PLANT BIODIVERSITY ACROSS DIFFERENT CANOPY COVERS OF *QUERCUS LEUCOTRICHOPHORA* A. CAMUS FOREST IN CENTRAL HIMALAYA

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ABSTRACT

This study aimed to identify the plant biodiversity of banj oak forest along the canopy cover and effects of canopy cover in species distribution. Banj oak (*Quercus leucotrichophora*) is a keystone species in mid elevation forest of central Himalaya which regulates many ecosystem functions in the area. The variation in tree species richness was narrow (5-7) while there is no variation in shrubs richness across the canopy. The higher herb species richness (24) was reported in open canopy followed by moderate (21) and close canopy (18). The tree density was higher in moderate and close canopy while basal area was higher for moderate and open canopy. Shrubs density and cover was almost similar across the canopy. The herb density and cover was higher in close canopy compared to moderate and open canopy. This may be because open canopy provide opportunity for greater number of herbs species while moist and shade of oak forest support the herb density and cover in close canopy.

Keywords: Oak, Biodiversity, Canopy cover, *Quercus leucotrichophora.*

INTRODUCTION

The most striking feature of the earth is the existence of life, and the most striking feature of life is its diversity (Tilman 2000). Biodiversity reflects the totality of genes, species and ecosystem in a region. This diversity is however severely threatened; nearly 25 percent of all species are presumed to become extinct during the next twenty to thirty years (Singh 1998). The causes for the loss of species are numerous but the most important is the loss and fragmentation of natural habitats. In the Himalayan region, a global biodiversity hotspot, chronic form of disturbances is prevalent. Such disturbance often does not allow plants or ecosystems to recover adequately (Singh 1998). Disturbance of an ecosystem has implications for the maintenance and restoration of biodiversity at all hierarchical levels (Naughton 1989; Walker 1989; Pickett *et al.,* 1994). Such changes have a direct impact through habitat destruction and over-exploitation on the composition of the atmosphere and the climate, both of which directly affect biodiversity (Heywood 1995). Anthropogenic pressure is a major factor arresting succession as evident by a complete absence of trees in the higher girth classes and relatively low recruitment of seedlings in oak forest (Khera *et al.,* 2001). The Oak (*Quercus leucotrichophora*) is a major forest forming species in central Himalaya. These forests provide several direct and indirect ecosystem services to the people. As such Oak has emerged as a keystone species in this region, which regulates many ecosystem structures and functions, including its important habitat role to support rich biodiversity. With this realization, the main objective of this study was to enumerate the plant biodiversity of Oak forest under different canopy openings.

MATERIALS AND METHODS

The study area (29°22' -29°23' N latitude and 79°27' - 79°28' E longitude) is located between 1800-2000 m elevations in Central Himalaya (Table 1). Three oak forest sites were selected for the present study, each sites further categorized as open (<30%), moderate (30-60%) and closed (>60%) canopy.

All the three vegetation layers i.e. trees, shrubs and herbs were assessed for detailed vegetation parameters. Most of the species (>90%) present were collected and identified with the help of plant taxonomist and consulting regional flora such as A Forest Flora for Kumaun, Flora Simlensis and Flowers of Himalaya (Osmaston 1926; Collett 1971; Polunin *et al.,* 1984). The size and number of the sample were determined (Saxena *et al.,* 1982). The trees

Table 1. Site characteristics of Oak forest

Site	Mean Elevation	Canopy Status	Mean Canopy Cover (%)
Kailakhan	1800m	Open	30.0
		Moderate	46.8
		Close	60.0
Hanumangarh	2000m	Open	26.8
		Moderate	42.0
		Close	60.0
Pines	1900m	Open	27.1
		Moderate	52.0
		Close	65.2

were sampled as above 30cm cbh (Circumference at Breast Height). Circumference at breast height was taken at 1.37m for trees to determine the basal area while percent vegetation cover was taken for shrubs and herbs. 10 quadrats of 10×10m were randomly placed for assessment of trees while shrubs were analyzed in 10, 5×5m sub quadrats and herbs in 10, 1×1m sub quadrats for each canopy cover class. The cover of shrubs was measured by taking line transect of 5m while herb cover was determined by placing a line transects of 1m on the ground, percent ground cover occupied by each species was noted avoiding overlap (Misra 1968). The vegetation parameters were quantitatively analyzed for density, frequency and abundance (Curtis *et al.*, 1950). The ratio of abundance and frequency was used to interpret the distribution pattern of the species (Whitford 1949). The Importance Value Index (IVI) for trees, shrubs and herbs were also determined as the sum of relative frequency, relative density and relative dominance (Philips 1959). These vegetation parameters were used to determine the relative importance of the species in different vegetation layers and canopies.

RESULTS AND DISCUSSION

Species richness

A total 52 species (8 trees, 12 shrubs, 32 herbs) were present in Oak forest under different canopy cover. Among tree species, *Quercus floribunda, Quercus leucotrichophora* and *Cupressus torulosa* were present under all three canopy covers. *Myrica esculenta* was present only in close canopy forests. Shrub species, which are common in all three canopy cover, include *Asparagus racemosa, Berberis aristata, Eupatorium cannabinum, Indigofera heterantha, Randia tetrasperma, Daphne cannabina* and *Rubus ellipticus.* In herb layer, only one species *Erigeron karvinskianus* is present in all three canopy covers (Table 2).

The present study indicated that there is little or no variation in tree and shrub richness along the canopy cover while herb richness was higher in open canopy compared to close and moderate canopy. The plant biodiversity of Banj oak forest reported by different workers varied from 51 to 186 species of trees, shrubs and herbs (Upreti 1982; Rikhari 1989; Kharkwal 2002; Ram *et al.*, 2004; Tewari 2008). A comparative account of range of plant species richness in oak forests of the region (Table 3). Thus, there is a wide variation in plant biodiversity as studied by various workers. While the variation in tree species composition is low, a wide variation in shrub and herb species composition is apparent. This may be due to variation in timing of collection of data in different seasons; because the rainy season supports the recruitment, sprouting and growth of new and dormant plant parts of herb and shrub species. The species composition is mainly made by ephemerals which grow in late summer and rainy seasons.

Table 2. Plant biodiversity in different canopy covers of Oak forest

Tree Species	Close	Moderate	Open
Acer oblongum Wallich ex. DC	+	+	-
Cedrus deodara Loudon.	-	+	+
Cupressus torulosa D. Don.	+	+	+
Myrica esculenta Buch-Ham.	+	-	-
Pinus roxburghii Sarg	-	+	+
Quercus floribunda Lindl	+	+	+
Quercus leucotrichophora A. Camus	+	+	+
Rhododendron arboreum Smith	-	+	+
Shrub Species			
Arundinaria falcata Nees.	-	+	-
Asparagus racemosus Willd.	+	+	+
Berberis aristata DC.	+	+	+
Debregeasia longifolia Burm. f.	-	-	+
Daphne cannabina Wall.	+	+	+
Desmodium elegans DC.	+	-	-
Eupatorium cannabinum Linn.	+	+	+
Indigofera heterantha Wallich ex Brandis	+	+	+
Randia tetrasperma Roxb.	+	+	+
Rosa moschata Mill	-	+	-
Rubus ellipticus Smith	+	+	+
Urtica dioica Linn.	+	-	+
Herb species			
Cnicus argyracanthus DC.	+	-	-
Erigeron karvinskianus DC.	+	+	+
Galium aparine Linn.	+	+	-
Geranium wallichianum Sweet	+	-	-
Nepeta leucophylla Benth.	+	-	+
Oxalis latifolia Humb.	+	+	-
Rumex nepalensis Spreng.	-	-	+
Desmodium gangeticum DC.	-	+	+
Goldfusia dalhousenia Nees.	+	+	+
Bidens pilosa Linn.	-	+	+
Valeriana wallichii DC.	+	+	+
Rubia manjith Roxb. ex Fleming	+	+	-
Micromeria biflora Benth.	-	-	+
Leucas lanata Benth.	-	+	+
Thalictrum foliolosum DC.	+	+	+
Indigofera tinctoria Linn.	-	-	+
Boenninghausenia albiflora Reichenb.	+	+	+
Anaphalis contorta Hook. F.	-	+	+

Pouzolzia indica Gaud.	-	+	-
Polygonum capitatum Buch.-Ham.	-	-	+
Origanum vulgare Linn.	-	-	+
Anaphalis cinnamomea C.B. Clarke.	-	+	+
Frageria spp.	+	+	+
Commelina benghalensis Linn.	+	+	-
Potentilla fulgens Wall.	-	+	+
Grass species			
Arthraxon lanceolatus Hochst.	+	-	+
Cynodon dactylon Pers.	+	+	+
Oplismenus undulatifolius Beauv.	+	+	+
Setaria intermedia Roem. & Schult.	-	-	+
Sedge			
Carex condensata Nees.	-	-	+
Carex nubigena D. Don.	+	+	+
Climber			
Hedera nepalensis K. Koch.	+	+	-

Table 3. Comparative study of plant biodiversity in banj Oak forest

Vegetation layer	Upreti, N. (1982)	Rikhari, H.C.(1989)	Kharkwal (2002)	Ram *et al.*, (2004)	Tewari (2008)	Present Study
Tree	9	6	10	11	18	8
Shrub	14	11	17	35	46	12
Herb	28	-	43	121	122	32
Total	51		70	167	186	52

Vegetation parameters

The vegetation parameters for important tree species (Table 4).

Table 4. Vegetation parameters for tree in different canopy cover of Oak forest

Species Tree	Density (tree/ha)	TBA (m^2/ha)
	Close	
Quercus leucotrichophora	300	6.4
Myrica esculenta	60	5.5
Cupressus torulosa	95	2.6
Quercus floribunda	60	3.1
Acer oblongum	50	5.3
Total	**565**	**22.9**
	Moderate	
Quercus leucotrichophora	233	28.2
Cupressus torulosa	60	6.0
Pinus roxburghii	85	7.5
Quercus floribunda	60	11.6
Cedrus deodara	80	3.2
Acer oblongum	40	6.5
Rhododendron arboreum	30	9.8
Total	**588**	**72.9**
	Open	
Quercus leucotrichophora	213	10.7
Cedrus deodara	30	43.7
Pinus roxburghi	56	6.4
Cupressus torulosa	40	4.5
Quercus floribunda	50	1.6
Rhododendron arboreum	10	12.5
Total	**399**	**79.4**

Total tree density varied from 399-588 trees/ha and total basal area 22.9-79.4 m^2/ha across the canopy covers classes. In all the canopy cover classes, *Quercus leucotrichophora* was the dominant tree species and contributed 39.6% to 53.4% density and 13.4 to 38.7% basal

Table 5. Vegetation parameters for shrubs in different canopy cover in Oak forest

Species	Density (Shrub/ha)	Cover (%)
	Close	
Randia tetrasperma	400	5.0
Eupatorium cannabinum	384	2.0
Desmodium elegans	320	3.0
Berberis aristata	304	3.0
Indigofera heterantha	280	1.0
Asparagus racemosus	420	3.0
Dephne cannabina	440	3.0
Rubus ellipticus	400	3.0
Urtica dioca	200	1.0
Total	3148	24.0
	Moderate	
Rosa moschata	840	7.1
Dephne cannabina	320	2.4
Randia tetrasperma	320	2.5
Eupatorium cannabinum	332	1.4
Asparagus racemosus	304	0.8
Berberis aristata	492	2.9
Indigofera heterantha	160	3.2
Arundinaria falcata	120	0.7
Rubus ellipticus	80	0.8
Total	2968	22.0
	Open	
Eupatorium cannabinum	504	3.3
Asparagus racemosus	280	2.3
Indigofera heterantha	360	3.9
Dephne cannabina	520	4.9
Randia tetrasperma	320	2.3
Urtica dioca	260	2.1
Berberis aristata	252	1.1
Debregeasia longifolia	440	3.3
Rubus ellipticus	80	0.8
Total	3016	24.0

area of all the species present. The contribution of associated species varied from 46.6 to 60.4 % across the canopy cover classes. There is no clear cut dominance of any shrub species in close canopy and showed almost similar density of 5 species (Table 5). *Randia tetrasperma* showed slightly higher cover (20.8%) and 5 other species showed similar cover in close canopy. In moderate canopy, *Rosa moschata* showed highest density (28.3%) and cover (32.3%) and rest 8 species contributed remaining density and cover. More than 50% density and cover were contributed by *Eupatorium cannabinum, Daphne cannabina* and *Debregeasia longifolia* in open canopy. Thus, close and open canopy support growth of many species while moderate canopy support the growth of few species.

Table 6. Vegetation parameters for herbs in different canopy covers in Oak forest

Species	Density (Herb/m^2)	Cover (%)
Close		
Erigeron karvinskianus	1.6	7.0
Hedera nepalensis	1.6	7.0
Galium aparine	1.8	3.5
Oxalis latifolia	1.0	6.0
Geranium wallichianum	1.0	5.0
Carex nubigena	0.8	4.5
Nepeta leucophylla	1.0	4.0
Cnicus argyracanthus	1.5	6.0
Arthraxon lanceolatus	1.8	3.0
Cynodon dactylon	0.7	4.0
Total	**12.8**	**49.0**
Moderate		
Erigeron karvinskianus	1.3	5.0
Cynodon dactylon	1.8	4.0
Carex nubigena	1.0	6.0
Galium aparine	0.7	4.0
Oxalis latifolia	1.0	3.0
Hedera nepalensis	1.0	4.0
Total	**6.8**	**26.0**
Open		
Carex condenseta	1.4	7.0
Setaria intermedia	0.5	2.0
Erigeron karvinskianus	0.9	4.0
Rumex nepalensis	1.3	5.0
Carex nubigena	0.9	3.0
Cynodon dactylon	0.7	3.0
Nepeta leucophylla	0.4	1.0
Arthraxon lanceolatus	0.4	2.0
Total	**6.5**	**27.0**

Out of the total 32 herbs species only 13 species are commonly distributed across the canopy cover classes. Vegetation analysis data showed greater number of species were present in close canopy (10) compared to open canopy, and indicated that many species in open canopy showed fragmented distribution. In close canopy, many species contributed to the total density while only two species contributed more than 40 % density for open canopy. In herb layer, no clear cut dominance of single species in close and moderate canopy while only two species, *Carex condensata* and *Rumex nepalensis* showed greater than 40% dominance in open canopy (Table 6).

CONCLUSION

This study indicated that the tree and shrub species richness was not dependent on the canopy cover differentiation but the total herb richness was increased from close to open canopy. The density was decreased in all the canopy cover classes for all the vegetation layers. The dominance increase for tree layer from close to open canopy and reverse for herb layer. There was no profound effect on shrub cover across the canopy cover classes. The decreased in density was reported from close to open canopy for *Quercus leucotrichophora.* Thus, this study concluded that the anthropogenic disturbance causes decrease in dominance of Oak (*Quercus leucotrichophora*) which needs immediate attention for conservation and management of these forests. The effect of recent phenomenon of climate change would also be evaluated view of phenology and regeneration of Oak species which may also impact the dominance of this important Oak in future.

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