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Conifers and their association with the understory shrubs along a temperate riparian ecosystem in Bhaderwah, Jammu and Kashmir

Sharma, Anu; Sharma, Neeraj and Sharma, Monika

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Abstract

The present study has been conducted in the slopes along Neeru stream, Bhaderwah Jammu and Kashmir at an elevation ranging from 850m (Puldoda) to 2200m (Thanalla). The present study deals with the spatial distribution of conifers along a riparian gradient with that of understory component. The findings revealed that dominant tree species was *Cedrus deodara* followed by *Pinus wallichiana* and *Pinus roxburghii*. In two of the fifteen study sites namely Galgander and Puldoda only *Pinus roxburghii* was found and no associated conifer species was observed. Other associated trees found were broad-leaved trees like *Alnus nitida*, *Ficus palmata*, *Quercus baloot*, *Quercus leucotrichophora*, *Melia azedarach*, *Robinia pseudo-acacia*, *Populus ciliata, Morus alba* etc. The associated shrub/lianas included *Berberis lycium*, *Daphne oledeoides*, *Prinsepia utilis*, *Hedera helix*, *Rubus ellipticus*, *Rubus niveus*, *Rosa brunoni*, *Jasminum humile, Indigofera heterantha* etc. Pearsons correlation has been applied to species diversity, richness and soil parameters like Nitrogen, phosphorus and Potassium. Correlation has also been established between elevation and other abiotic factors (Environmental variables).

Keywords: Conifers | Distribution | Phytosociology | Shrubs | Trees | Correlation

Introduction

Conifers belong to gymnosperms and family Pinaceae. They are the needle-leaved trees widely distributed at the uplands of the Neeru stream. *Pinus roxburghii* and *Pinus wallichiana* mostly grow in the dry upslope stretch whereas *Cedrus deodara* is also available near the stream in the moist belt. These conifer forests have wide ecological amplitude and are found all along the stream. They are not only significant from the forests point of view but also owe a lot of significance because of their economic and medicinal value. *Pinus* spp. are known for the resin production. They are also significant for the asthmatic patients. *Cedrus deodara* is known for timber production. The area is quite rich in the conifer forests. Conifer forests are the evergreen trees of temperate and subalpine and alpine climate.

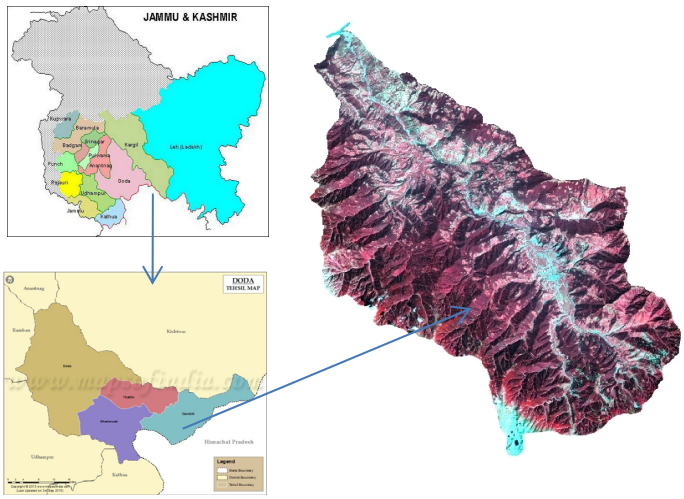
For Correspondence:

Institute of Mountain Environment, Bhaderwah Campus, University of Jammu, India
Email: **anu0007sharma@gmail.com**

They are a source of timber and shade throughout the year. Their wide canopy and shape gives way to number of understory growth of shrubs and herbs which are a source of immense medical and aromatic value. These are important natural resources to sustain life in the Kashmir Himalayas. The role of these forests lies in the maintenance of biodiversity, watershed protection as well as supplying timber, non-wood forest products, grazing land and habitat for threatened taxa (Ahmed *et al.*, 2006 & 2010).

Natural population of conifers increases exponentially in suitable conditions when resources are freely available (Watkinson, 1997). Variation in species diversity along environmental gradient is a major topic of ecological investigation in latest years and has been explained by reference to climate, productivity, biotic interaction and habitat heterogeneity (Givnish, 1999; Willig *et al.*, 2003 and Currie & Francis, 2004). Species diversity and the functioning of the ecosystem are the major areas of interest for the ecologists worldwide. Species diversity incorporates two components (Stirling & Wilsey, 2001); evenness (how evenly abundance or biomass is distributed among species) and richness (number of species per unit area). The composition of the understory species beneath tree canopies often differs with the canopy composition. Overstory species can directly affect understory species by altering the precipitation distribution under their canopy, soil bulk density, soil moisture, soil oxygen, soil surface temperature, available sunlight, soil and leaf litter accumulation, soil nutrient concentration, and seed bank density (Warnock *et al.*, 2007). Interactions of various biological and physical factors determine the distribution of tree populations in an area. Physiographic characteristics of specific landforms such as slope, aspect, parent materials and soils are used for characterizing vegetation over the space (Barnes *et al.*, 1997).

Study area and Methodology



False color composite image of study area

Map 1: Map of the study area

The study area includes the linear hydromorphological unit of Neeru stream (from near its origin at Thanalla and its confluence with river Chenab at Pul Doda) as a corridor 35 km long and ~1.5 Km wide including the river bed and flood plain and the edge upslopes (~ 200 m on either sides). The area forms the south-western part of Chenab catchment with an altitudinal range of 850 m (tail at Pul Doda) to 2200m (Thanalla) lying between 32°55′32″ to 33°08′26″N and 75°32′41″ to 75°46′50″ E. The field surveys were conducted during the years 2015 and 2016. Fifteen sites were identified for the analysis of various phytosociological parameters along both banks of the stream using species area curve approach. 24 quadrats of 100 m^2 were laid each containing two quadrats of 25 m^2 in

opposite corners for different parameters frequency, density and abundance, basal area following Curtis & McIntosh, 1950 and diversity by Shannon-Weiner, 1963. The geo-coordinates and elevation were recorded with the help of GPS (Garmin- Montana 650). For soil analysis, the samples were collected by removing litter from the surface and digging out from 0-30 cm randomly from each sub-site. Indices of dominance (Simpson index), diversity (Shannon-weiner) and richness (Margalefs and Menhinick) were calculated for the trees and the associated shrubs. About 200 g of soil samples were collected in polyethylene bags and were sealed and labeled properly and then pooled together. Then the samples were air dried at 20 to 25^{0}C, and passed through a 2 mm sieve. Soil analysis was performed for different parameters *i.e.,* pH (Philips make digital pH meter), moisture content, Electrical conductivity, Nitrogen (Subbiah & Asija, 1956), Phosphorus (Jackson, 1958) and Potassium (Pratt, 1965, Jackson 1958 and Peech & English, 1944).

Results and Discussion

The visual representation of conifers along the elevational gradient is substantiated with our findings wherein a clear trend of conifer distribution is obtained along the rising elevation. *Abies pindrow*, *Picea smithiana*, *Cedrus deodara*, *Pinus wallichiana* and *Pinus roxburghii*. *Abies pindrow* and *Picea smithiana* were found only at site 15 (Thanalla). An analysis of table 1 shows that *Cedrus deodara* was found to be dominant at 6 sites followed by *Pinus wallichiana* found at 5 sites and *Pinus roxburghii* found at 4 sites. Table 1 also reveals that maximum density (9.666) was found at site 5 (Seri) and minimum (2.333) at site 1 (Puldoda). Basal area was found to be maximum (0.09963) at site 6 (Drudu) and minimum (0.01435) at site 2 (Galgander). Out of the fifteen study sites *Cedrus deodara* was found at 11 sites, *Pinus wallichiana* at 12 sites and *Pinus roxburghii* at all the 4 study sites. Thus the range of *Cedrus deodara* in the study area was from 1200m to 2200m, *Pinus wallichiana* was 950m to 2200m and *Pinus roxburghii* from 850m to 1240m. Variety of Shrubs have been found growing under these conifer tree species. The dominance was shown by *Berberis lycium* and *Daphne oloedoides* found at all the 15 sites followed by *Prinsepia utilis* found at 13 out of 15 sites. The various other shrub species which followed the list were *Rubus ellipticus, Rubus niveus, Hedera helix, Ficus sarmentosa, Jasminum officinale, Jasminium humile, Indigofera heterantha, Vibubrnum grandiflorum, Rosa brunoni, Rosa webbiana.* It was observed that the conifers showed a linear trend with the shrubs. Shrubs were observed to follow the similar trend as the conifers followed. Conifers and shrubs showed an increase in diversity and richness from the lower to higher elevation and Simpson index showed a decrease from lower to higher elevation. Conifers showed the highest diversity (1.382) and richness (1.057, 0.7538) at 2200m and shrubs showed the highest diversity (2.096) and richness (2.0247, 2.867) and 1804m and 2200m respectively (Table 2). All the soil parameters (Organic carbon, organic matter, Nitrogen, Phosphorus) showed and increase with the rising elevation except pH and Phosphate. Soil texture was loamy at all the

sites. Electrical conductivity and water holding capaity showed an irregular trend

Site	Ele (m)	Dominant specie	Density	Basal	IVI	Other conifers in terms of IVI	Dominant broad-leaved trees in terms of IVI	Understory shrubs in terms of decreasing IVI
Puldoda	850	*Pinus roxburghii*	2.33	0.014	75.26	*nil*	*Melia azedarach,* (86.7)	*Berberis, lycium, Daphne oledeoides, Prinsepia utilis, Rubus ellipticus, Justicia adhatoda, Cactus*
Galgander	950	*Pinus roxburghii*	2.66	0.014	82.59	*nil*	*Q.baloot,* (206.6)	*Berberis, lycium, Daphne oledeoides, Prinsepia utilis*
Pranoo	1000	*Pinus roxburghii*	4.83	0.022	46.64	*nil*	*Alnus nitida,* (153.6)	*Berberis, lycium, Daphne oledeoides, Prinsepia utilis, , Rubus ellipticus, Rosa brunoni*
Bhalla	1240	*Pinus roxburghii*	4.16	0.033	97.54	*Pinus wallichiana*	*Alnus nitida,* (222.8)	*Berberis, lycium, Daphne oledeoides, Prinsepia utilis, , Rubus ellipticus, Rosa brunoni,*
Seri	1295	*Cedrus deodara*	9.66	0.083	116.38	*Pinus roxburghii and Pinus wallichiana*	*Alnus nitida,* (150.6)	*Berberis, lycium, Daphne oledeoides, Hedera helix, Prinsepia utilis, , Rubus ellipticus, Jasminum officinale, Clematis montana, Ficus sarmentosa, Rosa brunoni, Rubus ellipticus*
Drudu	1372	*Cedrus deodara*	8.66	0.099	197.70	*Pinus wallichiana*	*Alnus nitida,* (161.4)	*Berbris, lycium, Daphne oledeoides, Prinsepia utilis, , Rosa brunoni, Rubus ellipticus, Jasminum humile*
Dranga	1410	*Cedrus deodara*	6.33	0.061	210.62	*Pinus wallichiana*	*Alnus nitida,* (178.1)	*Berberis, lycium, Daphne oledeoides, Hedera helix, Prinsepia utilis, , Rubus ellipticus, Jasminum officinale, clematis Montana*
Amiranagar	1465	*Pinus wallichiana*	6.00	0.040	114.78	*Cedrus deodara*	*Alnus nitida,* (179.3)	*Berbris, lycium, Daphne oledeoides, Ficus sarmentosa, Hedera helix, Prinsepia utilis, , Rosa brunoni, Rubus ellipticus*
Gatha	1480	*Cedrus deodara*	4.66	0.033	269.89	*Pinus wallichiana*	*Alnus nitida,* (221.5)	*Berberis, lycium, Daphne oledeoides, Hedera helix, , Prinsepia utilis*
Renda	1563	*Pinus wallichiana*	3.00	0.017	115.66	*Cedrus deodara*	*Alnus nitida,* (192.2)	*Berberis, lycium, Daphne oledeoides, Prinsepia utilis, Rubia manjith, Rubus niveus, Clematis montana*
Guptganga	1610	*Pinus wallichiana*	7.16	0.047	67.66	*Cedrus deodara*	*Alnus nitida,* (108.4)	*Berberis, lycium, Daphne oledeoides, Hedera helix, Indigofera heterantha, Jasminum humile, Prinsepia utilis, Rubus niveus, Spiraea canescens*
Dareja	1667	*Pinus wallichiana*	6.33	0.048	48.75	*Cedrus deodara*	*Alnus nitida,* (204.8)	*Berberis, lycium, Daphne oledeoides, Ficus sarmentosa, Jasminum humile, Prinsepia utilis. Eleaegnus umbellate, Rhamnus triquater*
Bheja	1804	*Pinus wallichiana*	6.16	0.030	154.11	*Cedrus deodara*	*Alnus nitida,* (129.8)	*Artemisia maritima, Berberis, lycium, Daphne oledeoides,Indigofera heterantha, Rosa brunoni, Rosa webbiana, Rubus niveus, Sarcococca saligna, Prinsepia utilis*
Thanthera	2160	*Cedrus deodara*	7.66	0.041	226.53	*Pinus wallichiana*	*Alnus nitida,* (127.9)	*Artemisia maritima, Berberis, lycium, Daphne oledeoides, Eleagnus parviflora,Indigofera heterantha, Jasminum humile, Prinsepia utilis*
Thanalla	2200	*Cedrus deodara*	2.5	0.015	187.45	*Pinus wallichiana, Abies pindrow and Picea smithiana*	*Q.leucotrichop hora,* (82.0)	*Berberis, lycium, Daphne oledeoides, Ficus sarmentosa, Hedera helix, Indigofera heterantha, Viburnum grandiflorum*

Table 1: Phytosociological analysis of conifer species and associated trees and shrubs in the study area

	Trees				Shrubs			
Site	Simpson's index	Shannon-weiner index	Margalefs index	Menhinick index	Simpson's index	Shannon-weiner index	Margalefs index	Menhinick index
Puldoda	1	0	0	0.2672	0.1931	1.281	1.144	0.8703
Galgander	1	0	0	0.25	0.3099	1.08	0.6792	0.6882
Pranoo	0.7415	0.418	0.2836	0.404	0.1951	1.579	1.0389	0.7293
Bhalla	0.5376	0.642	0.2749	0.3244	0.1746	1.725	1.2022	0.75
Seri	0.3919	0.995	0.4215	0.2797	0.1228	2.029	1.6895	1.007
Drudu	0.4010	0.967	0.4215	0.2797	0.1718	1.719	1.3377	0.925
Dranga	0.4115	0.943	0.4708	0.3585	0.1374	1.903	1.5499	1.01
Amiranagar	0.4149	0.94	0.4708	0.3585	0.1338	1.968	1.7894	1.131
Gatha	0.4523	0.883	0.5195	0.4375	0.2405	1.359	0.858	0.6963
Renda	0.3513	1.046	0.5498	0.4866	0.1655	1.709	1.456	1.0777
Guptganga	0.4421	0.872	0.4478	0.3219	0.1213	1.011	1.7028	1.0243
Dareja	0.4663	0.828	0.4757	0.0016	0.1515	0.859	1.5762	1.0435
Bheja	0.4687	0.799	0.4708	0.3585	0.1176	2.096	2.0247	1.248
Thanthera	0.4543	0.841	0.4423	0.3127	0.1254	1.983	1.8728	1.234
Thanalla	0.2642	1.382	1.057	0.7538	0.1833	1.678	1.3554	2.2867

Table 2: Describing the various indices of diversity and richness of conifers and associated shrubs

S. No.	Site name	Soil pH	EC	Texture	WHC	Soil moisture (%)	Organic carbon (%)	Organic matter (%)	Nitrogen (Kg/ha)	Phosphorus (Kg/ha)	Potassium (Kg/ha)
1.	Puldoda	7.47	0.65	Loamy	15.77	4.62	2.0	5.17	20.85	26.28	225.62
2.	Galgander	6.95	0.65	Loamy	18.58	4.23	8.75	15.09	59.08	33.77	132.46
3.	Pranoo	6.90	0.78	Loamy	15.63	4.74	54.0	93.1	375.3	37.54	80.82
4.	Bhalla	6.75	0.81	Loamy	15.28	4.55	38.0	65.51	264.1	37.54	199.8
5.	Seri	6.65	0.79	Loamy	19.71	4.21	35.0.	60.34	243.25	11.26	90.92
6.	Drudu	6.60	0.66	Loamy	19.03	4.40	33.0	56.89	229.35	30.03	69.03
7.	Dranga	6.55	0.68	Loamy	17.67	4.45	68.0	117.23	472.6	26.28	332.82
8.	Amiranagar	6.25	0.69	Loamy	15.7	4.31	56.0	96.54	389.2	11.26	125.16
9.	Gatha	6.25	0.71	Loamy	17.56	4.56	33.0	56.89	229.35	26.27	85.31
10.	Renda	6.20	0.71	Loamy	21.81	4.31	87.5	150.5	608.13	3.75	76.33
11.	Guptganga	6.15	0.77	Loamy	17.42	4.37	135.5	233.6	441.73	37.54	103.83
12.	Dareja	6.10	0.66	Loamy	17.66	4.22	112	193.08	778.33	30.03	124.03
13.	Bheja	6.10	0.57	Loamy	14.05	3.90	99.5	171.54	691.53	22.52	91.48
14.	Thanthera	6.10	0.76	Loamy	19.08	3.85	148	255.15	1028.6	33.78	136.94
15.	Thanalla	6.10	0.79	Loamy	18.52	3.73	209.5	361.18	1178	41.28	182.96

Table 3: Physico-chemical characteristics of the soil of the study sites

(Table 3). The composition of conifers in the study area included the five main species namely *Abies pindrow*, *Picea smithiana, Cedrus deodara Pinus wallichiana* and *Pinus roxburghii*. The distribution of conifers in relation with the shrubs in the present study revealed that where diversity and richness of trees and shrubs followed the similar trend. *Abies pindrow* and *Picea smithiana* was restricted in the highest elevation (2200 m). *Cedrus deodara* was widely distributed in the region. *Cedrus deodara* and *Pinus wallichiana* was found at higher elevations and towards the NW aspect which was facing the lesser sunshine. *Pinus roxburghii* was found to be dense towards the SW aspect which was sun facing side of the stream.

Similar studies have been conducted by the various researchers like Barbier *et al*. (2008) who studied the influence of tree species on understory vegetation diversity. Understory light is closely dependent on the canopy structure. Air temperature and air humidity in the understory are also dependent on canopy structure, particularly canopy density (Sharpe *et al*., 1996). Variations of these factors among tree species have been observed (Hunter, 1990 & Porte´ *et al*., 2004) and are sometimes discussed as affecting understory flora (Nihlgard, 1969). Tree species may affect soil water availability by changing (i) amounts of non-intercepted water, (ii) quantity of water absorbed by tree roots, and (iii) spatial distribution of water at the tree scale (trunk and crown) (Barbier *et al*., 2008). *P. roxburghii* has a wide ecological amplitude and considerable economic importance, providing large stretches of grazing lands due to its typically well-developed grass layer (Wahab, 2011) and valuable timber-wood and resin.

Conclusion

From the following study it has been observed that the canopy of the trees do have influence on the understory shrubs as they influence the availability of sunlight, stem flow, rainfall, air temperature and also the availability of soil water and nutrients to the understory shrubs and species. It is therefore concluded that the diversity and richness of

conifer species lead to the growth of diverse shrub species. Conifers support the understory shrub species. The probable reasons are

1. The conifer trees provide the understory shrubs the shade and protect them from the intense sunlight thereby regulating the air and soil temperature and moisture as well.
2. The droppings of the trees help in modifying the soil conditions which includes the soil pH and water holding capacity, organic matter, organic carbon and NPK and make them available to the shrubs for their better growth and nourishment.

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