Journal of Tropical Forest Science 9(4): 449-457 (1997)

COMMUNITY STRUCTURE AND PHYSICAL ENVIRONMENT: A CASE STUDY OF THE TEMPERATE MIXED CONIFEROUS LATA FOREST IN THE MALARI VALLEY OF GARHWAL HIMALAYA

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Received July 1994

KUMAR, A., SHARMA, C.M. & BADUNI, N.P. 1997. Community structure and physical environment: a case study of the temperate mixed coniferous Lata forest in the Malari valley of Garhwal Himalaya. Community structure of the temperate mixed coniferous forest of Lata area in the Malari valley of Garhwal Himalaya was analysed in relation to its geoecological environment. Garnetiferous mica schists and sericite chlorite quartzite are the main rock types in the area. The soil is loam predominating sand, with high average levels of organic carbon (1.2%), low phosphorus (11.28 kg ha^{-1}) and high potash (322.17 kg ha^{-1}) contents. *Pinus wallichiana* constitutes 41% of the total basal area, followed by *Cedrus deodara* (35%), *Cupressus torulosa* (12%), *Taxus baccata* (9%) and *Betula utilis* (only 3%) in the tree layer. The total tree density ranges from 33 to 366 trees ha^{-1}, whereas the total basal area is between 1.75 and 24.52 m^2 ha^{-1}. The commonly associated species of shrubs include *Prinsepia utilis, Berberis asiatica* and *Contoneaster acuminata,* which form a heterozygous vegetational cover.

Key words: Malari valley - Garhwal - soil - trees - shrubs - density - basal area

KUMAR, A., SHARMA, C.M. & BADUNI, N.P. 1997. Struktur komuniti dan persekitaran fizikal: kajian kes di hutan konifer campur sederhana Lata di lembah Malari di Garhwal Himalaya. Struktur komuniti bagi hutan konifer campur sederhana kawasan Lata di lembah Malari, Garhwal Himalaya dianalisis berhubung dengan persekitaran geoekologinya. Syis mika garnetifer dan quarzit klorit serisit merupakan jenis batuan yang utama di kawasan tersebut. Tanahnya lorn tetapi lebih banyak berpasir, dengan tahap purata kandungan karbon organik yang tinggi (1.2%), tahap purata kandungan fosforus yang rendah (11.28 kg ha^{-1}) dan tahap purata kandungan potasy yang tinggi (322.17 kg ha^{-1}). *Pinus wallichiana* meliputi 41% daripada jumlah kawasan asas, diikuti dengan *Cedrus deodara* (35%), *Cupressus torulosa* (12%) *Taxus baccata* (9%) dan *Betula utilis* (hanya 3%) dalam lapisan pokok. Jumlah kepadatan pokok berjulat daripada 33 hingga 366 pokok ha^{-1} manakala jumlah luas asas adalah diantara 1.75 dan 24.52 m^2 ha^{-1}. Spesies pokok renik yang biasa termasuklah *Prinsepia utilis, Berberis asiaticac dan Contoneaster acuminata yang* membentuk penutup tumbuhan yang heterozigus.

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Introduction

The Himalayan vegetation ranges from tropical dry deciduous forest in the foot hills to alpine meadows above the timberline. The Himalayan forest ecosystems have been repeatedly damaged in the geological past, due to the inherent vulnerability of the mountains to landslides caused by tectonic stresses. Human interference has generally led to substantial reduction of forest cover through deforestation, cultivation and road building activities. This in turn has led to serious ecological disasters as soil erosion, loss of soil fertility and violent floods. Therefore, for any study of the ecology of a forest, a quantitative evaluation of its vegetation is a prerequisite. Although qualitative descriptions of the forest vegetation of the Himalaya are available (Champion & Seth 1968), attempts to make quantitative examinations are fragmentary and have only been made recently (Ralhan *et al.* 1982, Saxena & Singh 1982, 1984, Kalakoti *et al.* 1986, Sharma & Kumar 1992). In addition, knowledge of the environmental impact on the forest richness is important to understand the complete ecosystem dynamics, particularly in any temperate mixed coniferous forest of Himalaya.

The presentstudy examined the community structure of the temperate mixed coniferous forest of the Lata area in the Malari valley of Garhwal Himalaya in relation to its physical environment, through an analysis of (i) the geoecological factors of the forest, (ii) the physico-chemical properties of the soil, and (iii) the phytosociological attributes of the species in the forest.

Materials and methods

Study area

Geoecological details

Garhwal Himalaya lies in the central part of western Himalaya between 30" 31° N and 70-80° E. The Lata forest (30° 20'N, 79° 43'E; 2450 - 2775 m a.s.l.) in the Malari valley covers an area of 1500 ha and supports a mixed coniferous montane forest (Figure 1). The climate of Lata area is cold and semi-arid. The average maximum temperature ranges from 6.0 °C in January to 22.0 °C in June. However, the average minimum temperature of the forest is from -1 °C in January, to 13.5 °C in July. The rainfall was fairly high between 12 mm (January) and 716 mm (August) during 1988. Relative humidity varies from 40% (November) to 94% (July) throughout the year (Figure 2). The minimum soil temperature of 3 °C is recorded in January and the maximum of 18.5 °C in August.

Major human activities in relation to forests in Lata area are due to nomadic races (Tolchhas), who lead a pastoral life-style, traversing the entire elevation gradient, that involves destroying the trees to clear the land for cultivation of *Fagopyrum esculentum* (locally called as ugal), potato, beans and utilising the trees for fuel and temporary buildings (locally called chhans) on a substantial basis.

The population of these inhabitants together with their animal husbandry activities is increasing, causing serious threats to the forest. They migrate towards lower altitudes during winter after their stay of seven months (April-October) at the Lata area.

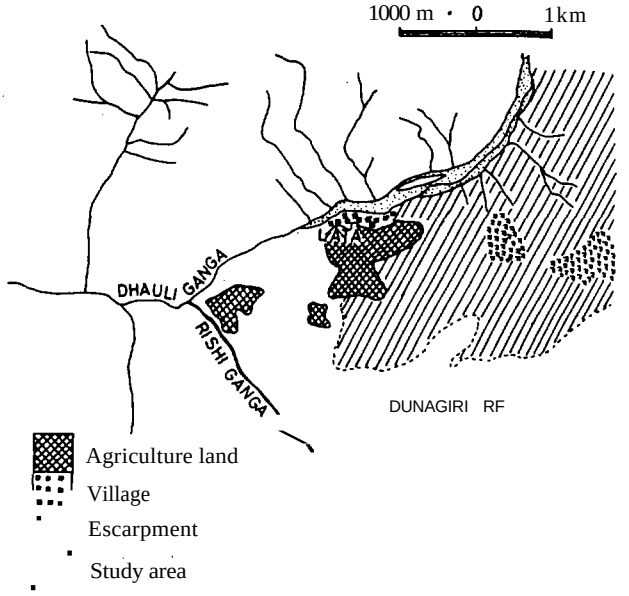

Figure 1. Location map of the study area

Geology

Geologically the area comes under the crystalline rocks of the Vaikrita group (Valdiya 1978) and the lower part of Tethys sediments. The Vaikrita group consists of the lower Lata formation which is tectonically overlain by the Ramani formation. The geological succession of the area is as below:-

Martoli formation (Heim & Gansser 1939)
Thrust
Kharapatal formation
Ramani fault or Malari fault (Shah & Sinha 1974)
Ramani formation
Lata fault
Lata formation
Vaikrita thrust

(After Yuji 1979).

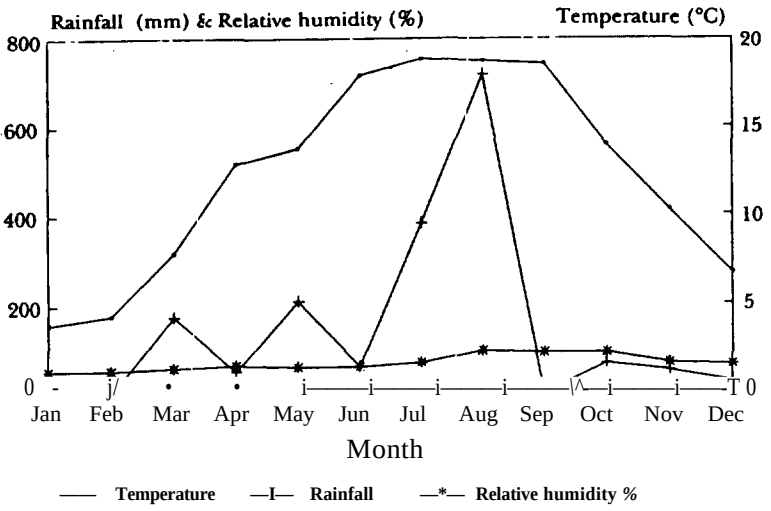

Figure 2. Mean meteorological data of study area

The Lata formation is exposed in the lower reaches of Rishi Ganga and Dhauli Ganga, which comprise garnetiferous mica schist, sericite chlorite quartzite and thick series of mica quartzite. The rocks are highly metamorphosed and foliated. The Ramani formation consists of schist and gneisses of high metamorphic grade. The lower part of the Tethys consists of mainly black ferrugenous quartzite and schist, followed by phyllites interbedded with sericite-quartz peletic phyllites.

The grade of metamorphism gradually decreases from the Lata formation to the Martoli formation, i.e. garnetiferous schist and gneisses at the base and phyllite on the top.

Sampling and analysis

Soil samples from different sites were collected during March to April 1988, from the top (0-10 cm), middle (11-20 cm) and lower (21-30 cm) layers. The soil reaction was assessed by a control dynamics digital pH meter (model No. APX 175 E/C). The organic carbon percentage was determined by the Walkley and Black's Rapid Titration Method (Walkley & Black 1934). Available P was determined by the phosphomolybdic blue colorimetric method (Jackson 1958) and exchangeable K was determined by flame photometer (model No. EEL127) after leaching the soil with ammonium acetate solution (Jackson 1958). The total water holding capacity and existing moisture content of the soil were determined according to Misra (1968).

The phytosociological analysis of forest was done on 10 X 10 m quadrats. In all thirty quadrats were laid out randomly at each stand. The size and number of quadrats were determined following the species-area curve method (Misra 1968) and running mean method (Kershaw 1973). All trees with circumference at breast height (cbh at 1.37 m from the ground) > 31.4cm in each quadrat were measured and recorded individually per species. Each quadrat was subdivided into five 5 X 5 m sample plots for examining the shrubs, and five 2 X 2 m sample plots for examining the herb species.

The vegetational data were quantitatively analysed for abundance, density and frequency according to Curtis and Mclntosh (1950), because the communities were recognised as discrete units of populations. The relative values of frequency, density and dominance were determined following Phillips (1959). These values were summed to represent the importance value index (FVI) of individual species (Curtis 1959).

Results and discussion

The community is the resultant functional system of species interaction and community structure in any ecosystem. Importance value progressions and species diversities are interrelated expressions of the interaction and organisation of species in communities (Whittaker 1970). Thus Whittaker has taken the structure, function and dynamics into account for expressing a community.

Geophytological analysis

In the Lata area *Cupressus torulosa was* found growing on the limestone terrain. Blue pine *(Pinus wallichiana)* was observed on the steep slopes of schists, whereas the dip slopes of schists was found to mainly support deodar *(Cedrus deodard)* forests. Similarly *Taxus baccata forests* were associated with gneisses and the upper reaches of the inaccessible terrain, full of phyllites, promote the growth of birch *(Betula utilis)* forests.

Soil analysis

The soil of the Lata forest is loam predominating sand. It is greyish-brown in colour with pH ranging between 6.6 and 6.7 at different depths. The average level soil organic carbon is 1.20% (range 0.88- 1.60%). Available phosphate is 11.28 kg ha^{-1} at an average (range 8.05 - 14.67 kg ha^{-1}) at different depths. Available potash in the soil is higher with an average of 322.17 kg ha^{-1} (range 305-342 kg ha^{-1}). The average water holding capacity of the soil is 64.94% (range 60.4- 69.3%) (Table 1).

Table 1. Physico-chemical characteristics of the soil at the study area

Sample no.	Soil layer	Depth (cm)	pH	Organic carbon (%)	Available phosphate (kg ha^{-1})	Available potash (kg ha^{-1})	Water holding capacity (%)	Soil moisture (%)
PI	Top layer	0-10	6.6	0.88	14.67	326	60.4	80.0
P2	Middle layer	11-20	6.7	1.18	8.05	318	66.5	83.4
P3	Lower layer	21-30	6.7	1.52	10.74	305	69.3	86.5
P4	Top layer	0-10	6.7	0.93	13.84	342	62.3	82.0
P5	Middle layer	11-20	6.6	1.08	9.85	328	64.8	84.5
P6	Lower layer	21-30	6.7	1.60	10.53	314	66.3	85.7
	Average		6.7	1.20	11.28	322	65.0	83.7

The soil of the Lata area is rich in average organic carbon, which increases its water holding capacity and as therefore good for plant growth. The lower levels of phosphorus are believed to be compensated for by the high organic carbon content, which is considered a reservoir for phosphorus and sulfur. In fact the reduced growth of trees at certain places in the forest is attributed to phosphorus deficiency. But because phosphorus is most available at pH 6.5 for mineral soil, the supply of phosphorus is recognised as normal in most parts of the forest. The soil of the Lata area, is richer in mica (the more soluble mineral source), as a result of which the average potassium content is also high which is important for the development of young seedlings.

Quantitative analysis of phytosociological attributes

The Lata forest is fairly dense and rich in its vegetational cover. Trees dominate the inner parts of the virgin forest whereas shrubs and grasses dominate the forest-agriculture fringes. *Pinus wallichiana, Cedrus deodara and Taxus baccata* show a random pattern, while *Cupressus torulosa* and *Betula utilis* have a contiguous pattern of distribution. The respective densities of these trees are 366, 266, 100, 100 and 33 trees ha^{-1} with total basal area of 41, 35, 12, 9 and 3% (FigureS). The mean basal area was found largest for *Cedrus deodara* (0.079m^2 tree^{-1}) and least for *Betula utilis* (0.053 m^2 tree^{-1}). The maximum total basal area was found to be highest for *Pinus wallichiana* (24.52m^2 ha^{-1}) and minimum (1.75 m^{2}ha-') for *Betula utilis* (Table 2).

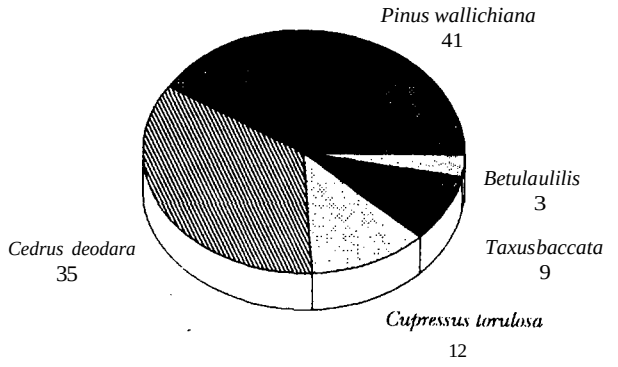

Figure 3. Relative basal area % of the various tree spp. in the Lata forest

Table 2. Frequency, density, mean basal area, total basal area and importance value index of the tree species

Species	Frequency (%)	Density (no. ha^{-1})	Mean basal area (m^2 plant^{-1})	Total basal area ($m^2 ha^{-1}$)	Importance value index (IVI)
Knits Wallichiana	87.50	366	0.067	24.52	112.92
Cedrus deodara	51.50	266	0.079	21.01	83.64
Cupressus torulosa	90.00	100	0.069	6.90	53.59
Taxus baccala	47.50	100	0.057	5.70	37.18
Belulautilis	17.50	33	0.053	1.75	12.67

The phytosociological characters may differ among different positions (site quality) and types (composition) of forest even in the same vegetation type. This is because of variations in altitude, slope angle (Shank & Noorie 1950), and natural and biological disturbances. Comparative values for various types of forests in central Himalaya have been summarised for total basal cover and density by several workers. Adhikari *et al.* (1991) reported the tree density range of 420 to 490 trees ha^{-1} and total basal cover of 83.8 to 98.1 m^2 ha^{-1} for *Abies pindrow* forest stand, and Tripathi *et al.* (1991) reported the tree density range of 340 to 590 trees ha^{-1} and total basal cover of 29.3 to 49.7 m^2 ha^{-1} for the oak zone in and around Nainital in central Western Himalaya.

However, in the present study *Pinus wallichiana* was observed as an important dominating species with an IVI of 112.92 followed by *Cedrus deodara* (83.64). The relatively lower values of density and total basal cover in the Lata forest are attributed to the location of this area near the snow line in higher Himalaya, difficult topography, occurrence of more coniferous species and prolonged nomadic settlements.

Table 3. Frequency, density, mean basal area, total basal area and importance value index (IVI) for the shrub species

Species	Frequency (%)	Density ha^{-1}	Mean basal area (cm^2 $plant^{-1}$)	Total basal area (cm^2 ha^{-1})	Importance value index (IVI)
Prinsepia utilis	90	15.80	2.20	3476.0	120.43
Berberis asiatica	60	8.80	1.15	1012.0	56.95
Crataegus crenulata	35	4.60	0.74	340.4	28.24
Rhododendron campanulatum	30	2.80	3.74	971.6	31.37
Rosa macrophylla	15	2.00	0.04	8.0	10.15
Rubus ellipticus	10	0.80	0.46	36.8	5.91
Indigofera dosua	10	0.80	1.20	96.0	6.79
Spirea canescens	10	1.80	1.38	248.4	11.45
Lonicera angustifolia	10	1.20	0.06	7.2	6.46
Pyracantha crenulata	5	0.60	0.45	27.0	3.57
Jasminium humile	5	0.40	0.41	16.4	2.92
Desmodium microphyllum	5	0.80	1.20	96.0	5.07
Cotoneaster acuminata	5	0.60	8.34	500.4	10.49

In the Lata area thirteen shrubs were recorded with all having contiguous distributional pattern. Dominant among them were *Prinsepia utilis* (with IVI 120.43 and TBC 3476.0 cm^2 ha^{-1}), *Berberis asiatica* (IVI 56.95 and total basal area, TBA, 1012.0 cm^2 ha^{-1}) and *Rhododendron campanulatum* (IVI 31.37 and TBA 971.6 cm^2 ha^{-1}). As contrast the lowest values of IVI (2.92) and TBA (7.2 cm^2 ha^{-1}) were recorded for *Jasminium humile* and *Lonicera angustifolia* respectively (Table 3).

In general, except for *Pinus wallichiana,* most of the canopy species did not show frequent reproduction, suggesting that these communities are undergoing compositional changes. The heavy removal of *Taxus baccata* for fuel by the nomadic Tolchhas, increased xericness due to disturbed canopy, and increased grazing and trampling, in recent years, can be cited as the strongest factors for poor regeneration of these species in the Lata area.

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