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Composition, structure and diversity of tree species along an elevational gradient in Dudu forest range, Jammu and Kashmir, India

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Abstract
The present study has been undertaken along an altitudinal gradient (950-3500m a.s.l.) in Dudu Forest Range of Udhampur Forest Division, Jammu & Kashmir, India to understand the composition, structure and diversity of tree species along an elevation gradient in the area. Ten forest types characterised by different dominant tree species with subtropical and temperate elements of vegetation have been recognised in the area.Overall average values of diversity indices such as Margalef's Index (MI); Menhinik Index (MeI); Shannon-Weiner Index (H') and Simpson Index (D) have been observed to be 1.70, 0.85, 1.66 and 0.61, respectively. The study suggested that distribution and species richness are largely regulated by physiographic and climatic factors along the gradient.

Keywords: Altitudinal gradient, Community structure, Diversity indices, Dudu forest range, Tree species

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INTRODUCTION

Mountains are of great significance owing to the fact that they support very diverse ecological communities, including many endemic species (Korner, 2003) and have great value for historic, aesthetic and economic reasons. In mountain areas, the vegetation is greatly affected by differences in the microclimate, aspect and altitude (Pande *et al*.,2002; Chaudhary, 1999). The natural forest stand of any place is the result of the interaction of various environmental factors. The physiographic features such as elevation and aspect have a profound influence on the distribution, growth, form and structure of tree species, as a result of which the individual tree species has different values for density and basal area at various altitudes and aspects (Wikum and Wali, 1974). The factors such as soil nutrient content, slope, aspect and altitude have been shown to exert an important control on species richness and diversity on a great variety of ecosystems (Brocque and Buckney, 2003).

Altitude itself represents a complex combination of related climatic variables closely correlated with numerous other environmental properties (Ramsay and Oxley, 1997). The type of tree group at any place might also be due to the properties of vegetation itself in accordance with the climatic zones in which particular classes of vegetation are expected to flourish or due to the properties of a mature ecosystem comprising the vegetation–environment complex, reflecting the interrelation of these elements (Gairola *et al.,* 2011). Several studies, especially focusing on the species composition along elevational gradients, have been conducted and described by Saxena *et al*. (1985);Adhikari *et al*. (1992); Austin *et al.(*1996); Brun *et al*.(2006); Sharma *et al*. (2009); Majila and Kala (2010);Mark (2012); Rezende *et al*.(2015); Song *et al*.(2016); Sharma *et al.* (2017); and Sinha *et al.* (2018) who have reported that vegetation types differ with change in altitude. In Jammu and Kashmir also, some studies have been carried out to describe the variation in vegetation along altitudinal gradient. These include the works of Jhangir (2004), Raina and Sharma (2012); Arshad *et al.* (2013); Sharma and Raina (2013); Sharma *et al.* (2016). However, no such studies have been reported so far from the Dudu forest range of Jammu & Kashmir (J&K), India where the present work has been undertaken with the objective to describe and examine the structure and composition of the tree vegetation along an altitudinal gradient.

MATERIALS AND METHODS

Study area: The present study has been carried out in Dudu forest Range of Udhampur Forest Division ($33^0$10´ North latitude and $75^0$35´ East longitude) of J&K state, India. Data has been col-

lected along the altitudinal gradient ranging from 950 to 3500 m a.s.l. in which vegetation strata varies from subtropical forest to temperate forest (Fig.1). The area lies adjacent to the Shivaliks range and is highly mountainous region marked with rugged topography. Snowfall is a regular feature at higher elevations during winter whereas summer is moderate and pleasant.

Sampling and data analysis: The general survey of the study area has been carried out to determine the nature of terrain, tree composition, distribution and accessibility of different forest types of the study area. After the reconnaissance survey, different forest types according to altitude, aspect and species compositions were selected for the study and named according to the composition of dominant tree species as per Prakash (1986), Gairola *et al*.(2011) and Sharma and Raina (2013), viz., > 75 % as pure; 50 – 75 % as mainly; 25 – 50 % as mixed and < 25 % as miscellaneous. Physiographic factors i.e. altitude and aspect across different forest types were measured by GPS (Garmin-GPS map 60CSx). For the collection of primary data, 15 quadrats of 10x10 m^2 size each were laid out in each forest type for quantitative analysis of the tree vegetation (Curtis and McIntosh, 1950). Species richness (SR) was simply taken as a count of total number of species in that particular forest type.

Margalef index (Margalef, 1958) and Menhinik index (Whittaker, 1977) has been calculated to work out the species richness (number of species per unit area) by using the following formulas:

Margalef index: SR = (S-1/ In N)

Menhinik index: S/√N, where, S = number of species and N= total number of individuals of all the species

The diversity (H') has been determined by using Shannon–Wiener diversity index (H' = – Σ *p*i In *p*i) (Shannon and Weaver 1963) while the Simpson concentration of dominance has been calculated for each forest type by using the relationship DS=∑n(n-1)/N(N-1)), (Simpson, 1949).

RESULTS AND DISCUSSION

Community structure and composition: The present study revealed the presence of 10 different types of the forests along the altitudinal gradients (950 m to 3500 m a.s.l.) of the study area (Table 1). The lower altitudes (950-1300 m a.s.l.) exhibited the prevalence of subtropical tree species with marked predominance of Chir pine community having *Pinus roxburghii* as dominant species along with *Robinia pseudoacacia*, *Dalbergia sissoo*, *Ficus palmata, Ailanthus excelsa, Pyrus pashia, Alnus nitida, Olea ferruginea etc.*

The mid altitudinal ranges in the present study area exhibited the dominance of temperate coniferous species. In the middle portion of the slope (1400-2100 ma.s.l.), the increase in elevation results in change of dominance of species from *P. wallichiana* to *Cedrus deodara*. *P. wallichiana* in this portion is having the association with the broad leaved species like *Quercus leucotrichophora*, *A. nitida*, *Juglans regia*, *Morus alba* etc. *C. deodara* starts its appearance at elevation of about 1700m and dominates the area above 1800 m up to 2900 m a.s.l. However, in some areas of the study it also occurs as co-dominant species with *P. wallichiana* (2100-2500m a.s.l) and *Abies pindrow* (2500-2900 m a.s.l.).

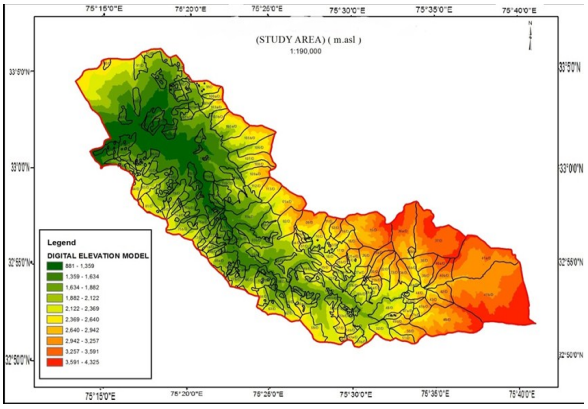

Fig.1. *Digital elevation map of Dudu Forest range of Udhampur Forest Division, Jammu and Kashmir state. (Source- ICT PI Division Jammu, J&K).*

In the upper portion of the region, having steep to very steep slopes, coniferous species like *C. deodara*, *A. pindrow*, *Picea smithiana* exhibited their predominance. The broad leaved trees inter spreading in *C. deodara* in this portion includes, *A. excelsa*, *Aesculus indica*, *A. nitida*, *J. regia*, whereas in *A. pindrow* forest the broad leaved associates includes *Rhododenderon arboreum*, *A. indica*, *Quercus semicarpifolia*, *Betula utilis* etc. However, at tree line, broad leaved species of *B. utilis* predominates the area and is associated with few individuals of *A. pindrow*, *P. smithiana*, *R. arboretum* which are, however, of small sizes.

Species richness and diversity parameters: The various diversity indices calculated for the different tree species along the altitudinal gradient (950 m to 3500 m a.s.l.) has been depicted in Table 2.

Species richness: The mid altitudinal ranges have been reported to have higher species richness which decreases towards upper as well as lower altitudes (Chawla *et al.,* 2008, Arshad *et al*., 2013). In the present study also, overall species richness has been recorded higher in the middle ranges (1600-2500 m a.s.l.) of the gradient as compared to lower and as well higher elevation ranges (Table 2). However lower altitudinal range having Subtropical Pine Forest (13), Subtropical scrub (10) and Pinus /Oak mixed forest (7) have higher diversity in comparison to higher altitudinal range *B. utilis*/ Fir forest (3), Deodar / Silver fir

Table 1. Environmental variables across different altitudes of Udhampur Forest Division, Jammu and Kashmir State.

S.N.	Forest type	Altitude (in m above sea level)	Climate	Aspect	Nature of Slope	Position
1.	*Betula utilis* /Fir forest	3100-3500		Northeast	Steep	Upper
2.	Fir / Spruce mixed forest	2900-3300		Northeast	Very steep	Upper
3.	Deodar /Blue pine mixed forest	2500-2900		North west	Steep	Upper
4.	Deodar Pine mixed forest	2100-2500	**Temperate**	South east	Steep	Upper
5.	Mainly *Cedrus deodara* forest	1800-2300		South east	Steep	Upper
6.	Deodar/ Oak mixed forest	1700-2100		North west	Moderate	Middle
7.	*Pinus roxburghii* /Oak mixed forest	1600-1900		Northeast	Steep	Middle
8.	*Pinus wallichiana* / *Alnus* mix forest	1400-1900		South east	Moderate	Middle
9.	Subtropical Pine Forest	950-1300m		South west	Moderate	Lower
10.	Subtropical scrub	950-1100	**Subtropical**	South	Moderate	Lower

Table 2. Diversity parameters of tree species along altitudinal gradient of Udhampur Forest Division, Jammu and Kashmir State.

S.N.	Forest type	Altitude (in m above sea level)	Climate	SR	MI	MeI	H'	D
1	*Betula utilis*/ Fir forest	3100-3500		3	0.47	0.36	0.98	0.59
2	Fir / Spruce mixed forest	2900-3300		5	0.87	0.50	1.48	0.27
3	Deodar / Silver fir mixed forest	2500-2900		8	1.51	0.79	1.59	0.20
4	Deodar/Blue Pine mixed forest	2100-2500	**Temperate**	9	1.71	0.87	1.59	0.27
5	Mainly *Cedrus deodara* forest	1900-2300		6	1.27	0.83	1.86	0.45
6	Deodara/ Oak mixed forest	1700-2100		11	2.20	1.13	2.04	0.15
7	*Pinus wallichiana* / *Alnus* mix forest	1600-1900		11	2.22	1.16	1.46	0.39
8	*Pinus* /Oak mixed forest	1400-1900		7	1.35	0.76	1.80	0.18
9	Subtropical Pine Forest	950-1300	**Subtropical**	13	2.33	1.99	2.18	0.15
10	Subtropical scrub	950-1100		10	1.96	1.01	1.6	0.34
Average				8.30	1.70	0.85	1.66	0.61

Where, MI: Margalef's Index; MeI: Menhinik Index ;H': Shannon-Weiner Index and D: Simpson Index.

mixed forest (5) and Fir / Spruce mixed forest(8). Mid altitudinal range having *P. wallichiana* / *Alnus* mix forest(11), Deodar/ Oak mixed forest (11), mainly *C. deodara* forest(6) and Deodar/Blue Pine mixed forest(9) have the maximum species richness(SR). Singh *et al.* (2006) also found maximum species richness at intermediate elevations. The value of the SR has been reported to decreases with the increase in the altitudes (Sinha *et al.*, 2018; Raina and Sharma, 2012) which have also been recorded in the present study.

The Species richness indices, Menhinik Index (MeI) and Margalef's Index (MI), also exhibited the same trend in their values (Table 2) and have the maximum values in the mid altitudinal ranges having *P. wallichiana* / *Alnus* mix forest; Deodara/ Oak mixed forest; mainly *C. deodara* forest and Deodar/Blue Pine mixed forest. However, towards lower as well as towards upper portion of the slope, the value of MeI and MI decreases. The values of these indices were more or less similar to the values reported for other regions of Himalayas (Gairola *et al*., 2011, Sharma and Raina, 2013, Pala *et al*., 2016, Geelani *et al.,* 2018).

The higher diversity of plants in the middle portion of these ranges can be attributed to the merging of species from lower as well as upper portion of the ranges and also occurrence of some characteristic species of this elevation only. Also, higher diversity of species at lower as well as mid altitudinal ranges can be attributed to human interference in these areas which facilitates the introduction of non-native species as has also been reported by Rawat and Pangtay (1994).

The Shannon-Weiner diversity Index (H') Index for Indian forests has been found to range between 0.83-4.1 (Visalakshi, 1995), the value of which generally ranges from 1.5 to 3.5. In Himalayan forests, its value has been reported to vary from 0.4 to 2.8, 0.08 to 1.29, and 1.55 to 1.97 by Singh *et al*. (1994), Shivnath *et al*. (1993) and Mishra *et al*.(2000),respectively. During the present investigation its value ranges from 0.47 to 2.33 in different types forests.

The value of Simpson index decreases with increasing diversity (Simpson, 1949). In the present study the values of Simpson index ranges from 0.15 to 0.59 and decreased with increasing diversity i.e. highest in *Betula*/ Fir forest (0.59) and lowest if Subtropical pine forest (0.15). The values of Simpson index were more or less similar to the earlier reported values for the temperate forests such as 0.33-.46 in Western Himalayas (Gairola *et al.,* 2011); 0.31-.42 in Gharwal Himalayas (Mishra *et al*., 2000) and 0.19-0.99 for temperate vegetation (Whittaker, 1965).The lower diversity and consequently greater Simpson value in the temperate vegetation could be due to lower rate of evolution and diversification of communities and severity of environment (Sharma *et al*., 2009; Simpson,

1964).

On comparing the average values of diversity indices (Table 2), it was found that the overall values of Shannon-Weiner Index (1.66), Margalef's Index (1.70), Menhinik Index (0 .85) were lower than temperate forests of Kishtwar (2.78, 2.95, 0.37) as reported by Kumar (2012), and higher than the values of temperate forests of Chattargalla Ridge, Bhaderwah (1.20, 0.89, 0.36) as reported by Sharma *et al*.(2016).

The present data recorded to understand the composition, structure and diversity of tree species along an altitudinal gradient also find support from the studies carried out by various ecologists for the different temperate forests of Himalayan region (Rawat, 2001; Pande *et al.*,2002; Singh and Koushal, 2006, Gairola *et al.,* 2011 and Sharma and Raina, 2013).

Conclusion

The present study revealed the poor status of species richness varying from 3 to 9 at higher altitudes of temperate forests while higher species richness ranging from 7 to 11 has been recorded in the middle portion of the elevation gradients. Menhinik Index (MeI), Margalef's Index (MI) and Shannon-Weiner diversity Index (H'), more or less, also have same trend while the values of Simpson index decreases with increasing diversity. Thus, cold and higher elevational portion of the regions which have the least diversity, require priorities for constant monitoring and conservation. The study also suggests that the species richness and distribution of different types of forest vegetation are largely regulated by varying climatic and physiognomic condition.

REFERENCES

1. Adhikari, B.S., Joshi, M., Rikhari, H.C. and Rawat, Y.S. (1992). Cluster Analysis (Dendrogram) of high altitude (2150-2500 m) forest vegetation around Pindari glacier in Kumaun Himalaya, *Journal of Environmental Biology*,13:101-105.
2. Arshad, M.,Choudhary, S.K., Manzoor, K.Fatima,S., Mustafa, G.,Malik, N.Z. and Akrim, F. (2013).Altitudinal variation in plant species diversity and its components at kotli hills, Azad Kashmir. *Archives Des Sciences*,66(5):614-621.
3. Austin, M.P., Pausas, J.G. and Nicholas, A.O. (1996). Patterns of species richness in relation to environment in south eastern New South Wales, Australia. *Australian Journal of Ecology*, 21:154–164
4. Brocque, A.F. and Buckney, R.T. (2003). Species richness–environment relationships within Coastal sclerophyll and mesophyll vegetation in Ku-ring-gai Chase National Park, New South Wales, Australia. *Austral Ecol*. 28:404–412.
5. Brun, M.A., H.H., Moen, J., Virtanen, R., Grytnes, J.A., Oksanen, L. and Angerbjorn, A. (2006).Effects of altitude and topography on species richness of vascular plants, bryophytes and lichens in alpine communities. *Journal of Vegetation Science* ,17:37-46.
6. Chaudhary, R.P.(1999). Vegetation Pattern. In:T. C. Majpuria (ed). *Nepalnature'sparadise*,105- 111.
7. Chawla, A. Rajkumar, S., Singh, K.N., Lal, B. and Singh, R.D. (2008). Plant Species Diversity along an Altitudinal Gradient of Bhabha Valley in Western Himalaya. *J. Mt. Sci*., 5: 157–177.
8. Curtis, J.T. and McIntosh, R.P. (1950). The interrelations of certain analytic and synthetic phytosociological characters. *Ecology*, 31(3):434–455.
9. Gairola ,S., Sharma, C.M. , Ghildiyal, S.K. and Suyal, S. (2011). Tree species composition and diversity along an altitudinal gradient in moist tropical montane valley slopes of the Garhwal Himalaya, India. *Forest Science and Technology*, 7(3): 91–102.
10. Geelani, S.N., Bhat, G.N., Mughal, A.,Husain, M.,Qaiser, Q.N. and Khan, P.A. (2018). Phytosociological status of trees and shrubs of Romshi range of Shopian forest division in Kashmir valley. *Journal of Pharmacognosy and Phytochemistry*, 7(3): 696-702
11. Jhangir, M. (2004). Phytodiversity characterisation using remote sensing and GIS of district Kathua, Jammu and Kashmir. Ph.D. thesis. University of Jammu, Jammu, India.
12. Korner, C., (2003). Functional Plant ecology of high mountain ecosystems. *Alpine Plant Life*, 1-7.
13. Kumar, R. (2012) EIA of Rattle Hydro electric project, Kishtwar, J&K. Ph. D. Thesis submitted to the University of Jammu.
14. Majila, B.S. and Kala, C.P. (2010). Forest Structure and Regeneration along the Altitudinal Gradient in the Binsar Wildlife Sanctuary, Uttarakhand Himalaya, India. *Russian Journal of Ecology*, 41(1):75–83.
15. Margalef, D.R.(1958). Information theory in ecology. *Genetics and systematic*, 3: 36-71.
16. Mark, A.F. (2012).The altitudinal gradient in forest composition, structure and regeneration. *New Zealand Journal of Botany*.1(2):188-202.
17. Mishra, A., Sharma, C. M., Sharma, S. D. and Baduni N P. (2000). Effect of aspect on the structure of vegetation community of moist Bhabar and Tarai *Shorea robusta* forest in Central Himalaya. *Indian Forest*, 126(6): 634–642.
18. Pala, N.A., Negi, A.K., Gokhale, Y.,Shah, S., and Kumar, M.(2016). Community Structure and Plant Diversity of Community Based Religious Conserved Forests of Garhwal Himalaya, India. *Journal of Earth Science & Climatic Change,*7(2): 334.
19. Pande, P.K., Negi, J.D.S.and Sharma,C. (2002). Plant species diversity, composition, gradient analysis and regeneration behaviour of some tree species in a moist temperate Western Himalayan Forest ecosystem. *Indian Forester*, 8: 869-886.
20. Prakash, R. (1986). Forest management. Dehradun, India: International Book Distributors. p. 214
21. Raina, A.K. and Sharma, N. (2012).Species composition and diversity of tree species along an altitudinal gradient in Sewa catchment of north-western Himalayas, Jammu and Kashmir, India. *Environment Conservation Journal*,13(1&2):173-179.
22. Ramsay, P.M. and Oxley, E.R.B. (1997). The growth form composition of plant communities in the Ecuadorian Paramos. *Plant Ecology*, 131: 173-192.
23. Rawat, R.S. and Pangtey,Y.P.S.(1994). High altitude forests in part of Kumaon, central Himalaya. In: *Proceedings of Indian National Sciences Academy*, 60 (B):557-564.
24. Rawat, R.S. (2001). Phytosociological studies of

woody vegetation along an altitudinal gradient in montane forest of Garhwal Himalayas. *Indian Journal of Forestry*, 24 (4):419-426.
25. Rezende, V.L., Pedro, L. S., Miranda, D., Meyer, L., Moreira, C.V., Mariana, F., Linhares, M. and Filho, AT.O. (2015). Tree species composition and richness along altitudinal gradients as a tool for conservation decisions: the case of Atlantic semideciduous forest. *Biodivers. Conserv*., 24:2149–2163.
26. Saxena, A.K., Pandey, T. and Singh, J.S. (1985). Altitudinal variation in the vegetation of Kumaon Himalayas. In: D.N. Rao. K.J. Ahmed. M. Yunus & S.N. Singh (eds.) Perspectives in Environmental Botany. Print House, Lucknow, 43-66.
27. Shannon,C.E. and Weaver, W. (1963).The mathematical theory of communication. University of Illinois Press, Urbana, USA.
28. Sharma, C.M., Suyal, S., Gairola, S. and Ghildiyal, S.K. (2009).Species richness and diversity along an altitudinal gradient in moist temperate forest of Garhwal Himalayas. *Journal of American Science* ,5 (5):119-128.
29. Sharma, C.M., Mishra, A.K., Tiwari, O.P., Krishan, R. and Rana, Y.S. (2017). Effect of altitudinal gradients on forest structure and composition on ridge tops in Garhwal Himalaya. *Energ. Ecol. Environ* ,*Springe*r. DOI: 10.1007/s40974-017-0067-6.
30. Sharma, N., and Raina, A.K. (2013). Composition, structure and diversity of tree species along elevational gradient in Jammu province of north-western Himalayas, Jammu and Kashmir. *J. Bio.&Env. Sci*.,3 (10):12-23.
31. Sharma, N., Najeeb, A. and Singh, D. (2016). Vegetation diversity and distribution along an elevation gradient on both sides of Chattergalla Ridge, Bhaderwah, Jammu and Kashmir, India. *Indian Forester,*142(9):820-826
32. Sharma, P., Rana, J. C., Devi, U., Randhawa, S.S. and Kumar, R. (2014). Floristic diversity and distribution pattern of plant communities along altitudinal gradient in Sangla Valley, Northwest Himalaya. *Scientific World Journal*,1- 11.
33. Shivnath, S., Gupta K. and Rajwar, G.S. (1993). Analysis of forest vegetation in a part of Garhwal Himalaya. *Recent Research in Ecology and Environmental Pollution*, 6:47-58.
34. Simpson, E.H. (1949). Measurement of diversity. *Nature,*163:168.
35. Simpson, G. G.(1964). Species diversity of North American recent mammals. *Syst Zool.*, 13: 52–73
36. Singh, K.N. and Kaushal, R. (2006).Diversity and quantitative analysis of dominant tree species in district Chamba of Himachal Pradesh. *Indian Journal of Forestry*, 29 (3): 254-251.
37. Singh, S.P., Adhikari, B.S.and Zobel, D.B. (1994). Biomass productivity, leaf longevity and forest structure in the Central Himalaya. *Ecologic Monogr*,64:401 -421
38. Sinha, S. Badola, H.K.,Chhetri, B., Gaira, K.S., Lepcha, J. and Dhyani, P. (2018). Effect of altitude and climate in shaping the forest compositions of Singalila National Park in Khangchendzonga Landscape, Eastern Himalaya, India. *Journal of Asia-Pacific Biodiversity,*11: 267-275.
39. Song, X., Nakamura, A., Sun,Z., Tang, Y. and Cao, M. (2016). Elevational Distribution of Adult Trees and Seedlings in a Tropical Montane Transect, Southwest China. *Mountain Research and Development,* 36 (3):342-354.
40. Visalakshi, N.(1995). Vegetation analysis of two tropical dry evergreen forests of southern India. *Tropical Ecology*, 36:117-127.
41. Whittaker R H. (1965). Dominance and diversity in land plant communities. *Science*, 147: 250–260.
42. Whittaker, RH.(1977). Evolution of species diversity in plant communities. *Evolutionary Biology*, 10: 1-67.
43. Wikum, D.A. and Wali, M.K. (1974). Analysis of North Dakota Gallery forest vegetation in relation to topographic and soil gradients. *Ecologic. Monogr*., 44:441 –464.