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Analysis of Herbaceous Vegetation under Oak and Pine Forests Along an Altitudinal Gradient in Central Himalaya

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Abstract

Phytosociological analysis for herbaceous cover carried out in two predominant *Quercus leucotrichophora* A. Camus and *Pinus roxburghii* Sarg. forests along an altitudinal gradient of 1,800 to 1,975 m and 1,600 to 1,800 m respectively. In oak forest *Eragrostis nigra* and in pine forest *Oxalis corniculata* had the maximum density. The similarity indices were high for species of same community but were low for species of different communities. Distribution pattern revealed that contagious distribution was most common for herb layer in both forests. In general the dominance diversity curves followed a geometric series confirming niche pre-emption hypothesis.

In Central Himalaya grasslands cover large areas intermixed with the forest vegetation. The forest vegetation ranges from tropical dry deciduous forest in the foothills to alpine meadows above the timber line. Extensive biotic activities like cultivation, burning and heavy grazing pressure have led to the development of widespread open grasslands. Apart from these, the groundfloor vegetation under different forests are extensively used as grazing grounds. All these grazing lands in this region have been under heavy grazing pressure, both by sedentary and migratory graziers. For instance, the grazing in Naini Tal Tahsil is about 4.7 times higher than the carrying capacity of the forest (1). Besides grazing, harvesting of the floor vegetation for forage is also a common practice. The present study deals with some phytosociological analysis of the forest floor vegetation in 50 stands in each of two forest types spread in the middle altitudinal range (1,600—1,975 m), namely, oak forest and pine forest.

Study Area and Methods

The study sites are located between 29°19′ to 29°27′ N latitude and 79°32′ to 79°42′ E longitude in lesser Himalaya. The total annual rainfal recorded at the nearest observatory (Naini Tal) is 226.6 cm. Depending on climaic variations the year can be divided into three distinct seasons, namely rainy (June—September) winter (October—February) and summer (March—May). Due to the monsoonic climate the maximum rainfall occurs during rainy season.

The phytosociological analysis of the herb layer was accomplished by using 1 × 1 m quadrat randomly. The size of the quadrat was determined by species area curves following Misra (2). Each forest was divided into three stands, namely, hill base (HB), hill slope (HS) and hill top (HT). A total of 50 quadrats were sampled in each forest. The sampling was done when the herbaceous vegetation was at its peak, that is during last week of September to the first week of October in 1986. Herbaceous vegetation was studied through tiller analysis. Each tiller of a grass plant was considered as an individual plant (3). For creeping plants any unit of the plant having functional roots was considered as one plant (4). The vegetational data were quantitatively analyzed for frequency, abundance and density (5). The species diversity was calculated following Shannon-Wennier index, for density values. Similarity coefficient was calculated by following Jaccard (6).

Results and Discussion

Among the ground floor vegetation under *Quercus leucotrichophora* forest *Eragrostis nigra* had maximum density followed by *Digeteria cruciata*, *Abelmosches* sp., *Oxalis corriculata* was the dominant species of *Pinus roxburghii* forest (Table 1). Similarity coefficient between

Table 1. Phytosociological parameters for the herbaceous species under *Quercus leucotrichophora* and *Pinus roxburghii* forests.

Species	Density (tiller/m²)	Frequency %	A/F ratio
Quercus leucotrichophora Forest			
Hill base			
Cardamine impatiens	2.18	43.75	0.11
Digeteria cruciata	3.18	50.00	0.12
Eragrostis nigra Nees	8.50	93.75	0.09
Goldfusia dalhausiana	1.35	31.25	0.12
Hedera helix Linn.	1.31	31.25	0.13
Mondo intermedium	2.12	43.75	0.11
Reinwardtia indica	1.50	37.50	0.10
Thalictrum foliolosum DC.	1.75	37.50	0.12
Viola canscens	2.50	50.00	0.10
Hill slope			
Abelmoschus sp.	4.35	58.82	0.12
Ainsliapa aptera DC.	1.64	52.44	0.05
Agrimonia pilosa	1.64	47.05	0.07
Artemisia vulgaris Linn.	1.17	41.17	0.06
Digeteria cruciata	3.70	70.58	0.07
Eragrostis nigra Nees	5.88	70.58	0.11
Gallium rotandifolium Linn.	2.17	41.17	0.12
Hedera helix Linn.	1.58	47.05	0.07
Helinus sp.	1.41	35.39	0.11
Viola cansecers	1.82	52.94	0.06
Hill top			
Abelmoschus sp.	0.23	11.76	0.17
Ainsliaea aptera DC.	0.29	17.64	0.09
Agrimonia pilosa	0.3	23.52	0.06
Artemesia nilagirica (Clarke) Pamp.	0.23	17.64	0.07
Cnicus arggracanthus DC.	0.70	24.41	0.08
Digeteria cruciata	6.35	94.11	0.07

Table 1. Continued.

Species	Density (tiller/m²)	Frequency (%)	A/F ratio
Eragrostis nigra Nees	17.70	100.00	0.17
Erigeron canadensis Linn.	2.00	17.64	0.11
Geranium nepalense Sweet	1.05	35.29	0.08
Goldfusia dalhausiana	2.47	52.94	0.08
Hedera hilix Linn.	0.35	17.64	0.09
Indigofera hirsuta Linn.			
Pteris sp.	0.70	24.41	0.08
Saussurea hypoleuca Spreng	0.35	17.64	0.11
Trifolium repens Linn.	2.11	29.41	0.07
Viola canscens	0.41	17.64	0.13
Pinus roxburghii Forest			
Hill base			
Aster thomsonii Clarke	0.25	18.75	0.07
Bupleurum tennue D. Don.	0.43	25.00	0.07
Cynodon dactylon (Linn.) Pers.	3.12	37.50	0.22
Cnicus argyracenthus DC	2.31	56.25	0.06
Cynoglobossum glochidiatum Benth.	1.37	37.50	0.09
Chrysopogon serrulatus Trin.	1.31	37.50	0.09
Dicliptera roxburghiana	1.25	18.75	0.35
Digiteria cruciata	0.68	31.25	0.07
Erianthus sp.	0.62	25.00	0.11
Gallium apurine Linn.	8.56	62.50	0.21
Geranium nepalense, Sweet	0.56	18.75	0.18
Indigofera linifolia (Linn f.) R Retz.	0.68	25.00	0.11
Laucas lanata	0.56	25.00	0.09
Micromeria biflora (Buch.-Ham. ex D. Don.) Benth.	7.37	81.25	0.17
Myslactis sp.	1.50	43.75	0.07
Oxalis corniculata Linn.	2.18	56.25	0.06
Oenothera rosea	0.62	25.00	0.10
Poa annua Linn.	1.00	43.75	0.05
Sonchus oleracea	1.50	56.25	0.04
Senecio nudiculis Buch-Hum	0.68	37.50	0.04
Viola canescens	1.43	25.00	0.23
Hill slope			
Anaphalis cinnamomea C. B. Clarke	0.88	41.17	0.05
Calamintha umbrosum	1.76	29.41	0.20
Cnicus argyracanthus	0.76	35.29	0.06
Chrysopogon serrulatus Trin	0.70	29.41	0.08
Cynoglobossum glochidiatum Benth	0.58	29.41	0.06
Dicliptera roxburghiana	3.58	70.58	0.07

Table 1. Continued.

Species	Density (tiller/m²)	Frequency (%)	A/F ratio
Erianthus sp.	1.00	29.41	0.11
Gallium aparine Linn.	8.76	82.35	0.12
Geranium nepalense Sweet	1.58	41.17	0.09
Lactuca dissecta D. Don.	4.94	58.85	0.14
Micromeria biflora (Buch-Ham. ex D. Don.) Benth	8.47	88.23	0.10
Myriactis sp.	0.64	29.41	0.07
Oxalis corniculata Linn.	10.11	100.0	0.10
Senecio-nudicalis Buch-Ham	0.23	17.64	0.07
Viola canescens	1.35	52.94	0.04
Hill top			
Anaphalis cinnamomea CB Clarke	0.29	23.52	0.05
Bupleurum tenuue D. Don.	0.58	23.52	0.10
Cnicus argyracanthus DC	0.35	23.52	0.16
Dicliptera roxburghiana	1.88	29.41	0.21
Erianthus sp.	1.35	35.29	0.10
Gallium aparine Linn.	9.47	76.47	0.16
Geranium nepalense Sweet	0.64	35.29	0.05
Lactuca dissecta D. Don.	4.70	58.82	0.13
Micromeria biflora (Buch-Hum ex D. Don.) Benth	3.58	58.82	0.10
Oxalis corniculata Linn.	1.76	52.94	0.21
Polygonum capitatum Buch-Ham ex. D. Don.	0.68	23.52	0.15
Taraxacum officinale	0.70	29.41	0.08
Viola canscens	3.47	58.82	0.10

the species at their native forest was greater because most of the species are common but the degree of similarity between the forests were low (Table 2). As stated by Saxena and Singh (7) the herb strata under oak forests were more similar than the pine forest. Due to close canopy cover under oak forest species were more similar to each other than the species under greater light intensity of pine forest. Mc Naughton (8) reported that within a given soil type the community becomes floristically more distinct along gradient from cool, moist to warm, dry exposures in Californian grasslands. Interestingly, across both the forests species of HB were more similar to that of HS but were more dissimilar to HT. Similarly, HS species were more similar to HT species. The floristic dissimilarities within a forest cover indicate greater sensitivity of herb layer to microenvironments compared to tree layer.

Table 2. Similarity coefficient. HB, hill base; HS, hill slope; HT, hill top.

		Oak-forest			Pine-forest		
		HB	HS	HT	HB	HS	HT
Oak-forest	HB	100	42.10	40.0	13.3	8.3	9.1
	HS		100.00	61.5	12.9	8.0	17.4
	HT			100.0	21.6	19.4	20.7
Pine-forest	HB				100.0	66.7	52.9
	HS					100.0	64.3
	HT						100.0

Dominance-diversity curves have been repeatedly used to interpret the community organization in terms of resource share and niche space (9, 10). In the *Quercus leucotrichophora* forest, the curves fit the geometric series (Fig. 1) which conforms to the niche pre-emption hypothesis, and for *Pinus roxburghii* forest approach Preston's (11) log normal situation. Thus while the vegetation under *Pinus roxburghii* forest approached the log normal distribution, these for the *Quercus leucotrichophora* forest relatively closer to the geometric series. *Pinus roxburghii* forest showed a stronger single species dominance in the herb layer thus the top species niche represented a greater proportion of the total community resources compared to herb strata under other forest covers.

Table 3 indicates a greater diversity in stands of *Pinus* forest compared to *Quercus leucotrichophora* forest. Thus while greater light intensity in the *Pinus roxburghii* forest increased the diversity, uniform greater shade under *Quercus leucotrichophora* forest canopy reduced the diversity. Thus total niche space for the herbaceous species also decreased from relatively open-canopied *Pinus roxburghii* forests to relatievly close canopied *Quercus floribunda* forest.

Concentration of dominance was found gre-

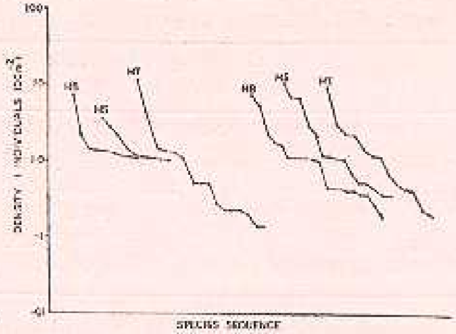

Figure 1. Dominance-diversity curves for the study sites. HB, hill base ; HS, hill slope ; HT, hill top.

ater in hill top of oak-forest followed by hill base of some forest and hill top of pine-forest and lowest in hill base of pine-forest. The species richness of the herb strata in the present area was found to be greatest in stand hill base, namely, 21 of *Pinus roxburghii* forest and least under *Quercus leucotrichophora* forest. The species richness can be interpreted as a function of environmental stress and intensity of management such as grazing, mowing, burning and trampling (11—14). These tend to prevent potentially competitive species for attaining maximum size and vigor. He attributed low species richness in environmentally stressful or frequently disturbed sites to the small number of species adapted to the imposed stress. Low species richness in the stable or highly productive sites results from the ability of a few species to pre-empt resources, thereby suppressing richness by competitive exclusion.

The abundance to frequency ratio for distribution pattern of herbaceous layers revealed that the contagious distribution was most common. This may be because majority of herb species reproduce vegetatively. However, the vegetative reproduction may not be the only reason for this. As the recent researches indicate that contagions in vegetation is due to multitude of factors (11).

Regression equation was developed between species diversity and concentration of dominance across the stands as :

$$Y = 0.027 - 0.145\ X \quad (r = -0.92,\ P < 0.01)$$

where X —species diversity and Y = concentration of dominance of different stands across the aspects and slope. Thus a significant inverse relationship between these two parameters indicates greater diversity at the site, lower will be the dominance.

Table 3. Species richness, diversity and concentration of dominance of groundfloor vegetation index in oak and pine-forests.

		Species richness	Evenness	Species diversity	Conc of dominance
Oak-forest	HB	9	0.041	2.83	0.180
	HS	10	0.017	3.10	0.133
	HT	16	0.020	2.45	0.294
Pine-forest	HB	21	0.006	3.69	0.114
	HS	15	0.012	3.16	0.145
	HT	13	0.017	3.00	0.166

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