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Study of interrelation of plants species richness found in different habitats in Uttarakhand Himalaya

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Abstract: **A total of 229 plants species were present in the study area. Out of which 35 were trees, 52 shrubs, 110 herbs and 12 climbers, 17 tree trunk vegetation (in which 7 epiphytes, 5 pteridophytes, and 5 bryophytes) and 3 parasites occurring on stem and on branches of trees and shrubs. The study are divided into two elevations and per elevation four forest habitats as stream bank, dry, ridge and moist habitats. The maximum tree species were recorded on moist habitat at low elevation, stream bank and moist habitats at high elevation (19 spp each) whereas minimum on stream bank habitat at low elevation. The maximum shrubs species were recorded on ridge and at low elevation and minimum on ridge habitat at high elevation. The maximum herbs species were recorded on stream bank, dry and moist habitats (39 spp each) at low elevation. The minimum herbs species was stream bank habitat at high elevation. The maximum Climbers species were recorded on ridge and moist habitats at high elevation (6 spp each) whereas minimum on ridge habitat at low elevation. The mean trees species richness was found maximum on stream bank habitat (6.3±0.2) at low elevation and minimum on ridge habitat (3.5±0.2) at high elevation. The mean shrubs species richness was found maximum on moist habitat(6.1±0.3) at low elevation and mean species richness of herbs was found maximum on ridge habitat (10.3±0.4) at low elevation However, minimum shrubs and herbs species richness on stream bank habitat (3.2±0.3), (6.4±0.3) at low elevation. The mean climber species richness recorded was maximum on moist habitat (1.5±0.4) at low elevation and minimum on ridge habitat (0.7±0.1) at high elevation. The value of similarity was varied from 52.94% - 8 5.71% for trees layer, 48.28% - 75.00% for shrubs layer, and 22.45% - 68.04% for herbs layer and 42.86% - 76.92% for climbers layer respectively. It was high similarity on stream bank and moist habitats in both elevations.**

Keywords: **Species richness, Vegetation, Habitat, Similarity, Elevation.**

I. INTRODUCTION

Central Himalaya, accounting for 8.68% of the total Indian Himalayan area (594.36km^2), harbours a great variety of forest, ranging from tropical dry deciduous in foothills to alpine scrub near the timberline [1]. Ecologists face the complex task of identifying pertinent scales of variation of community structure, determining biological and environmental characteristic of species-habitat relationships and examining mechanisms that can relate processes at one scale to patterns at another [2]. Species richness, the number of biological species, is related to community productivity for a broad range of organisms found in different type of ecosystems [3],[4].[5],[6]. Often biological species richness increases with increase in productivity are associated with a decline in species richness [7]. Principal environmental factors such as climatic, soil type and disturbances strongly influence ecosystem functioning [8], but likewise organisms can effect their environment[9]. The forest vegetation of Himalaya has been of major interest to ecologists since long. Chamoli District is a home of species richness in Garhwal Himalaya of Uttarakhand state. The Badrinath forest division was cover of many species of plant. The species presently in habitating Earth are the result of over 3 billion years of natural selection likely

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favored efficiency, productivity and specialization [10]. Most theoretical and empirical work on functional consequences of changing biodiversity has focused on the relationship between species richness and ecosystem functioning [11]. Species richness, species relative abundance and heterogeneity of their special or temporal distribution in a given area are the central subject of community ecology [12]. The species composition of an area will change over lime in a process usually called ecological succession. Some of these changes will be due to dispersal but other will be the products of initial conditions [13]. The over exploitation of plant and animal species plays an important role in the destruction of the habitats [14].The present study in an attempt to identify different habitat forest within the western Pinder region of Badrinath forest division of Garhwal Himalaya between 2200-2500m elevation range.

II. MATERIAL AND METHODS

Present study area was located between 30°2'43" N and 30°3'27" N Latitude and 79°24'43" and 79°26'46" Longitude between 1900m–2500m als elevation. The study area divided into two elevation, and each elevation selected four habitats i.e. stream bank habitat, dry habitat, ridge habitat and moist habitat at study area were visited frequently for collection of plant species.

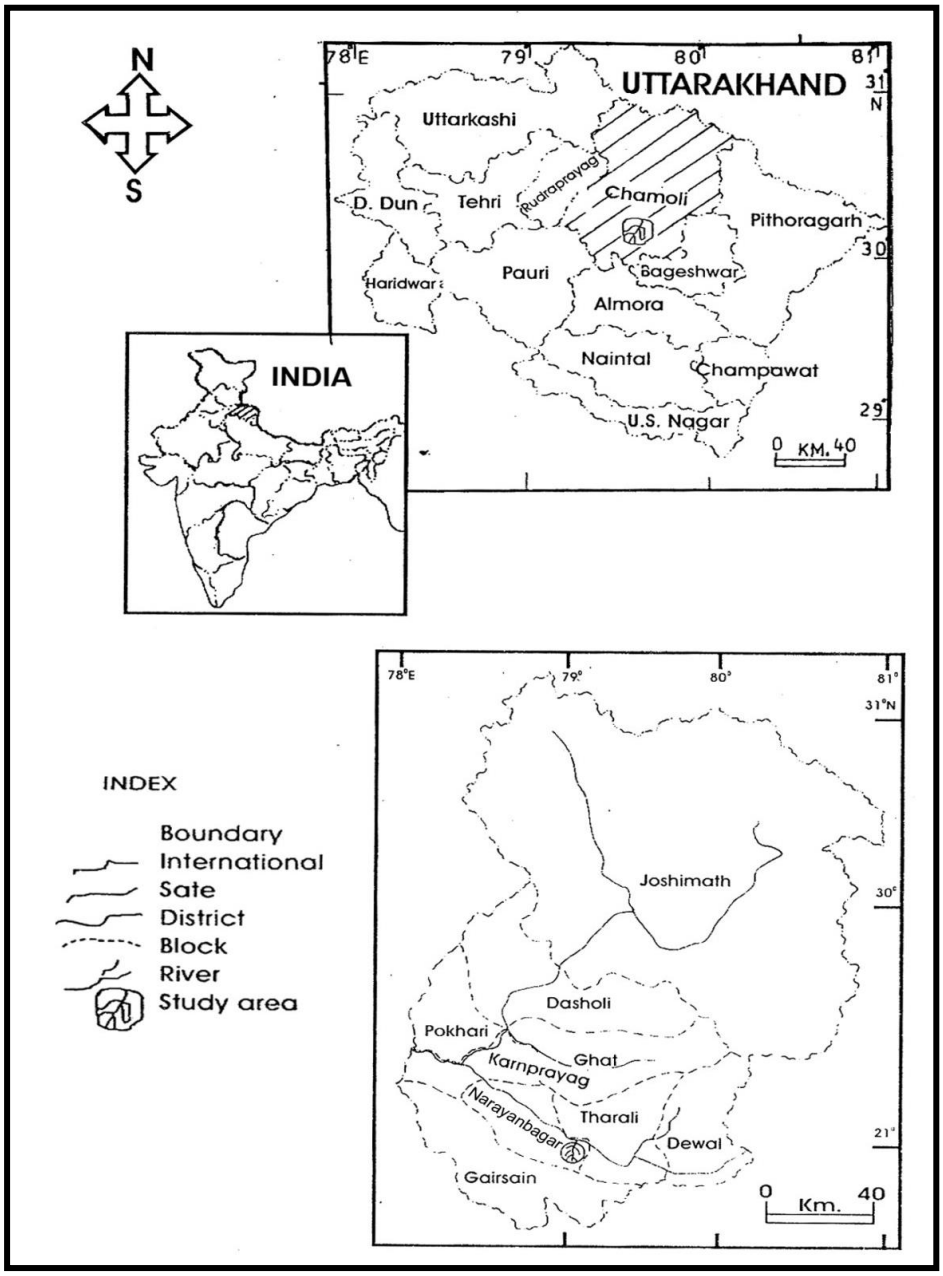

Fig. 1: Location map of the study area

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Efforts were made to collect almost all the plant species present in the study area (represent > 90% species). The trees, shrubs, herbs, climbers, tree trunk vegetation (viz epiphytes, pteridophytes and Bryophytes) and parasites were collected by visiting the study area. The plant species collected annually and brought to the laboratory, preserved and mounted in herbarium sheets for identification. Plants were identified with the help of plant taxonomists. Forest Flora of Kumaun[15], Flora Simlensis[16], Flora of Chamoli [17] and Flowers of Himalaya[18]. Phytosociological analysis in the area was done by placing randomly 10, 100 m2 circular quadrates, the size and number of samples were determined following[19]. The vegetation data were calculated for density, frequency, abundance [20]. Species diversity was computed by using Shannon-Wiener index [21]. Common species between any two habitats were also studied. Various species restricted on different habitats were also identified for their distribution. Total species richness was the sum of all species present in a site considering all samples and mean species richness was determined as the number of species per unit area[22],[23]. 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 habitats and between the elevations. Mean trees richness was determined in $100m^2$, shrubs in 25 m^2, herbs in 1 m^2, and climbers in 25 m^2 plots. T-test was also applied to differentiate the species richness between elevations by [24].

III. RESULTS

A total of 229 plants species were present in the study area. Out of which 35 were trees, 52 shrubs, 110 herbs and 12 climbers, 17 tree trunk vegetation (in which 7 epiphytes, 5 pteridophytes, and 5 bryophytes) and 3 parasites occurring on stem and on branches of trees and shrubs. A total of 209 plant species were present at low elevation out of which 29 were trees, 50 shrubs, 102 herbs, 11 climbers, 14 tree trunk vegetation (in which 7 epiphytes, 4 pteridophytes, and 3 bryophytes) and all 3 parasites species. A total of 179 plants species were present at high elevation out of which 28 were trees, 37 shrubs, 85 herbs, 12 climbers, 15 plant species occurring on tree trunks (5 epiphytes, 5 pteridophytes, 5 bryophytes) and 3 parasites.

TABLE I: Total species richness at different habitats and both elevation of study area

Elevation	**Habitat**	**Trees**	**Shrubs**	**Herbs**	**Climbers**	Tree Trunk Vegetation			Parasite	**Total**
						Epiphytes	Pteridophytes	Bryophytes		
Low Elevation	Stream bank	12	20	39	4	4	2	1	3	**85**
	Dry	14	21	39	4	1	4	1	2	**86**
	Ridge	13	23	31	3	3	2	0	1	**76**
	Moist	19	19	39	5	3	4	3	0	**92**
High Elevation	Stream bank	19	18	24	3	3	3	4	0	**74**
	Dry	17	15	29	6	1	3	1	2	**74**
	Ridge	13	13	25	4	1	2	1	2	**61**
	Moist	19	17	33	6	2	4	5	0	**86**
Overall Total		**35**	**52**	**110**	**12**	**7**	**5**	**5**	**3**	**229**

Note- The Overall total number of plant species was not match, because many species common on different habitat and both elevations.

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A total 22 plant species were common in the study area. *Cornus capitata*, *Quercus leucotrichophora*, *Lyonia ovalifolia*, *Myrica esculenta* and *Rhododendron arboreum* trees were widely distributed and common on both the low and high elevations. The dominant shrubs species such as *Berberis asiatica*, *Berberis chitria*, *Eupatorium adenophorum* and *Viburnum coriaceum* were distributed and present on both low and high elevations. Ten herbs including grasses and sedges were common on both low and high elevation..

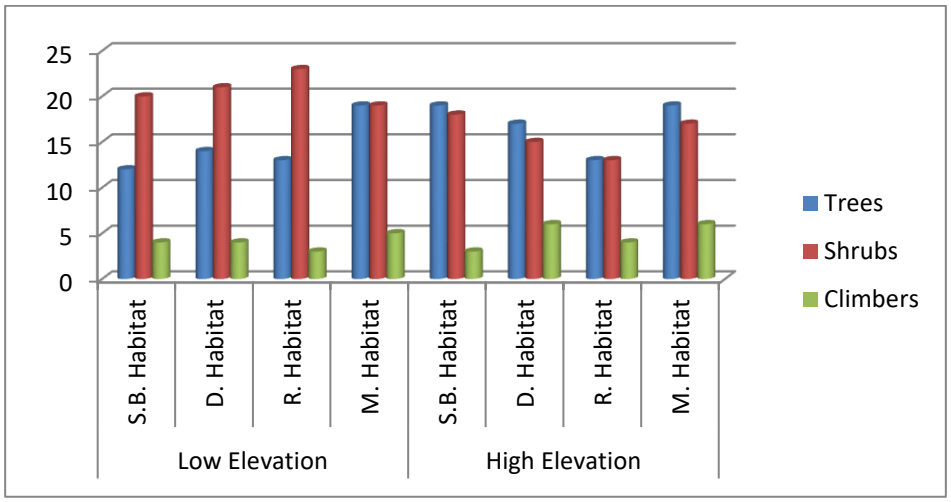

Fig. 2: Cylinder diagram of tree, shrub and climber species richness of different habitats in both elevations

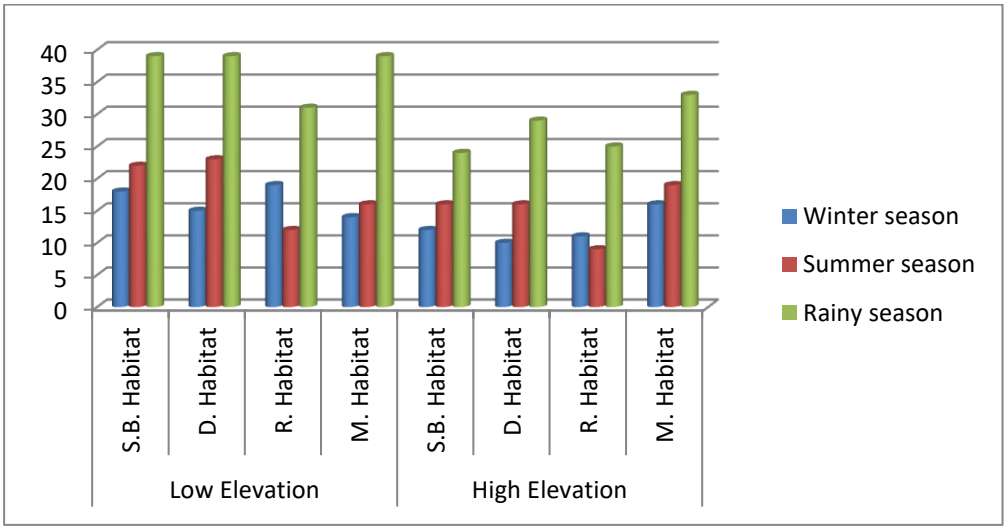

Fig. 3: Cylinder diagram of herb species richness of different habitats in both elevations

The dominant herbs were *Ainsliaea aptera*, *Carex condensata*, *Conyza japonica*, *Galium rotundifolium*, *Gerbera macrophylla*, *Geum elatum*, *Ocimum tenuiflorus*, *Ranunculus diffusus*, *Scutellaria angulosa* and *Viola Canescens.* Only one climber, i.e. *Parthenocissus himalayana* was found on low and high elevation sites. The plants growing on tree trunk showed that only 2 pteridophytes i.e. *Araiostegia pseudocytoteris and Lepsorus sesquapedalis* were common both on low and high elevations. The maximum tree species were recorded on moist habitat at low elevation, stream bank and moist habitats at high elevation (19 spp each) whereas minimum on stream bank habitat at low elevation. The maximum shrubs species were recorded on ridge and at low elevation and minimum on ridge habitat at high elevation. The maximum herbs species were recorded on stream bank, dry and moist habitats (39 spp each) at low elevation. The minimum herbs species was stream bank habitat at high elevation. The maximum Climbers species were recorded on ridge and moist habitats at high elevation (6 spp each) whereas minimum on ridge habitat at low elevation. The maximum Epiphytes species were recorded on stream bank habitat at low elevation and minimum on dry habitat at low elevation, dry and ridge habitats at high elevation (one spp each).Pteridophytes were recorded maximum on dry habitat at low elevation and moist habitat at high elevation. Bryophytes were recorded on moist habitats at high elevation and parasites were recorded maximum on stream bank habitat at low elevation (TABLE I.}.

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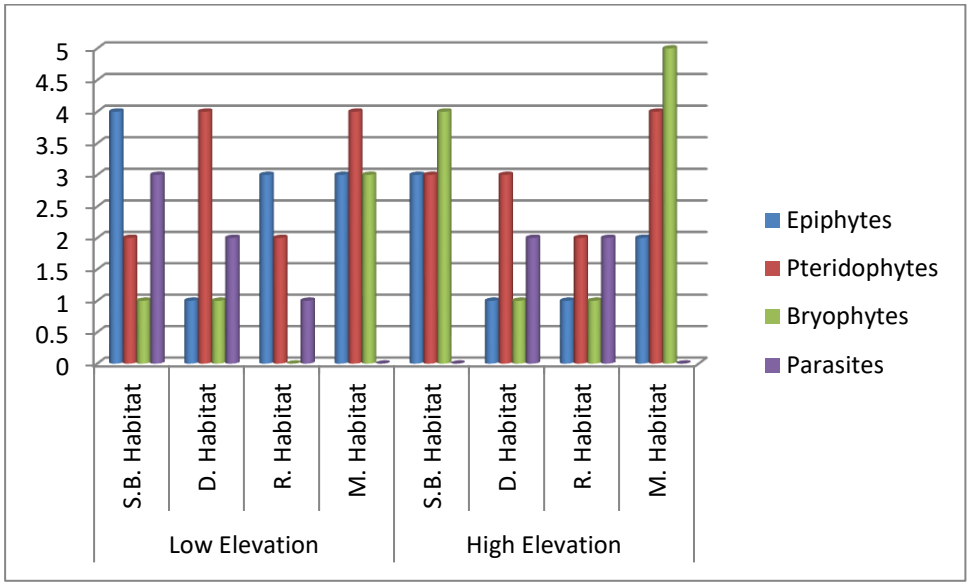

Fig. 4: Cylinder diagram of tree trunk vegetation of different habitats in both elevations

Seven tree species were restricted at low elevation, while 6 tree species at high elevation. Fifteen shrub species were restricted at low elevation and only two shrubs at high elevation. Twenty five herbs were restricted at low elevation and 8 herbs at high elevation. Only one climber species was restricted on each elevation. It was observed that only one pteridophyte was present at high elevation. The bryophytes were not restricted at low elevation and only two species were restricted to high elevation. The parasites and epiphytes were not restricted both at low and high elevations. The all over study area, six tree species were restricted on moist habitat at low elevation whereas not restricted tree species on dry habitat at high elevation. Five shrubs species were restricted on dry habitat at high elevation whereas no shrubs species restricted present on stream bank habitat at low elevation. 11 herbs species were restricted on moist habitat at high elevation whereas only one restricted herbs species on stream bank habitat at low elevation. Two restricted species of climbers were on moist habitat at high elevation and respectively.

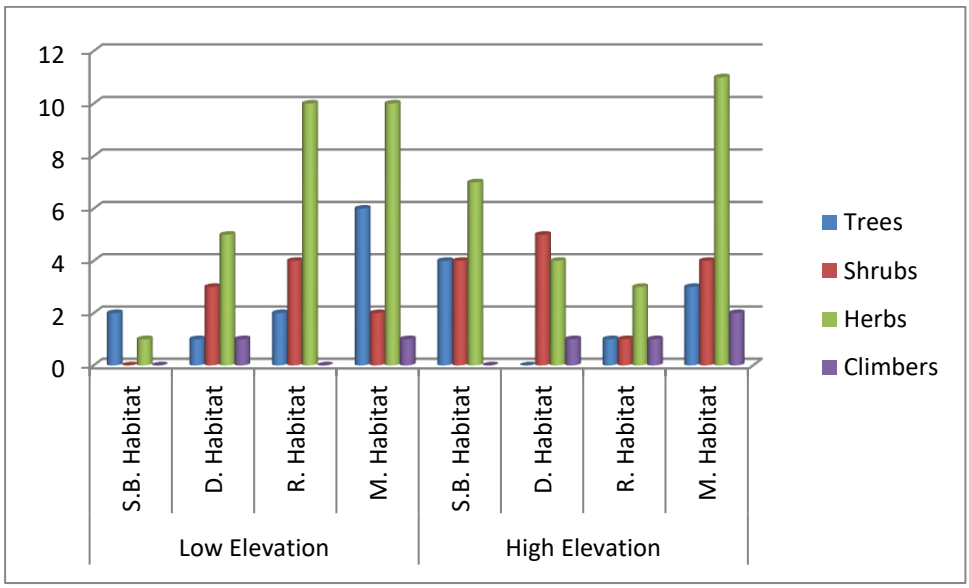

Fig. 5: Cylinder diagram of trees, shrubs, herbs and climbers restricted species of different habitats in both elevations

Abbreviations: S.B= Stream bank, D= Dry, R= Rigde, M= Moist

The mean trees species richness was found maximum on stream bank habitat (6.3±0.2) at low elevation and minimum on ridge habitat (3.5±0.2) at high elevation. The mean shrubs species richness was found maximum on moist habitat(6.1±0.3) at low elevation and mean species richness of herbs was found maximum on ridge habitat (10.3±0.4) at low elevation However, minimum shrubs and herbs species richness on stream bank habitat (3.2±0.3), (6.4±0.3) at low elevation. The mean climber species richness recorded was maximum on moist habitat (1.5±0.4) at low elevation and minimum on ridge habitat (0.7±0.1) at high elevation. The all over study area, mean species richness of trees was found maximum on stream bank habitat (5.6±0.2) and minimum on ridge habitat (4.6±0.2). The mean species richness of shrubs, herbs and climbers was found maximum on moist habitat (5.1±0.3, 9.5±0.1 & 1.2±0.2) and minimum on ridge habitat (4.4±0.3, 7.2±0.2, 0.7±0.1) respectively. The value of similarity of trees layer indicates that maximum was in dry and ridge habitats at high elevation, minimum in ridge and moist habitats at low elevation (TABLE II).

TABLE II: Mean Species richness in various habitats at both elevations in study area.

Elevation	Habitats	Trees (species/100m^2)	Shrubs (species/25m^2)	Herbs (species/1m^2)	Climbers (species/25m^2)
Low elevation	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
High elevation	Steam Bank	4.9±0.3	3.2± 0.3	6.4± 0.3	0.9±0.2
	Dry	4.0±0.3	4.6± 0.2	7.0± 0.3	0.8±0.2
	Ridge	3.5± 0.2	3.4± 0.3	6.7± 0.3	0.7±0.1
	Moist	4.3± 0.2	4.2± 0.3	8.9± 0.4	1.3±0.1

Soil moisture content was ranged between 24.82±7.46% - 38.13±5.69% all the habitats. It was maximum on the moist habitat (38.13±5.69%)at low elevation and minimum on ridge habitat (24.82±7.46%) at high elevation.Bulk density content was ranged between (0.46±0.01 gm/cm^3 - 0.89±0.14 gm/cm^3) all the habitats. It was high on ridge habitat (0.89±0.14 gm/cm^3) and minimum dry habitat (0.46±0.01gm/cm^3) at low elevation. Soil porosity was comparatively higher value was observed on the dry habitat (82.24±0.43) at low elevation and lowest on ridge habitat (65.68±5.31) at low elevation ((TABLE III.).

TABLE III: Physical properties of soil in different habitats at both elevations

Elevation	Habitats	Mean moisture Content (%)	Bulk Density (gm/cm^3)	Porosity (%)
Low elevation	Stream bank	36.09±5.25	0.53±0.11	79.63±4.30
	Dry	34.05±3.93	0.46±0.01	82.24±0.43
	Ridge	29.50±2.67	0.89±0.14	65.68±5.31
	Moist	38.13±5.69	0.54±0.04	79.01±1.45
High elevation	Stream bank	29.74±3.93	0.56±0.04	78.38±1.45
	Dry	35.01±2.67	0.59±0.18	77.28±6.97
	Ridge	24.82±7.46	0.78±0.17	69.84±6.43
	Moist	36.20±5.98	0.49±0.08	81.32±3.15

The similarity values were 85.71% and 52.94%, respectively. In the shrubs layer and climbers layer maximum similarity was observed in stream bank and dry habitats(75.00% & 76.92%) at high elevation respectively, whereas similarly minimum on stream bank and moist habitats (48.28%) for shrubs layer, dry and moist habitats (42.86%) at low elevation for climbers layer . Examining the herbs layer, maximum similarity was observed in stream bank and ridge habitats (68.04%) at high elevation and minimum in ridge and moist habitats (22.45%) at low elevation.

ANOVA test indicates that mean trees, shrubs and herbs richness was significant and varied ($P<0.001$) among the sites as well as between sites, and also between low and high elevation. However, climber richness was not significant between the elevations ((TABLE IV).

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TABLE IV: Analysis of variance (ANOVA) for species richness

Source Trees	Type III sum of square	df	Mean square	F	Significance
Trees					
Elevation	87.60	1	87.60	43.34	0.00
Habitat	42.88	3	14.29	7.07	0.00
Elevation x Habitat	43.35	3	14.45	7.15	0.00
Error	468.97	232	2.02		
Shrubs					
Elevation	218.50	1	218.50	69.31	0.00
Habitat	25.05	3	8.35	2.65	0.05
Elevation x Habitat	20.31	3	6.77	2.15	0.10
Error	731.43	232	3.15		
Herbs					
Elevation	242.00	1	242.00	53.44	0.00
Habitat	184.61	3	61.54	13.59	0.00
Elevation x Habitat	54.05	3	19.68	4.346	0.00
Error	1050.63	232	4.53		
Climbers					
Elevation	2.20	1	2.20	2.134	0.15
Habitat	16.58	3	5.53	5.337	0.001
Elevation x Habitat	5.15	3	1.72	1.65	0.18
Error	240.57	232	1.04		

IV. DISCUSSION AND CONCLUSION

The flora of Himalaya, Tibet and west China has a common origin and they rediatiated into distinct eco-floristic zones gradually level to become the highest region in the world [25]. The biological diversity of the Himalaya is severely threatened by natural, as well as anthropogenic disturbances, such as, tree cutting, grazing, lopping of fuel wood and fodder litter removal etc. There are large number of environmental factors which influence the species richness and composition, such as elevation and habitat they occupy. The species richness varied from 17-22 for the entire study area without much variations habitats ($t_{0.05}$=0.42). Greater tree richness was recorded for stream bank habitat and lowest on ridge habitat. In indicates that stream bank habitat favors the regeneration of many tree species because of the availability of sufficient moisture for seed germination and survival of seedlings. The difference studies on the temperate oak and oak-mixed forests revealed that the tree richness ranged from 3-43 species [1],[26],[27],[28],[29]. The shrubs (16-25) and herbs (43-54) richness were greater in stream bank habitat and lowest ridge habitats. The shrub richness value reported for central Himalayan ecosystems by various workers ranged between 11 and 106 [1],[29],[30],[31. Similarly herb richness value reported by different workers for Himalaya varied from 34 to 414[29],[30],[31]. The high number of shrubs and herbs were also reported for deciduous and evergreen forests of Himalaya located between 1800-2000m elevations. The number of climber was greater in dry and moist habitats at lowelevation . No significant difference was observed for tree trunk vegetation among the study area. The pteridophytes were greater in number compared to epiphytes and bryophytes. Parasites were restricted only on dry and ridge habitats at study area.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[32] 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, soil moisture and similarity was high on stream bank and moist habitats, that indicate both habitats well for plants growth, due to similar environment conditions on both the habitats in both elevation.

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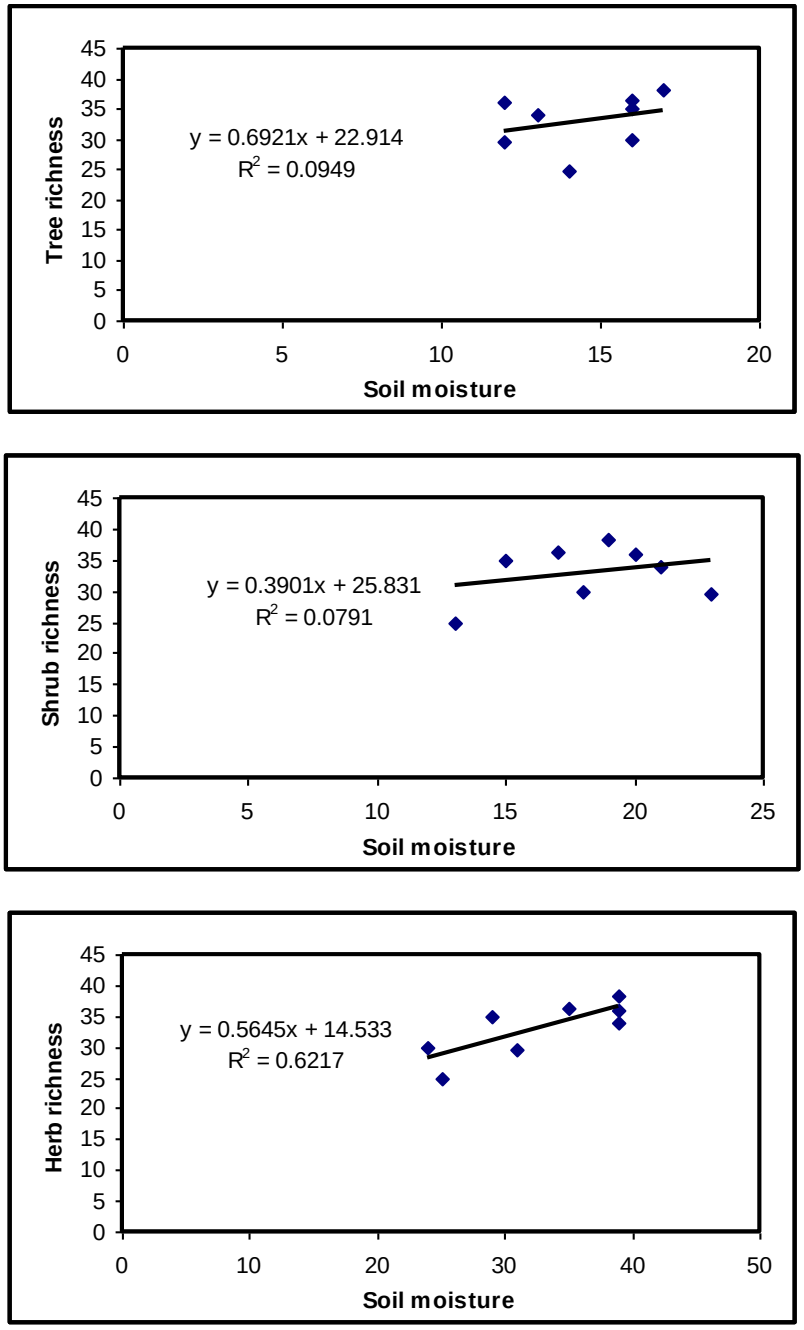

Fig. 6: (A.B.C) Relationship between soil moisture (%) and species richness

The various human activities in this area such as grazing of pets, lopping of trees for fodder, felling of trees for fuel wood are not affected. Some trees such as *Alnus nepalensis, Abies pindrow and Cedrus deodara* are used as timber for construction work in local rural areas.

REFERENCES

[1] H. C. Rikhari, B. S. Adhikari, and Y. S. Rawat, "Woody species composition of temperate forests along an elevational gradient in Indian central Himalaya," Jour. Trop. For. Sci. 10(2):197-211, 1997.

[2] S. A. Lavin, "The problem of pattern and scale in ecology," Ecology 73: 1943- 1967, 1992.

[3] J. P. Grime, "Competitive exclusion in herbaceous vegetation," Nature, 242: 344-347, 1973.

[4] M. A. Huston, "A general hypothesis of species diversity,"Am. Nat. 113: 81:101, 1979.

[5] M. L. Rosenzweig, and Abramsky, "How are diversity and productivity related. In: R.E. Ricklef and D. Schluter (eds.)" Species Diversity in Biological Communities, University of Chicago Press, Chicago Illinois, U.S.A. , 52-65pp, 1993.

[6] M. Proulox, and A. Mazumder, 1998. "Reversal of grazing impact on plant species richness in nutrient-poor vs. nutrient-rich ecosystems," Ecology, 79(8): 2581-2592.

[7] C. R. Margaules, and R. L. Pressey, "Systematic conservation planning," Nature, 405: 243-253, 2000

[8] D. A. Wardle, K. I. Bonner and K. S. Nicholson, Biodiversity and plant litter: experimental evidence which does not support the view that enhanced species richness improves ecosystem function. Oikos, 79: 247:258, 1997.

[9] C. G. Jones, J. H. Lawton, and M. Shachak, "Positive and Negative effects of organisms as physical ecosystem engineers." Ecology, 78: 1946-1957, 1997.

[10] D. Tilman, "Causes; consequences and ethics of biodiversity," Nature, 405: 208-211, 2000.

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

[12] Fangliang. He, and Pierre. Legendre, "Species Diversity Patterns Derived from Species-Area Models." Ecology, 83(5): 1185-1198, 2002.

[13] C.R Margules and R. L Pressey, "Systematic conservation planning," Nature(London) 405: 243-253, 2000.

[14] V.Shiva, "Biodiversity-Social and Ecological perspectives," Natraj Publishers,Deheradun 123p, 1992(ed).

[15] A. E. Osmaston, "A flora for Kumaun," International Book Distributors, Dehradun, 605 P, 1926.

[16] H. Collet, "Flora Simlensis: a hand book of the flowering plant of Simla and the neighbourhood," Bishen Singh Mahendra Pal Singh, Dehradun (Reprinted 1980), 1902.

[17] B. D. Naithani, "Flora of Chamoli Districts," Vol. I- II. Botanical Survey of India, Howrah, New Delhi, 1984 and 1985.

[18] O. Polunin, and A. Stainton, "Flowers of the Himalaya," Oxford University Press, Oxford, 1984.

[19] A. K. Saxena, and J. S. Singh, "A Phytosociological analysis of woody species in forest communities of a part of Kumaun Himalaya," Vegetatio, 50: 3-22, 1982.

[20] J. T. Curtis and R. P McIntosh (1950). "The interrelations of certain analytic and synthetic phytosociological characters," Ecology,31: 438- 455.

[21] C. E Shannon and W. Weaver, "The Mathematical theory of communication" University of Illinois Press, Urbana,1963.

[22] R. H Whittaker, "Evolution and measurement of species diversity," Taxon, 21: 213-251, 1972.

[23] R. H. Whittaker, "Communities and Ecosystems," 2nd edn. Macmillan Pub. Co. New York, U.S.A., 385 PP, 1975.

[24] G. W. Snedecor, and W. G. Cochran, Statistical Methods, Oxford and IBM, New Delhi, 593 PP,1967.

[25] S. R. Kashyap, "The vegetation of west Himalayas and west Tibet in relation to climate," Indian Bot.Soc.,4:13-65, 1925.

[26] J. C. Tewari, and S. P. Singh, "Vegetation analysis of a forest lying in transitional zone between lower and upper Himalayan moist temperate forest," In G. S. Paliwal (ed.). The vegetational wealth of Himalayas Punjab Publishers, New Delhi, 104-119pp, 1982.

[27] N. P. Baduni, and G. M. Sharma, "Effect of aspect on the structure of some natural stands of Cupressus torulosa in Himalaya moist temperate forests," Proc. Ind. Nat. Sci. Acad. 1362: 345-352, 1997.

[28] S. Ghildiyal, N. P. Baduni, V. P. Khanduri, and C. M. Sharma, "Community structure and composition of oak forests along altitudinal gradients in Garhwal Himalaya," Ind. Jour. For. 21(3): 242-247, 1998.

[29] R. P. Singh, J. Ram, and A. Kumar, "Evolution Dynamics of central Himalayan Forests in Relation to Biodiversity," Final Technical Report Submitted to Indian Council of Forestry Research and Education, Dehradun p.1-208, 1999.

[30] G. Kharkwal, P. Mehrotra, Y. S. Rawat, and Y. P. S. Pangtey, "Phytodiversity and growth form in relation to altitudinal gradient in the Central Himalaya (Kumaun) Region of India," Curr. Sci. 89: 873-878, 2005.

[31] J. Ram, A. Kumar, and J. Bhatt, "Plant diversity in six forest types of Uttaranchal, Central Himalaya, India," Curr. Sci. 86: 975-978, 2004.

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