COMMUNITY STRUCTURE OF SOME NATURAL FOREST STANDS IN LANSDOWNE FOREST RANGE OF GARHWAL HIMALAYA

C.M. Sharma & A. Kumar

Department of Forestry, H.N.B. Garhwal University, Srinagar (Garhwal), U.P. 246 174, India

Received March 1991

SHARMA, C.M. & KUMAR, A.1992. Community structure of some natural forest stands in Lansdowne forest range of Garhwal Himalaya. Three major forest types of the Lansdowne range were studied, namely pure pine, pure oak and mixed forests to analyse the community structure and their environment. The pH of the soil ranged from 5.7 to 5.0. The major forest types are of *Pinus roxburghii, Quercus leucotrichophora* (as pure stands) and mixed forests of other species like *Rhododendron arboreum, Myrica nagi, Nyctanthes arbor-tristis, Prunus cerasoides, et cetera.* Their association depends upon the altitude, aspect and other growth conditions.

Key words: Transect - distributional pattern - frequency - density - abundance

SHARMA, C.M. & KUMAR, A.1992. Struktur komuniti beberapa dirian hutan asli di banjaran hutan Landsdowne di Garhwal Himalaya. Tiga jenis hutan utama di banjaran Landsdowne telah di selidiki, iaitu pain asli, oak asli dan hutan campuran untuk dianalisa struktur komuniti dan alam sekitarnya. pH tanahnya adalah diantara 5.7 ke 5.0. Jenis hutan utama mengandungi *Pinus roxburghii, Quercus leucotrichophora* (sebagai dirian tuha) dan hutan campuran terdiri dari spesies-spesies lain seperti *Rhododendron arboreum, Myrica nagi, Nyctanthes arbor-tristis, Prunus cerasoides,* dan lain-lain. Perhubungan mereka bergantung kepada aspek ketinggian dan keadaan pertumbuhan lain.

Introduction

Garhwal is an integral part of Western Himalaya, India (lat. 29°45'- 50° 0'N, longtd. 78°32'-78°45'E). It is covered with a variety of forest types, varying with altitude. Within one altitude the co-factors like topography, aspect and inclination of slope and soil type affect the forest composition (Shank & Noorie 1950). Although qualitative descriptions of the forest vegetation of the Himalaya are available (Champion & Seth 1968), attempts at quantitative examinations have only recently been made (Saxena & Singh 1982, 1984, Ralhan *et al.* 1982, Kalakoti *et al.* 1986). The literature on community analysis data of Garhwal Himalayan forests is fragmentary. Recently, Tiwari *et al.* (1987) have also stressed upon the need for investigations on the structure and function of different pure and mixed forests of Garhwal Himalaya.

The present study has therefore been undertaken to assess the phytosociological analysis and to find out the structural attributes of three forest stands, namely pine, oak and mixed forests in Lansdowne forest range of Garhwal Himalaya. The analysis included : (i) physico-chemical properties of soil samples from different forests; (ii) phytosociological attributes, namely abundance to frequency ratio, density ha^{-1}, mean basal area per plant, total basal area per *ha*, importance value index of all the species of different forests; and (iii) the distributional pattern of species of the range.

The stands were selected so as to represent the whole array of major forest variations of the area. This study will be helpful in understanding the climatic fitness of pure and mixed stands and their performance in other parts of the same climatic zones.

Study area

The Lansdowne forest range varies from 1,500 to 2,100 *m* above sea level. The study area is about 3,500 *ha* and is located at 30°8' to 29°37' N latitude and 78°45' E longitude. The mean annual temperature ranged between 5.7°*C* (December) and 31.4°*C* (May). The monthly rainfall ranged between 38 *mm* (June) and 583 *mm* (August) during 1987. The annual rainfall averages at 1,570 *mm.*

Materials and methods

Three major forest types, namely pure pine, pure oak and mixed forests of Lansdowne range in Garhwal Himalaya were observed. Three transects were selected and named as Dhobighat to Evat line (DE altitude 1,500-1,700 *m*), Jaiharikhal to Tip on Top (JT, altitude 1,660 - 1,875 *m*) and Kitchner Line to Church (KC, altitude 1,850-2,000 *m*). By transect is meant the habitat of the forest community - a more or less homogeneous area with regard to soil, topography, aspect and climate; and one on which a more or less homogeneous forest type may be expected to develop. This homogeneity is strictly relative and is defined with respect to the trees rather than to the lesser plants.

The soil samples were collected during October to November, 1985. The soils were analysed for nutrients at the Regional Soil Testing Laboratory, Srinagar-Garhwal.

The vegetation was quantitatively analysed for frequency, density and abundance following Curtis and McIntosh (1950). The relative values of frequency, density and dominance were determined as per Phillips (1959). These values were summed to represent IVI (Importance Value Index) of individual species (Curtis 1959). The ratio of abundance to frequency for different species was calculated to elicit the distributional patterns. This ratio indicates regular (0.025), random (0.025 - 0.05) and contagious (>0.05) distributions (Curtis & Cottam 1956). The abundance to frequency ratio, density per *ha*, mean basal area per plant, total basal area per *ha* and importance value index were estimated quantitatively for different transects separately, and in each transect their values were also calculated. The transects were also analysed phytosociologically. This was done through random quadrat sampling using 10 × 10*m* quadrats. A total of 90 quadrats were studied (30 for each transect) for their association and distributional patterns.

Results and discussion

The community is a functional system of interacting, niche-differentiated species and community structure differentiation in space and time. Importance Value progressions and species-diversities are inter-related expressions of the interaction and organisation of species in communities (Whittaker 1970). Thus Whittaker has taken into account the structure, function and dynamics of a community to express it.

Soil analysis

Soil factors include all the physical, chemical and biological properties of the soil. The nature of the soil profile, soil pH and the nutrient cycle between the soil and the trees are some of the important dimensions in determining the site quality.

The pH of the soil ranged from 5.7 to 5.0, clearly indicating that the soil is acidic in nature and there is not much variation in the pH values of different soil samples (Table 1). The soil analysed for percentage organic carbon, phosphate *kg* ha^{1} (in the form of P_2O_5) and potash *kg* ha^{-1} (in the form of K_2O_5) has shown that there was a great variation in the amount of available potash in different soil samples (Table 1). The percentage organic carbon varied from 0.26 (Horizon 'B' of DE Transect) to 2.29 (Horizon 'A' of JT transect). Maximum phosphate contents were observed in the Horizon 'C' of DE transect (33.88 *kg* ha^{-1}) while minimum in the Horizon 'C' of KC transect (8.47 *kg* ha^{-1}). The availability of potash ranged from 15.2 *kg* ha^{1} (Horizon 'A' of KC transect) to 35.2 *kg* ha^{1} (Horizon 'B' of KC transect).

Table 1. Some physico-chemical characters of soil under forest types

Forest type	pH	Organic carbon (%)	Phosphate (P_2O_5) *kg* ha^{-1}	Potash (K_2O_5) *kg* ha^{-1}
Pine (DE)				
Horizon A	5.7	1.97	18.72	25.6
Horizon B	5.3	0.26	15.26	22.8
Horizon C	5.2	0.90	33.88	21.6
Oak (JT)				
Horizon A	5.0	2.29	12.80	32.2
Horizon B	5.6	1.50	10.84	28.0
Horizon C	5.5	0.30	13.40	18.0
Mixed Forest (KC)				
Horizon A	5.6	2.07	27.58	15.2
Horizon B	5.7	1.04	28.96	35.2
Horizon C	5.6	1.19	8.47	28.8

Quantitative estimation of phytosociological attributes

Phytosociological characters differ among aspect and position, even in the same vegetation type. The values for total forest basal cover and for density have been recorded for certain forests in the temperate and tropical regions by different authors (e.g.Cottam 1949, Wikum & Wali 1974, Saxena & Singh 1982, 1984). Values of these parameters recorded for the present forests can be summed up as follows:

Transect DE - The distribution pattern of the single species *Pinus roxburghii* was almost random (Table 2).

Table 2. Abundance to Frequency Ratio (A/F), Density ha^{1}, Mean Basal Area (M.B.A. m^2/plant), Total Basal Area (T.B.A. m^2 ha^{1}), and Importance Value Index (I.V.I.) for the tree species in the three transects

Transect	Name of species	A/F	D ha^{-1}	M.B.A. (m^2/plant)	T.B.A. (m^2 ha^{1})	I.V.I.
DE	*Pinus roxburghii*	0.02	2000	0.1207	24.14	300
JT	*Quercus leucotrichophora*	0.062	620	0.0445	27.59	189.08
	Myrica nagi	0.050	180	0.0523	9.41	69.53
	Rhododendron arboreum	0.075	120	0.0328	3.93	41.40
KC	*Pinus roxburghii*	0.034	340	0.0451	15.34	104.49
	Quercus leucotrichophora	0.026	260	0.0508	13.21	89.29
	Myrica nagi	0.778	100	0.0501	5.01	34.35
	Rhododendron arboreum	0.013	80	0.0486	3.88	30.28
	Nyctanthes arbor-tristis	0.050	20	0.0321	1.28	23.10
	Robinia imtis	0.050	20	0.0250	0.50	10.52
	Prunus cerasoides	0.050	20	0.0241	0.48	7.82

Transect JT - The *Myrica nagi* and *Rhododendron arboreum* had a random distribution pattern, whereas *Quercus leucotrichophora* was clumped. The total basal area m^2 ha^{-1}, density ha^{-1} and IVI values of *Q. leucotrichophora* were comparatively higher than those of *M. nagi* and *R. arboreum* (Table 2).

Transect KC - Of the seven tree species observed in the transect, *Pinus roxburghii, Robinia imtis, Prunus cerasoides* and *Nyctanthes arbor-tristis* had random pattern and all other species were clumped. The A/F ratio of *M. nagi*, D ha^{-1} ratio of *P. roxburghii*, M.B.A. m^2/plant of *Q. leucotrichophora*, T.B.A. m^2 ha^{-1} and IVI of *P. roxburghii* were highest whereas the values of A/F ratio, D ha^{-1}, M.B.A m^2/plant, T.B.A. m^2 ha^{-1} and IVI of *P. cerasoides* were comparatively lower (Table 2).

The abundance to frequency ratio (0.778) of *M. nagi* in KC transect, the density ha^{-1} (620 ha^{-1}) and the total basal area (27.59 m^2 ha^{-1}) of *Q. leucotrichophora* in JT transect, the mean basal area (0.1207 m^2 plant^{-1}) along with IVI (300) of *P. roxburghii* in DE transect were found highest, while all the values were comparatively lower for *P. cerasoides* (Table 2) in KC transect.

The higher elevations promote greater diversity (KC transect). The cause may be the presence of more atmospheric humidity at higher altitudes. Developing communities at seral stages of succession have less number of species than the developed climax communities, which possess maximum number of species and have high species diversity.

Thus species diversity is a very useful parameter for composition of two or more communities especially to study the influence of biotic disturbances or to know the state of succession and stability in the community.

The invasion of *P. roxburghii* due to biotic interferences leads to mixed community of oak-pine at some places which is a developmental stage of secondary succession. The interference in oak forest results in the formation of *Pinus* monoculture creating a microclimate which is not fit for other species.

Due to biotic interferences, particularly lopping of oak trees for fodder and fuel, there is a reduction in the vigour and rate of seed production. According to Spurr and Barnes (1980), heavy exploitation of a single species may change the entire structure of the plant community. The biotic factors are also responsible for effecting the soil structures and ultimately community structure.

References

CHAMPION, H.G. & SETH, S.K. 1968. *A Revised Survey of the Forest Types of India.* Government of India Publication, Delhi.

COTTAM, G. 1949. The phytosociology of an oak wood in South Western Wisconsin. *Ecology* 30: 271-287.

CURTIS, J.T. 1959. *The Vegetation of Wisconsin.* University of Wisconsin Press, Madison. 657 pp.

CURTIS, J.T. & COTTAM, G. 1956. *Plant Ecology Workbook Laboratory Field Reference Manual.* Burgess Publishing Co. Minnesota 193 pp.

CURTIS, J.T. & MCINTOSH, R.P. 1950. The interrelations of certain analytic and synthetic phytosociological characters. *Ecology* 31: 434-455.

KALAKOTI, B.S., PANGTEY, Y.P.S. & SAXENA, A.K. 1986. Quantitative analysis of high altitude vegetation of Kumaun Himalaya. *Journal of Indian Botanical Society* 65: 384-396.

PHILLIPS, E.A. 1959. *Methods of Vegetation Study.* Henry Holt and Co. Inc. 107 pp.

RALHAN, P.K., SAXENA, A.K. & SINGH, J.S. 1982. Analysis of forest vegetation at and around Naini Tal in Kumaun Himalaya. *Proceedings Indian National Science Academy* B 48: 121-137.

SAXENA, A.K. & SINGH, J.S. 1982. A phytosociological analysis of woody species in forest communities of a part of Kumaun Himalaya. *Vegetatio* 50: 3-22.

SAXENA, A.K. & SINGH, J.S. 1984. Tree population structure of certain Himalayan forest associations and implications concerning their future composition. *Vegetatio* 58: 61-69.

SHANK, R.E. & NOORIE, E.N. 1950. Microclimate variation in a small valley in Eastern Tannesse. *Ecology* 11: 531-539.

SPURR, S.H. & BARNES, B.V. 1980. *Forest Ecology.* John Wiley and Sons, New York. 687 pp.

TIWARI, S.C., RAWAT, K.S. & SEMWAL, R.L. 1987. Extent and source of fire in forest landscape of Garhwal Himalaya and call for land management through fire and environmental education. Pp. 553-564 in Pangtey, Y.P.S. & Joshi, S.C. (Eds.) *Western Himalaya: Environment, Problems and Development.* Gyanodaya Prakashan, Nainital, U.P.

WHITTAKER, R.H. 1970. *Communities and Ecosystems.* MacMillan Co., New York.

WIKUM, D.A. & WALI, M.K. 1974. Analysis of North Dakota Gallery forest: Vegetation in relation to topographic and soil gradients. *Ecology Monograph* 44: 441-464.