POPULATION STRUCTURE AND IMPLICATIONS FOR FUTURE COMPOSITION OF WESTERN HIMALAYAN OAK FORESTS

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ABSTRACT

This study deals with the population structure, natural regeneration *and describes future possibilities of management in four oak forests of western Himalaya.* It was recorded that *Quercus leucotrichophora* forest, although forest composition will remain unchanged for some time, but the increasing biotic stress may alter the recruitment pattern of dominant species (*Quercus leucotrichophora*) positively in this forest. The two oak forests namely, *Q. lanuginosa* and *Q. floribunda* forests had a stable population structure with a large percentage of young individuals (seedlings) and relatively few old ones, indicating that these forests are frequent reproducers. The girth class distribution of the individuals in the *Q. semecarpifolia* forest suggests that this forest is likely to disappear gradually in future. The complete absence of seedlings in this forest shows the possibility of its complete replacement by scrub or grassland vegetation.

Keywords: Himalayan forests, Natural regeneration, Oaks and Population structure.

INTRODUCTION

The west Himalayan temperate broadleaved forests constitute an important natural resource base which is largely dominated by one or the other species of oaks (*Quercus* spp.). Therefore, the noticeable decline in natural regeneration of oaks due to several reasons, like, excessive lopping, over grazing and tree felling, non-viable seeds, extreme weevil and pest infestation, animal and bird predation resulting in low acorn production *is* of great concern for this region. However, there is a lack of comprehensive understanding on such decline of regeneration of different oaks. A study was, therefore, carried out with an objective to quantitatively analyse representative oak forests in a representative site i.e., Nainital, Kumaun to record patterns of natural regeneration. Considering the dominance, a total of four oak forest types (i.e., *Quercus leucotrichophora*, *Q. lanuginosa*, *Q. floribunda* and *Q. semecarpifolia*) were identified for detailed study.

MATERIAL AND METHODS

STUDY AREA

About 15 km east from Nainital lies north western catchment of the river Gola. A reconnaissance of this area revealed the presence of three distinct oak forests namely, *Q. leucotrichophora*, *Q. lanuginosa* and *Q. floribunda*. At a horizontal distance of about 2 km from Nainital lake in the north western part of Nainital town is located Naina Peak; and *Q. semecarpifolia* is a characteristic species of its south-west facing hill slopes. Specific details of locations (altitude, latitude and longitude) were recorded using hand-held Global Positioning System GPS (Garmin make 12) (Table 1).

Field sampling and data analysis

Four plots (1 ha each) were established in each forest type and within each plot ten (10×10 m) quadrats placed randomly for enumeration of trees and saplings. For enumeration of seedling, within each quadrat, four (5×5 m) sub-quadrats were placed randomly. Number of individuals of each species was recorded in all the quadrats/sub quadrats. For trees, CBH (circumference at breast height, 1.37 m from the ground) of each individual was measured. Quadrat/sub-quadrat data was pooled by plots to estimate density and Relative Density (RD) of species following standard phytosociological approaches (Misra 1968, Muller et *al.*, 1974). The relative density (RD) in size (CBH) classes was employed to develop the population structure of tree species.

Table 1. Target study sites in Nainital area of Kumaun

S. No	Forest Types	Altitude (m asl)	Latitude	Longitude	Location
1.	*Q. leucotrichophora*	1950	N 29°24'	E 079°32'	Maheshkhan
2.	*Q. lanuginosa*	2040	N 29°24'	E 079°32'	Maheshkhan
3.	*Q. floribunda*	2070	N 29°24'	E 079°33'	Maheshkhan
4.	*Q. semecarpifolia*	2617	N 29°24'	E 079°26'	Naina peak

Table 2. Quantitative attributes of representative dominant tree species across studied forest sites

Forests	Dominant Species	Attributes of Dominant Species		
		Density (ind ha^{-1})	TBA ($m^2 ha^{-1}$)	IVI
Q. leucotrichophora	*Q. leucotrichophora* *M. esculenta*	783.3 258.3	36 11.1	117.3 51.4
Q. lanuginosa	*Q. lanuginosa* *Q. leucotrichophora*	541.7 175.0	19.8 15.1	107.6 50.8
Q. floribunda	*Q. floribunda* *Cedrus deodara*	908.3 233.3	30.8 15.9	104.0 48.9
Q. semecarpifolia	*Q. semecarpifolia* *Ilex dipyrena*	700.0 50.0	102.7 3.0	264.9 31.9

(A<10; B=11-30; C=31-60; D=61-90; E=91-120; F> 121-150; G>150 cm)

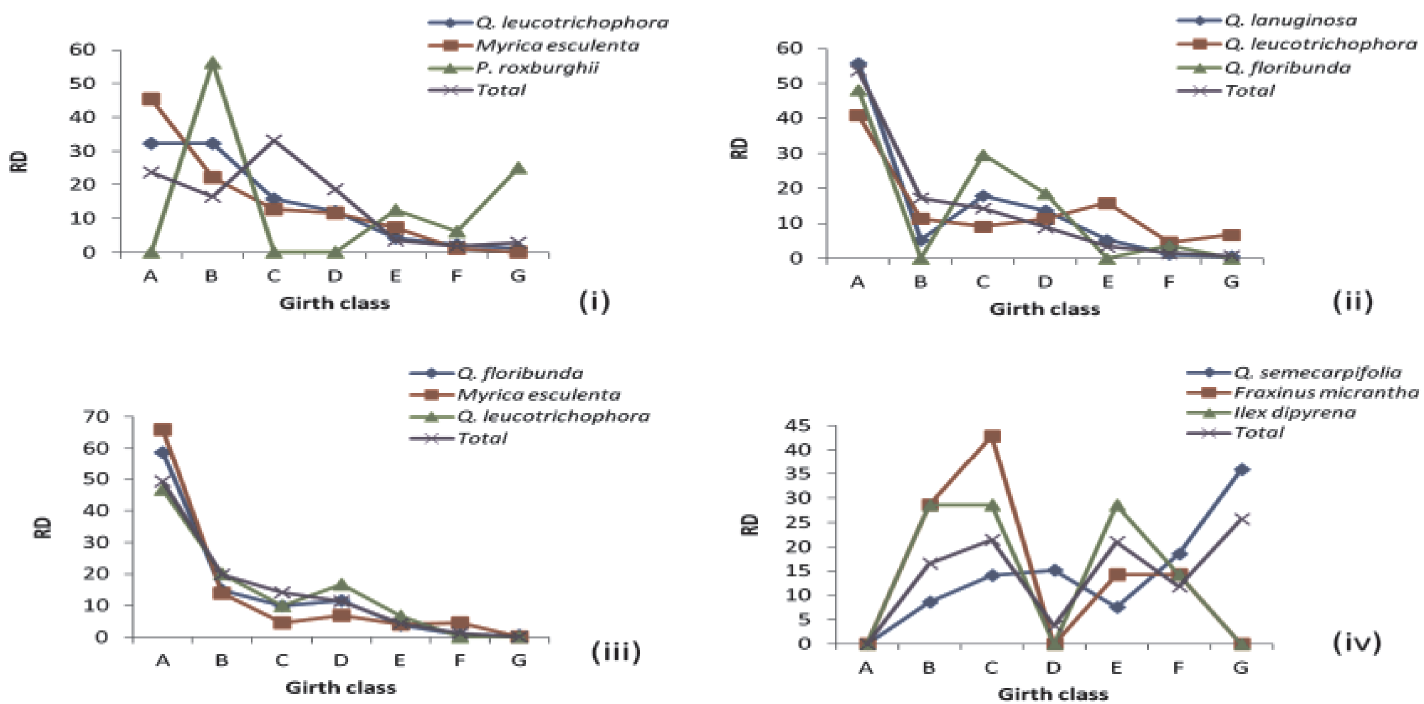

Fig. 1. Population structure of four western Himalayan oak forests (i) *Q. leucotrichophora* (ii) *Q. lanuginosa* (iii) *Q. floribunda* and (iv) *Q. semecarpifolia*

The individuals of tree species were grouped into six arbitrary CBH classes (A<10; B=11-30; C=31-60; D=61-90; E=91-120; F> 121-150; G>150 cm). The total number of individuals belonging to each of the above classes was calculated for individual in each forest. Class A and B represent seedling and sapling respectively; and other classes (C-F) represent tree individuals. Density (D) and the Relative Density (RD) were calculated as: (i) D = Total number of individuals of a species in all the quadrat/Total number of quadrat studied; (ii) RD= Number of individuals of a species in all the quadrats/ Number of individuals of all species in all the quadrats * 100.

RESULTS AND DISCUSSION

Compositional pattern

The quantitative attributes of dominant and co-dominant tree species as emerged from the study (Table 2).

Population structure

Population (age) structure of a species in a forest conveys its demographic behavior over time. The presence of a sufficient population of seedlings, saplings and young trees, indicates a successful regeneration of forest species. The patterns of density distribution in studied forests types is depicted (Fig.1). The Pooled information from the selected forests revealed variations in overall structure of different forests types. (i) *Q. leucotrichophora* forest exhibits higher number of individuals at juvenile and young tree size class (C) followed by seedling (A) stage and very low or almost negligible individuals towards older tree classes (classes E-G); (ii) While preponderance of individuals in seedling stage (A) and sharp decline towards sapling (B) and tree size classes (C-G) was characteristic of *Q. lanuginosa* forest site; (iii) A characteristic buldge at seedling followed by sharp decline of individual towards higher classes was characteristics of *Q. floribunda* forest and; (iv) The higher altitude *Q. semecarpifolia* forest showed noticeable accumulation of older trees (class G) and decline of individuals towards sapling stage, with no individuals at seedling stage. On the basis of the relative distribution of individuals in different cbh classes (Fig. 1), the following three patterns of population structure are recognized: (i) a greater proportion of individuals in lower girth classes compared to larger classes in stands 2 and 3 (*Q. lanuginosa* and *Q. floribunda* forests). This structure represents frequent reproduction (Knight 1975); (ii) more individuals in intermediate girth classes and decreasing numbers both towards the higher and the lower diameter classes in stand 1 (*Q. leucotrichophora* forests) which represents infrequent reproduction (Knight 1975) and; (iii) absence of established seedlings and preponderance of individuals in older tree class in stand 4 (*Q. semecarpifolia* forest). This indicates that the forest was well regenerating in past but at present its regeneration has stopped. According to Benton *et al.*, 1976 the population is on the way to extinction if such a trend continues.

Regeneration status and possible future compositional changes

To interpret the natural regeneration and future trend in species composition of the studied forests, the individuals of different species in the tree, sapling and seedling layers were calculated proportionally to the total number of individuals of all species in that layer (Fig. 1). The regeneration potential in the *Q. leucotrichophora* forest reflects that co-dominant *Myrica esculenta* is better regenerating than the dominant *Q. leucotrichophora*. Therefore, this species has a chance to spread in future at the expense of the presently dominant *Q. leucotrichophora*. Surprisingly, *Pinus roxburghii* showed no seedlings but maximum individuals in sapling layers and therefore, may regenerate in future, provided, the saplings remain undisturbed. Among oaks, the possible replacement of *Q. leucotrichophora* in the future is a noteworthy feature as this species, because of the luxuriance of the forests that it formed, was considered a climax species at lower altitude for the region (Kenoyer 1921). Majority of human inhabitation in the region is located in *Q. leucotrichophora* zone (Saxena 1979; Singh *et al.*, 1987) and, therefore, it is repeatedly lopped for good quality fodder and fuel-wood collection, resulting in reduced vigour and low seed production (Pandey *et al.*, 1984; Rawal *et al.*, 2012). In addition, the acorns are also eaten in excess by bears, birds, rodents, squirrels and monkeys. Since the seed output is reduced due to lopping, the pressure of these biotic agents increases on the remaining seed crop. Thus the viable seed population is further reduced. Such a heavy exploitation of a single species can cause the entire structure of the plant community to change (Spurr *et al.*, 1980).

In *Q. lanuginosa* forest, the dominant (*Q. lanuginosa*) and co-dominant (*Q. leucotrichophora* and *Q. floribunda*) species currently showed fair reproduction. However, the noticeable low number of sapling individuals draw attention towards the poor conversion of seedlings of these species into saplings.

In case of *Q. floribunda* forest, co-dominant (*M. esculenta* and *Q. leucotrichophora*) as well as dominant (*Q. floribunda*) exhibited good regeneration; therefore, these species are likely to continue as companions. Although the dominant species will remain the same, *Q. leucotrichophora*, which is presently the chief co-dominant species, is likely to be replaced in the future by *M. esculenta*.

However, no individuals in seedling layer of *Q. semecarpifolia* forest indicated that the regeneration under the old-growth forest canopy was very poor. It may be due to the overstories with high basal area, stem density, canopy coverage resulting in inadequate light in the understory as factors influencing regeneration establishment (Singh *et al.*, 1997).

Likewise, in the old-growth forests, canopy gap is an important factor often noted as the dominant processes driving forest dynamics (Liu 1997). Therefore, as reported earlier, this forest poses the danger of its complete replacement by a scrub or grassland vegetation in future (Ralhan *et al.*, 1982, Saxena 1990). Moreover, these results are consistent with many previous studies (Ralhan *et al.*, 1982; Upreti *et al.*, 1985; Singh *et al.*, 1997). Management practices involving thinning of old trees and controlled grazing may be useful for management of *Q. semecarpifolia* which requires canopy gap and exposed soil for its natural regeneration (Singh *et al.,* 1997).

CONCLUSION

Based on the studies conducted around Nainital, we conclude that *Q. floribunda* and *Q. lanuginosa* are showing better prospects and will continue to dominate in respective site. *Q. leucotrichophora* is likely to decline. The *Q. semecarpifolia* forests are not regenerating and may face local extinction if current scenario prevails in future.

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REFERENCES

Benton AH, Werner WE (1976). *Field Biology and Ecology*., 1(1): 564-569, Mc Graw-Hill, New York

Kenoyer LA (1921). Forest formations and succession of the Sattal Valley, Kumaun Himalayas. *Journal of the Indian Botanical Society*, 2: 236-256.

Knight DH (1975). A phytosociological analysis of species-rich tropical forest on Barro Colorado Island, Panama. *Ecological Monographs*, 45: 259-284.

Liu Q (1997). Structure and dynamics of the subalpine coniferous forest on Changbai Mountain. *China Plant Ecology*, 132: 97–105.

Misra R (1968). Ecological Work Book. *Oxford & IBH Publishing Company*, Calcutta, 1-65.

Muller-Dombois D, Ellenberg H (1974). *Aims and methods of vegetation ecology, John Wiley and Sons*, 3-9, New York.

Pandey U, Singh JS (1984). Energy flow relationships between agro- and forest ecosystems in Central Himalaya. *Environmental Conservation*, 11: 15-23.

Ralhan PK, Saxena AK, Singh JS (1982). Analysis of forest vegetation at and around Nainital in Kumaun Himalaya. *Proceedings of Indian National Science Academy*, 48: 121-I37.

Rawal RS, Gairola S, Dhar U (2012). Effects of disturbance intensities on vegetation patterns in Oak forests of Kumaun, west Himalaya. *Journal of Mountain Science*, 9: 157-165.

Saxena A (1990). Ecological Studies in High Elevational Cypress-Surai and Kharsu-Oak Forest Ecosystems of Kumaun Himalaya. Ph.D. thesis, Kumaun University, Nainital.

Saxena AK (1979). Ecology of vegetation complex of North-Western Catchment of river Gola. Ph.D. thesis, Kumaun University, Nainital.

Singh JS, Singh SP (1987). Forest Vegetation of the Himalaya. *Botanical Review*, 53: 80-192.

Singh SP, Rawat YS, Garkoti SC (1997). Failure of brown Oak (*Quercus semecarpifolia*) to regenerate in central Himalaya: a case of environmental semi-surprise. *Current Science*, 73: 371-374.

Spurr SH, Barnes BV (1980). Forest Ecology. *John Wiley press*, New York, 687-690.

Upreti N, Tewari JC, Singh SP (1985). The Oak forests of the Kumaun Himalaya (India): composition, diversity and regeneration. *Mountain Research and Development*, 5: 163-174.