Distribution pattern of Oak and Pine along altitudinal gradients in Garhwal Himalaya

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Abstract: The study was carried out in the oak and pine forest for community composition and soil characteristics along altitudinal gradients of Garhwal Himalaya. The soil pH of oak forest was acidic while in pine forest its slightly acidic. The soil organic carbon (SOC) was higher in oak forest. Although between the forests the SOC content decreased with increasing altitudes in both the forest. Nitrogen in both the forest also decreased with increasing altitudes however, the trend was reverse for phosphorus. Among the sites Quercus leucotrichophora was dominant on all the sites. As SOC and nitrogen decreased with increasing altitudes same pattern of species total density and TBC was reported which also decreased with increasing altitudes. Throughout the oak and pine forests *Quercus leucotrichophora* and *Pinus roxburghii* were distributed contagiously. The study can be concluded that SOC and nitrogen availability on the reducing trends in both the forests with altitudes might be due to reducing density and total basal cover of the trees with altitudes. [Nature and Science. 2009;7(11):81-85]. (ISSN 1554-0200)

Keywords: Distribution pattern, oak, pine, altitudinal gradient, Garhwal Himalaya

1. Introduction

The Garhwal Himalayas embodies a number of forest types that are distributed at various altitudes, geological formations and soil types (Champion and Seth, 1968; Saxena and Singh, 1982). The temperate forests of Western and Central Himalaya are usually distributed from 1200 to 3000 m asl, and characterized by extensive oak and coniferous forests (Kumar and Bhatt, 2006). Oak is the most preferred tree species in the temperate region, mainly used for fodder, fuel, and small timber.

Forest soils influence the composition of the forest stand and ground cover, rate of tree growth and other silviculturally important factors. Physiochemical characteristics of forest soils vary in space and time due to variations in topography, climate, physical weathering processes, vegetation cover, microbial activities, and several other biotic and abiotic variables. Vegetation plays an important role in soil formation (Chapman and Reiss, 1992). Plant tissues (from aboveground litter and belowground root detritus) are the main source of soil organic matter (SOM), which influences physiochemical characteristics of soil such as pH, water holding capacity (WHC), texture and nutrient availability (Johnston, 1986). Nutrient supply varies widely among ecosystems (Binkley and Vitousek 1989), resulting in differences in plant community structure and production (Ruess and Innis 1977).

The Himalayan forest vegetation ranges from tropical dry deciduous forests in the foothills to timberline. Forests are the main source of livelihood of the people living in Uttarakhand, Central Himalaya. Forests of this region are mainly dominated by *Pinus roxburghii* and *Quercus leucotrichophora. Pinus roxburghii* is the most common resin producing pine species of India and also provide alternate source of fuelwood and leaves for bedding materials, however *Quercus leucotrichophora* is important source of fuel, fodder and other daily needs of the villagers. Therefore, an attempt was made to analyze the forest community structure in relation to physiochemical properties along altitudinal gradient in both the forests in Garhwal Himalaya.

2. Materials and Methods

2.1 Study site

The present study was carried out in two different regions i.e., temperate oak forest (located 30° 07’ 09.9” to 30 ° 7’ 12.3” N and 78 ° 47’46.5” to 78 ° 47’42.5” E at an elevation range of 1700 to 1900 msl) and sub-tropical pine forest (located 30 ° 12’ 51.2” to 30 ° 12” 51.0” N and 78 ° 48’ 25.2” to 78 ° 49’ 02.2” E at an elevation range of 700 to 900 m asl).

The phytosociological study was carried in the tree layer by using 10 x 10 m quadrats. A total of 10 randomly placed quadrats were used on each site. The size and number of quadrats were determined by the species area curve (Misra 1968) and the running mean methods (Kershaw 1973). In each quadrate >30 cm circumference (at 1.37 m from the ground) were considered tree. The vegetation data were quantitatively analyzed for abundance, density and frequency (Curtis and McIntosh, 1950). The importance value index (IVI)

was determined as the sum of the relative frequency, relative density and relative dominance (Curtis 1959).

For the soil analysis, the samples were mixed well individually before use. Then samples were air dried at 20 to 25°C and 20% to 60% relative humidity (Jackson, 1958). Soil pH was measured with the help of dynamic digital pH meter. Soil organic carbon (SOC) percent was determined by Walkley and Black's rapid titration method (Walkley and Black, 1934).Total nitrogen (%) was measured using the standard kjeldal procedure. Exchangeable phosphorus (P) and available potassium (K) was determined by (Jackson, 1958).

3.2 Results and Discussion

3.1 Soil characteristics

In oak forest, the soil pH (Table 1) was 5.6±0.54 (1700m), 5.8±0.17 (1800m) and 5.5±0.25 (1900m). The SOC decreased with increasing altitude as 0.90±0.10 (1700m), 0.88±0.14 (1800m) and 0.80±0.07 % (1900m). Nitrogen has also remained same trend as SOC. The phosphorous was shown reverse trend with SOC and nitrogen at altitude. The values of phosphorous at altitude were 11.42±0.94 (1700m), 13.02±1.35 (1800m) and 13.45±0.51 kg ha^{-1} (1900m). Potassium at altitude 1700m was 108.2±6.55 kg ha^{-1} and at altitudes 1800m and 1900m 108.90±11.65, 99.02± 29 kg ha^{-1} respectively (Table 1).

In pine forest, the values of soil pH increased with increasing altitudes. The values of SOC decreased with increasing altitude (Table 1). The values of SOC were 0.75±0.05 (700m), 0.63±0.09 (800m) and 0.62±0.10 % (1000m). Nitrogen, potassium decreased with the altitude however, phosphorous increased with increasing altitudes (Table 1).

Table 1: Soil characteristics in oak and pine forests

Site/Altitude	Soil pH (1.2:5)	SOC (%)	Nitrogen (%)	Phosphorus (kg ha^{-1})	Potassium (kg ha^{-1})
Oak					
Site-I 1700m	5.6±0.54	0.90±0.10	0.045±0.005	11.42±0.94	108.2±6.55
Site-I 1800m	5.8±0.17	0.88±0.14	0.044±0.007	13.02±1.35	108.90±11.65
Site-I 1900m	5.5±0.25	0.80±0.07	0.040±0.003	13.45±0.51	99.02±22.29
Pine					
Site- I 700m	6.51±0.19	0.75±0.05	0.037±0.002	22.1±2.43	116.48±9.81
Site-II 800m	6.75±0.11	0.63±0.09	0.032±0.005	23.80±1.56	107.86±18.0
Site-II 1000m	6.77±0.13	0.62±0.10	0.031±0.005	24.18±0.96	105.15±30.25

3.2 Phytosociological study

3.2.1 Oak Forest

The quantitative information of oak forest is shown in Table 2. On site-I (1700m) the dominant tree was *Q. leucotrichophora* and the least dominant species was *P. roxburghii* which was very low in number at this altitude. The other tree species reported on this site were *Myrica esculenta, Rhododendron arboretum*. The associated ground floras were *Pteris* sp. and *Berberis asiatica*. The distribution pattern of *Q. leucotrichophora* and *M. esculenta* was contagious however, *R. arboreum* and *P. roxburghii* were distributed randomly.

On site-II (1800m), *Q. leucotrichophora* was again dominant with highest value of IVI (159.85), density (620 tree ha^{-1}) and TBC (38.38 m^2 ha^{-1}). Other competing trees were *M. esculenta*, *R. arboreum* and *P. roxburghii*. The distribution pattern of most trees was random except *Q. leucotrichophora* which was distributed contagiously (Table 2). The associated ground floras with trees were *Pteris* sp. *Berberis asiatica, Pyracantha crenulata* and *Eupatorium* sp.

On site-III (1900m), again the dominant tree was *Q leucotrichophora* and least dominant *P. roxburghii* (Table 2). *M. esculenta* and *R. arboreum* were the associated species. The distribution pattern of most species was contagious except *P. roxburghii* was randomly distributed (Table 2).

3.2.2 Pine Forest

The quantitative information of *P. roxburghii* is shown in Table 3. On site-I (700m). The frequency, density and TBC of the tree was 100 (%), 560 (tree ha^{-1}) and 56.94 (m^2 ha^{-1}) respectively. The distribution pattern of *P. roxburghii* was contagious. The shrub species reported on the site were *Asparagus racemoses, Rhus parviflora.*

On site-II (800m), the density of *P. roxburghii* was 540 (tree ha^{-1}) and total basal cover was 53.26 (m^2 ha^{-1}). The distribution pattern of *P. roxburghii* was contagious. Other associated ground floras were *Rhus parviflora, Carrisa spinarum, Asparagus racemoces, Mallotus phillipensis, Nepta*

hindostana, *Artemisia scorpia* and *Colebrookia oppositifolia*.

On site-III (1000m), of this forest, the density and TBC of pine tree was 500 (tree ha^{-1}) and 26.79 (m^2 ha^{-1}) respectively. The distribution pattern of a species was contagious. The associated ground floras were *Sapium insigne*, *Rhus parviflora*, *Lantana camara* and *Carissa spinarum*.

Table 2: Frequency (%), density, TBC, A/F ratio and IVI of oak forest in different altitude

Site/ Altitude	Species	Frequency (%)	Density (Trees ha^{-1})	TBC (m^2 ha^{-1})	IVI	A/F ratio
Site-I (1700m)	*Quercus leucotrichophora*	100	660	41.08	167.26	0.066
	Myrica esculenta	80	320	10.40	77.52	0.051
	Rhododendron arboreum	60	100	4.54	41.88	0.027
	Pinus roxburghii	20	100	2.84	13.34	0.0256
	Total		**1100**	**58.86**		
Site-II (1800m)	*Quercus leucotrichophora*	100	620	38.38	159.85	0.062
	Myrica esculenta	100	200	6.44	62.04	0.026
	Rhododendron arboreum	60	120	5.04	39.35	0.028
	Pinus roxburghii	60	100	5.78	38.76	0.026
	Total		**1040**	**55.64**		
Site-III (19000m)	*Quercus leucotrichophora*	100	520	25.82	155.8	0.052
	Myrica esculenta	60	200	5.62	57.64	0.053
	Rhododendron arboreum	40	120	5.34	40.96	0.075
	Pinus roxburghii	60	120	4.10	45.6	0.031
	Total		**960**	**40.88**		

Table 3: Frequency (%), density, TBC, A/F ratio and IVI of pine forest in different altitude

Site /Altitude	Species	Frequency (%)	Density (Trees ha^{-1})	TBC (m^2 ha^{-1})	IVI	A/F ratio
Site- I (700m)	*Pinus roxiburghii*	100	560	56.94	300	0.056
Site-II (800m)	*Pinus roxiburghii*	100	540	53.26	300	0.054
Site-III (1000m)	*Pinus roxiburghii*	100	500	26.79	300	0.051

4. Discussion

The range values of soil pH, SOC, nitrogen, phosphorus and potassium of oak and pine forests of present study is presented in Table 5. The comparative studies of the related soil parameters is also given by Sharma and Kumar (1991), Bhandari *et al.* (2000), Dhanai *et al.* (2000), Kumar *et al.* (2009) for Garhwal Himalaya forests and Singh and Bhatnagar (1997) and Khera *et al.* (2001) for Kumaun Himalaya (Table 4).

The range values of density, TBC is also present for oak and pine forests in Table 5. The comparative values of density and TBC of other forests is studied by various workers for Garhwal Himalayan forests (Rajwar, 1991; Kusumlata and Bisth, 1991 Sharma *et al.*, 2001) and Kumaun Himalayan forests (Pant, 1987; Nayak *et al.*,1991; Saxena and Singh, 1982).

Among the distribution pattern of the species most of the species in oak forest and pine in all the site was distributed contagiously and few species in oak forest were distributed randomly. Contagious distribution has been reported by several workers Greig-Smith (1957); Kershw (1973); Singh and Yadav (1974). Odum (1971) have emphasized that contagious distribution is the commonest pattern in nature. Kumar and Bhatt (2006) also reported contagious distribution pattern in foot-hills forests of Garhwal Himalaya.

Table 4: Comparative studies of soil of oak and pine forests.

Soil Parameter	Range values	Forest type	Regions	Authors
pH	5.5 to 5.8	Oak (mixed	Garhwal	Present study
SOC (%)	0.80 to 0.90			
N (%)	0.040 to 0.045			
P (kg ha^{-1})	11.42 to 13.45			

K (kg ha^{-1})	99.02 to 108.90			
Soil pH	6.51 to 6.77	Pine (mixed)		Present study
SOC (%)	0.62 to 0.75			
N (%)	0.031 to 0.037			
P (kg ha^{-1})	21.90 to 24.18			
K (%)	89.98 to 116.48			
SOC (%)	1.33 to 1.80	Oak (mixed)	Garhwal	Kumar *et al.*, 2009
pH	5.02 to 5.7	Oak-pine	Garhwal	Sharma and Kumar, 1991
SOC (%)	0.26 to 2.29			
P (kg ha^{-1})	8.47 to 33.88			
K (kg ha^{-1})	15.2 to 35.2			
pH	4.80	Oak	Kumaun	Singh and Bhatnagar 1997
SOC (%)	1.84			
pH	6.20	Pine		
SOC (%)	1.77			
pH	5.1 to 5.9	Oak	Garhwal	Bhandari *et al.*, 2000
SOC (%)	2.10 to 2.5			
N (%)	0.25 to 0.31			
P (kg ha^{-1})	14.40 to 21.60			
K (kg ha^{-1})	170.8 to 295.4			
pH	5.0 to 5.9	Oak (mixed)	Garhwal	Dhanai *et al.*, 2000
SOC (%)	1.12 to 6.80			
P (kg ha^{-1})	296 to 800			
K (kg ha^{-1})	11.82 to 31.32			
pH	7.0 to 8.4	Oak (mixed)	Kumaun	Khera *et al.*, 2001
SOC (%)	0.8 to 2.3			
N (%)	0.04 to 0.11			
P (kg ha^{-1})	13.4 to 24.7			

Table 5: Comparative studies of density and TBC of oak and pine forests

Forest type	**Regions**	**Density (tree/ha)**	**TBC (m^2/ha)**	**Authors**
Q. leucotrichophora	Garhwal (Pauri)	960-1100	40.88-58.86	Present study
Pinus roxburghii		500-560	26.79-56.94	Present study
Q. leucotrichophora	Kumaun	510 to 2060	-	Pant (1987) and Nayak *et al.* (1991
Q. leucotrichophora	Garhwal (Uttarkashi)	1020 to 2460	46.17 to 71.23	Rajwar (1991)
Q. leucotrichophora and *P. roxburghii* (mixed)	Kumaun (Nainital)	540	35.98	Saxena and Singh, 1982
Q. leucotrichophora	Garhwal (Puari)	790	35.39	Kusumlata and Bisth,1991
Q. leucotrichophora	Garhwal (Kinkaleshwar)	1550	57.67	Kusumlata and Bisth,1991
Q. leucotrichophora	Kumaun	940	53.02	Saxena and Singh, 1982
Q. leucotrichophora	Garhwal Mandal -Chopta	100-860	8.42-59.71	Sharma *et al.*, 2001

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