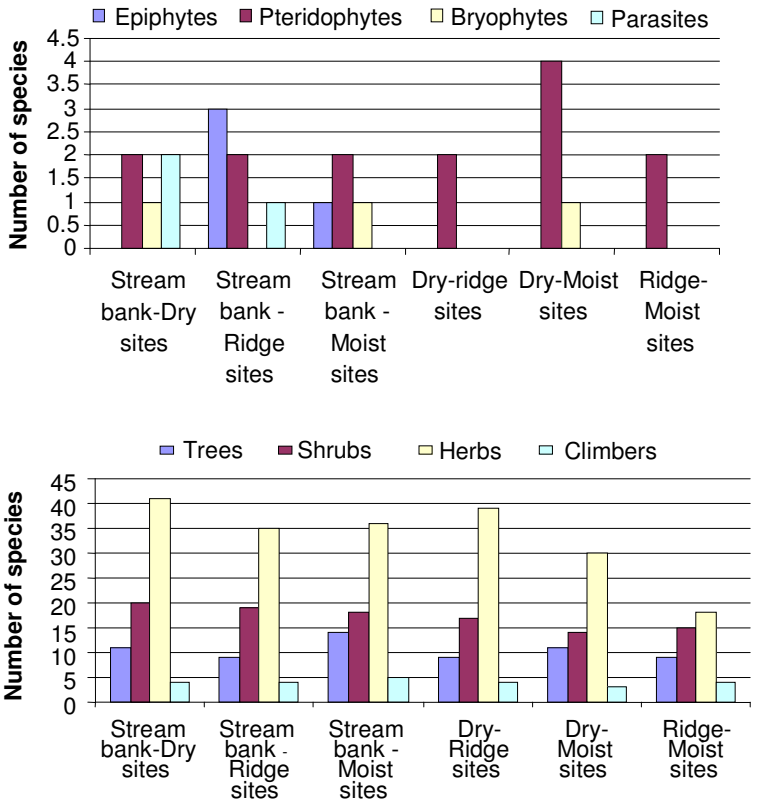

Figure 2. Species relationship between different sites.

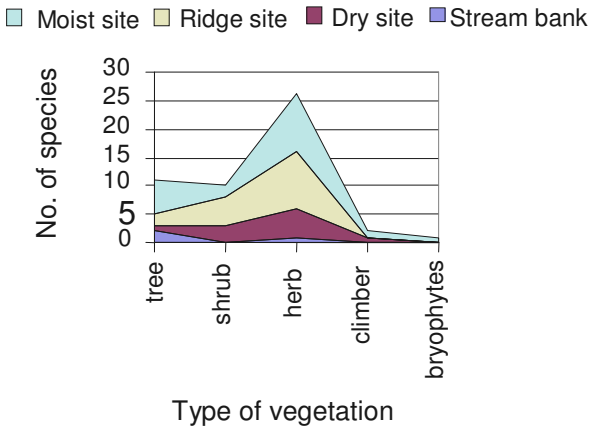

Figure 3. Restricted species along different sites.

pteridophytes and 1 parasite were common in stream bank and ridge sites. 14 trees, 18 shrubs, 5 climbers, one epiphyte, 2 pteridophytes and one bryophyte were present in stream bank-moist sites (Figure 2). Restricted tree species were highest on moist site (6) and lowest on dry site (1) beside this shrub were higher on ridge site (4) and lower on moist site (2). Restricted herb species were maximum on ridge and moist sites (10 species each), and minimum on stream bank site (1). (Figure 3).The mean tree, shrub and herb species richness was maximum on stream bank (6.3 ± 0.2), moist (6.1 ± 0.3) and dry (10.3 ± 0.4) and minimum on ridge site (4.6 ± 0.3), (5.5 ± 0.4), (7.6 ± 0.5) respectively (Table 1).

Comparison similarity between the sites revealed maximum similarity among stream bank and moist sites (70%) for trees and minimum between ridge and moist site

Table 1. Mean species richness of different sites.

Site	Trees (species/100 m^2)	Shrubs (species/25 m^2)	Herbs (species/1 m^2)	Climbers (species/25 m^2)
Steam Bank	6.3 ± 0.2	5.8 ± 0.3	9.1 ± 0.6	0.9 ± 0.1
Dry	5.1 ± 0.2	5.6 ± 0.2	10.3 ± 0.4	1.5 ± 0.1
Ridge	4.6 ± 0.3	5.5 ± 0.4	7.6 ± 0.5	0.7 ± 0.1
Moist	5.8 ± 0.2	6.1 ± 0.3	10.0 ± 0.4	1.5 ± 0.4

Table 2. Percent Similarity of vegetation of different sites at low elevation

	Tree layer			
H Habitat	**Stream bank**	**Dry**	**Ridge**	**Moist**
Stream Bank	100.00	68.75	60.00	70.00
Dry		100.00	69.23	61.11
Ridge			100.00	52.94
Moist				100.00
Shrub layer				
Stream Bank	100.00	64.42	63.33	62.07
Dry		100.00	56.67	48.28
Ridge			100.00	53.57
Moist				100.00
Herb layer				
Stream Bank	100.00	67.77	60.86	63.16
Dry		100.00	66.10	51.28
Ridge			100.00	32.43
Moist				100.00
Climber layer				
Stream Bank	100.00	61.54	61.54	66.67
Dry		100.00	66.67	42.86
Ridge			100.00	57.14
Moist				100.00

site (32.43%) for herbs (Table 2).

DISCUSSION

The biological diversity of the Himalaya is severely threatened by natural, as well as anthropogenic disturbances, such as, tree cutting, grazing, lopping, fuel wood, fodder and litter removal. There are large number of environmental factors which influence the species richness and composition, such as elevation and habitat. Tree species richness varied from 12 - 22 in the study area. Greater tree richness was recorded for moist habitat. Tree richness was low at dry and ridge site compared to stream bank and moist habitat. It indicates that stream bank and moist habitat favour the regeneration of many tree species because of the availability of sufficient moisture for seed germination and survival of seedlings. The different studies on the temperate oak and oak-mixed forests revealed that the tree richness ranged from 3 - 43 species (Baduni and Sharma, 1997; Rikhari et al., 1997; Ghildiyal et al., 1998). The shrubs richness in the present study were greater in stream bank (31) which lies between the values reported from central Himalayan by various workers i.e. between 11 - 106 (Chandra, 1991; Rikhari et al., 1997; Ram et al., 2004). The herb richness value, reported earlier by different workers varied from 34 - 414 (Tiwari 1985; Kharkwal et al., 2005) this is similar to

our values which is highest on dry habitat (62). Parasites were present in all the three habitats except moist habitat. Thus, harsh conditions favoured the growth and development of parasites. The common shrubs and herbs were greater for stream bank and dry habitats. Thus, favourable habitat for trees was stream bank and moist site, while stream bank and dry sites for shrubs. Along the entire altitudinal range of Garhwal Himalaya, the overlapping among species regimes are broad, therefore, transitional communities having mixture of species of more then one zone are present. However, ecosystem level studies of diversified forests under different anthropogenic stress such as, fire, grazing are available (Bhandari et al., 1995). This study indicates that the opening of canopy increase the richness of trees, shrubs, herbs, and climbers. This may be due to penetration of abundant light on the forest floor and warm temperature may be favourable for the regeneration of more trees, shrubs, herbs and climber species. Pant and Samant (2007) reported that high richness may be due to diverse habitats and suitable edaphic and climatic factors supporting growth and survival of the species. The mean species richness was higher on stream bank site. This may be related to high density of trees on this site. Shrub species richness was maximum on moist site, contrary to this herb and climber species richness was maximum on dry site.

REFERENCES

Arora RK (1995). Himalayan Resources, Diversity and Conservation, In: U. Dhar (ed.), Himalayan Biodiversity. Gyanodaya Prakashan, Nainital. 2: 39-55.

Baduni NP , Sharma GM (1997). Effect of aspect on the structure of some natural stands of *Cupressus torulosa* in Himalaya moist temperate forests. Pro. Ind. Natl Sci. Acad., 1362: 345-352.

Bhandari BS, Mehta JP , Tiwari SC (1995) Vegetation structure under different management regions in a grazing land at Srinagar (Garhwal). J. Hill Res., 8(1) 39-46.

Chapin,Stuart F, Erika S, Zavaleta V, Eviner, Naylor T, Rosamond L, Vitousek, Peter M, Reynolds, Heather L, Hooper, David U, Lavorel, Sandra, Sala, Osvaldo E, Hobbie, Sarah E, Mack, Michelle C , Daiz S (2000). Consequences of changing biodiversity. Nature, 405: 234-242.

Chandra R (1991). An altitudinal pattern of woody vegetation along water courses in parts of Kumaun Himalaya Ph.D. thesis, Kumaun University, Nainital.

Curtis JT , McIntosh RP (1950). The interrelations of certain analytic and synthetic phytosociological characters. Ecology, 31: 438-455.

Ghildiyal S, Baduni NP, Khanduri VP , Sharma CM (1998). Community structure and composition of oak forests along altitudinal gradients in Garhwal Himalaya, Indian. J. For., 21(3): 242-247.

Heywood VH (1995). (eds). Global Biodiversity assessment, UNEP, Combridge University Press, pp: 1140

Kharkwal G, Mehrotra P , Pangtey YPS (2005). Comparative studies on species richness, diversity and composition of oak forest in Nainital District, Uttaranchal. Curr. Sci., 89: 668-672.

Naithani BD (1984). Flora of Chamoli, Botanical Survey of India, Howrah, New Delhi. Vol 1-2

Pant S , Samant SS (2007). Assessment of Plant diversity and prioritization communities for conservation in Mornaula. Appl. Ecol. Environ. Res., 5(2): 151-166.

Polunin O , Stainton A (1984). Flowers of the Himalaya. Oxford University Press, Oxford.

Prentice C , Parish D (1990). Conservation of beat Swamp Forest: A forgotten ecosystem'. Proceed. of the Int. Conf. on Trop. Biodivers., In Harmony with Nature. Kualalampur. pp: 128-141.

Ram J, Kumar A, Bhatt J (2004). Plant diversity in six forest types of Uttaranchal, Central Himalaya, India. Curr. Sci., 86: 975-978.

Rikhari HC, Adhikari BS , Rawat YS (1997). Woody species composition of temperate forests along an elevational gradient in Indian central Himalaya. J. Trop. For. Sci., 10(2):197-211.

Saxena AK , Singh JS (1982). A phytosociological analysis of woody species in forest communities of a part of Kumaun Himalaya. Vegetation, 50:3-225.

Shannon CE , Weaver W (1963). The Mathematical theory of communication University of Illinois Press, Urbana.

Snedecor GW , Cochran WG (1967) Statistical methods, Oxford and IBM, New Delhi, pp: 593

Singh JS , Singh SP (1992). Pattern of soil and vegetation and factors determining their forms and hydrologic cycles in Nanda Devi Biosphere Reserve. Final technical report submitted to the Ministry of Environment and Forest, New Delhi, pp: 176

Singh SP, Adhikari BS , Zobel DB (1994). Biomass productivity, leaf longevity and forest structure in Central Himalaya, Eeo. Monog., 64:401-421.

Tewari JC , Singh SP (1985). Analysis of woody vegetation in a mixed oak forest Kumaun Himalaya. Proc. Indian Nat. Sci. Acad., 51B: 332-347.

Valdiya KS (1980). Strategraphic scheme of the sedimentary units of the Kumaun Lesser Himalaya. In: Valdiya, K.S. and Bhatiya S.B. (eds) Stratigraphy and Correlations of the Lesser Himalaya formations. Hindustan publication Corporation, Delhi, India, pp: 7-48.

Whittaker RH (1972). Communities and Ecosystems. 2nd ed. Macmillan Pub. Co. New York, U.S.A., 385 PP.

Zobel DB , Singh SP (1997). Himalayan forests and Ecological generalization. Bio Sci., 47(11): 735-745.