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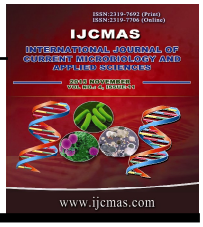

Original Research Article

Phytosociology, Diversity, and Species Richness of Hingla-Devi Forest of Champawat (Kumaun Himalaya), India

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Keywords

Phytosociology, Diversity, Species richness, Importance value index, population structure, Beta diversity

A B S T R A C T

An investigation is undertaken in the Kumaon Himalayan stretch of Hingla-Devi in Champawat, Uttarakhand to understand the vegetation structure and diversity pattern. Community structure and composition are important factors affecting diversity patterns in plant communities. Pertinently, species diversity along altitudinal gradient differs in different layers at different scales. An altitudinal gradient of 1600-2389m was selected for study. The study site is divided into three compartments. Regeneration potential of *Querecus floribunda* is high as compared to other species but co –dominance of *Lyonia ovalifolia and Cedrus deodara* with Q*uercus leucotrichophora. I.V.I* was significantly higher for *Q. leucotrichophora* than any other species in tree; sapling stratum was dominating in different compartment of forest.

Introduction

The Kumaun Himalayas are located between lat. 28°43□45□□-30°21□12□□N and long.78°44□30 □80°18□45□□E in the central Himalayan belt and share the character of eastern and western Himalaya. A highly diverse, compositional pattern of forest is characteristic of this region (Singh and Singh, 1987). Composition of the forest is diverse and varies from place to place because of different land form of the sector have varied climate, soil and topography and supports tropical, sub-tropical, temperate and alpine and in certain areas even arid or semi arid vegetation (Singh, 2006). Climate and edaphic factor plays important rate in determination of forest type and their growth.

Therefore, climatologically data viz. rainfall, maximum-minimum temperature, relative humidity and altitude were recorded for the studied forest. Puri (1946, 1930, 1960) has concluded that altitudinal zonation of different types of vegetation are governed by the geology and soil condition than altitude or climate while according to Mehta *et al.* (1978). Edaphic factors are of secondary importance in the study of forests located at high altitude. The forest communities distributed within 1200-3000m above sea level, the variable topography of the area supports luxuriant vegetation of *Quercus leucotrichophora, Q. floribunda, Q. semicarpifolia* and *Pinus roxburghii are dominant tree sp.* Singh and Singh (1987).

Vast exploitation of natural flora is due to increasing human intervention on forest biodiversity both economically and environmentally over the few decade and dependence on plant products. Anthropogenic disturbances changes ecosystem functioning, climatic change, change in plant structure, density, diversity, composition and regeneration. As a result of such heavy exploitation most of the sp. have become threatened and on the verge of extinction (Singh and Singh, 1987). Among human influence, commercial exploitation, agricultural requirements, fodder lopping, forest fire, and grazing pressure are the important sources of disturbance (Singh and Singh, 1992). In addition, environmental problems are particularly noticeable in this region as a form of degradation and depletion of the forest resources (Sati, 2005). Forest is the main source of livelihood for the local people in Uttarakhand, the human settlement practices in oak forests, lopping and felling as well as fire spreading in pine forests which reduced the area under oak forests (Champion and Seth, 1968).With increasing population there is also increase in the need of resources. With the increasing demand of plant resources it is essential to understand the structure and function of different kind of ecosystem. The present study aims to collect quantitative information on analytical characters and trace diversity in the forest and regeneration status of dominant tree at Hingla-Devi forest in Champawat district.

Materials and Methods

Study site

The present study site Hingla-Devi is located at a distance of 9kms from the main town of Champawat district, in Kumaun region of the western Himalayas. It is located between 29°19’5 N latitude to 80°04’49 E longitude. Of the total forest area of Champawat district, which are 122200 ha, of which 1261.60 is covered by Hingla-Devi forest. The forest extends from the base of villages Punabe (1700m altitude) to the top of hill (2489m altitude). There is temple of Hingla-Devi at the top of the hill.

For the detailed study of trees and shrubs layer composition and other vegetation parameters, the area was divided into three compartments, that is compartment A (East to North, 1900-2400m), compartment B (East to South, 1800-2400m), and compartment C (completely East, 1700-1900m).

The climate of the studied forest is of temperate type, characterised by warm and short summer season, moist and wet rainy season and pronounced sever winter season.

The year is roughly divided into three seasons- Winter (Oct-March), Summer (April – mid June), Rainy (mid June-September).

Climatic regime

The monthly average of minimum and maximum temperature fluctuates from 0.9° to 19.1°C and 15.8°C to 30.7°C respectively. The minimum temperature of 0.9°C in January and maximum of 30.7°C in April was recorded. The gradual increase in temperature was recorded in summer season through February- July with July being the hottest month of year. Slight decrease in average maximum temperature from May onward was recorded and this was associated with precipitation. There was fall of temperature from May onwards with January and February being the coldest months of the year (Fig. 1). Heavy snow fall was noticed during December and January at Hingla-Devi forest.

Rainy season begins from the month of June. The reason is marked by continues showers and heavy downpours. The maximum monthly rainfall of 530mm was noticed in the month of January. The average rainfall is 123.5mm was recorded. While the wettest months of the year were June, July, august and September, which together accounted for a total precipitation of 540.4mm in the year (43.2% of the total precipitation). The humidity was highest in the rainy season. The average value of humidity varied from 38 to 72% while the average value of humidity was 63.33. From dig 1, it's clear that humidity increases with the increase in rainfall intensity accompanied with rising temperature.

Quadrate measuring Species richness was determined as the number of species per unit area (Whittaker, 1965). Quadrates of 10 m × 10m were laid down. The entire forest was divided into three compartments, A, B, C. The tree sapling and seedling were analysed within the same quadrate. The plant having circumference at breast height (cbh) was 1.37m and above (Knight, 1963) and those having cbh lower than 30cms but not less than 10 cms were considered as tree and sapling, respectively. Individual whose cbh was below 10 cms were considered as seedling. Subsequently quadrates of 5×5m were laid with in 10 ×10m quadrates for study of shrubs. However diversity, concentration of dominance, and beta diversity of the same were determined by using Shannon wiener index (1963), Simpson (1949) and Whittakar (1975), respectively. The vegetation data were quantitatively analysed for abundance, density, frequency, according to Curtis and Mcintosh (1956); A/F ratio according to Whitford (1949), relative frequency, relative density, and relative basal area according to Phillips (1959). The sum of relative frequency, relative basal area and relative density represented important value index (IVI) for the various species (Curtis and Mcintosh, 1951). Species diversity was calculated using Shannon wiener information index (Shannon and Weaver, 1963) as:

$$\mathbf{H = - \sum (Ni/ n) \log 2 (Ni/n)}$$

Where, Ni is the IVI of a species and n the total IVI of all species in the forest.

Results and Discussion

The detailed characteristics of different forest compartment are mention in table 1. The total of 53species (13 sp. of tree, 24 sp. of shrubs, and 16 sp. of herbs) were recorded from Hingla-Devi forest. Compartment wise distribution of sp. (tree and shrubs) is presented in (Table 2 and 3) Herbaceous species encountered across the compartment in Hingla-Devi at the time of present study viz. *Anaphalis cinnamomea, Ageratum conizoids, Bidens biternatea, Boenninghausenia albiflora, Crassocephalum, Crepioides, Centella asitica, Cyanodon dactylon, Dicleptera sp., Fragenia sp, Leucas sp., Plectranthussp., Plectranthus coaster, Sonchus olerceus, Sonchus sp, Tripholium repense* and *Salvia sp.*

Dominance

Based on density, basal cover, and important value index (IVI):

The flora of the region represents the sum total of different types and kinds of plants. The vegetation represents the total effect produced by abundance or scarcity of plants. In a floristic study the number and quantity of the plants in an area need not be estimated but it's necessary, in vegetation analysis. It is the basic prerequisite in the

understanding of plant community. Odum (1971) emphasized that the number of species reflects the gene pool and adaptation potential of community. The three communities were clearly recognized from the base to top of the hill. *Lyonia ovalifolia*: was the most dominant species in north, south and east facing slope and covered about 18.45 m²/ha. The undergrowth of shrubs and herbs were well developed on the north and east facing slopes.

Quercus floribunda was the most dominant sp. at the higher altitude and was present in all compartments studied i.e., North (*c*ompartment A), South (compartment B) East (compartment C) and covered 24.52m²/ ha of the forest area. The under story was well developed.

Querecus leucotrichophora was the dominant sp. In north, south and east slopes and covered 86.09m²/ha of the forest area. The under story was better in north and eastern slopes in comparison to the southern slopes.

Rhododendronar boreum was the most dominant sp. Of studied forest and covered 33.09 m²/ha of the forest area. The under story was, however, poorly developed.

At compartment A: *Quercus leucotrichophora* was the dominant sp. and *Quercus floribunda* was the co-dominant sp in all tree layers. In sapling stratum *Myrica esculenta*is followed by *Cedrus deodara i*n dominance, while in seedlingstratum *Cedrus* d*eodara* is dominant and *Linde*r*a pulcherrima* is co - dominant sp. *Viburnum cotinifolium was another dominant sp which was followed by Daphne cannabina sp of shrubs of compartment A.*

At compartment B: *Quercus leucotrichophora* was the dominant sp. and *Rhododendron arboreum* was the co-dominant species in tree layers. In sapling stratum, *Quercus floribunda* was dominant and *Rhododendron arboreum* was co-dominant species while in seedling *Quercus floribunda was dominant & Cornus capitata* was co-dominant sp. *Viburnum continifolium* and *Elaeagnus umbellate* is dominant and co-dominant species in shrubs respectively.

At compartment C: *Quercus leucotrichophora* was the dominant and *Q. floribunda* was the co-dominant species in tree layers. In sapling stratum, *Q. leucotrichophora* is followed by Q *floribunda* is dominance, while in seedling stratum *Quercus floribunda* is dominant and *Rhododendron arborium* is co-dominant. *Coriaria nepaulensis* and *L. quinquelocularis* is dominant and co-dominant sp. in shrubs respectively.

Conclusion

The detailed characteristics of different forest compartment are mentioned in table 1. Compartment wise distribution of species is presented in table 2 and 3. The number of species in tree, sapling, seedling and shrub strata indicates that these forest stands are comparatively species rich. The compartment A is relatively species poor than compartment B and compartment C although dominance was shared by a number of species. The *Quercus* species is climax species. On the basis of density, basal cover and I.V.I., the species *Quercus leucotrichophora, Q. floribunda, Rhododendron arboretum* and *Lyonia ovalifolia* was the most important and dominant species in all forest stands of Hingla-Devi forest (Table 4, 5 and 6). However the presence of *Lyonia ovalifolia* in these forest strands particularly in

compartment A is an indication towards possible threat to the co-existence of climax and associated species (Table 4). The forest of *Quercus leucotrichophora and Q. floribunda*which is later successional and climax species, when disturbed by various anthropogenic factor (i.e. lopping, cutting, burning etc) are invaded by the early succession species such as *Lyonia ovalifolia and Persea duthiei.* Increasing human intervention on forest biodiversity both economically and environmentally over the few decade and dependence on plant products has led to vast exploitation of natural flora. Most of the sp. have become threatened and are on the verge of extinction (Singh and Singh, 1987). Among human influence, commercial exploitation, agricultural requirements, fodder, lopping, forest fire, and grazing pressure are the important sources of disturbance (Singh and Singh, 1992).

Total basal cover of three species ranged from 49.39 m²/ha, to 64.74 m²/ha, and for sapling species these value ranged 2.37 m²/ha, to 2.55 m²/ha. Total density for tree species varies from 1010 plant/ha – 1230 plant/ha, and sapling species 690 plant/ha - 770 plant/ha, across the forest stand. Total basal area and density of tree layer was reported in range of 27 -191.5 m²/ha and 350 to 1787 plant/ha, respectively for various broad leaved, traditionally conserved and protected forest of Kumaun and Garhwal Himalaya (Saxena and Singh, 1982; Singh and Singh, 1987; Bhandari and Tiwari, 1997; Singh and Maikhuri, 1998; Maikhuri *et al.* 2000). Higher value of density and lower value of basal cover suggest that Hingla-Devi forest stands are younger. High degree density suggest that diversity and luxuriance of these community forest stands may be maintained in healthy state if the extent of biotic pressure is maintained a optimum limit. Low tree density, basal cover and less number of species in compartment A reflect the forest is under high biotic pressure coupled with other abiotic factors which are not necessarily conducive for the growth.

The number (density) of seedling of any species can be considered as the regeneration potential of the species. From the density value (Table 4, 5, 6) it is concluded that the regeneration oak Q. *leucotrichophora* in compartment A and compartment B is low, as compared to compartment C, however alarming as has been pointed out elsewhere (Saxena *et al.*, 1978; Ralhan *et al.*, 1982; Tiwari and Singh, 1982; Saxena and Singh, 1984; Bankoti *et al.*, 1986). The regeneration of species such as*Cedrus deodara, Quercus floribunda, Lyonia ovalifolia* and *Rhododendron arboretum* was very well in the entire compartment. Degradation of the oak forest through high anthropogenic pressure will provide appropriate condition for *Lyonia ovalifolia, Persea duthiei.*

Table.1 General characteristics of the study sites

S NO	Study site	Forest type	Aspect	Do. Tree species
1.	Compartment A (1900-2400)	Banj- Tilonj	E to N	*Q. leucotrichophora* *Q. floribunda*
2.	Compartment B (1800-2400)	Banj- Buras	E to S	*Q. leucotrichophora* *R. arboretum*
3.	Compartment C (1700-1900)	Banj- Tilonj	E	Q. leucotrichophora Q. floribunda

Table.2 Tree sp. encountered on the three different compartments of the Hingla-Devi forest

SNo	TREE….SPECIES	Vernacular Name	COM-A	COM- B	COM- C
1	*Cedrus deodara*	Devdar	+	+	+
2	*Cornus capitata*	Bhamora	+	+	+
3	*Cornus oblonga*	Kasmol	-	+	+
4	*Cupressus torulosa*	Surai	-	-	+
5	*Lindera pulcherrima*	kunai	+	+	+
6	*Lyonia ovalifolia*	Angyar	+	+	+
7	*Myrica esculenta*	Kafal	+	+	+
8	*Pinus roxburghii*	Cheir	-	-	+
9	*Pyrus pashia*	Mehal	-	+	+
10	*Quercus floribunda*	Tilonj	+	+	+
11	Quercus *langinosa*	Rianj	-	+	+
12	*Quercus leucotrichophora*	Banj	+	+	+
13	*Rhododendron arboreum*	Burans	+	+	+

Table.3 Shurb sp. encountered on the three different compartment of the Hingla-Devi forest

S.NO	Shurb……Species	Vernacular name	COM-A	COM- B	COM- C
1.	*Berberis aristata*	Kilmora	+	+	+
2.	*Coriaria nepalensis*	Mokala	-	+	+
3.	*Cotoneaster bacillaris*	Ruins	+	-	+
4.	*Daphane cannabina*	Baruwa	+	+	+
5.	*Elaeagnus umbellate*	Gyanli	+	+	+
6.	*Gold fussia dalhousiana*	Jaundela	+	-	-
7.	*Hyper*icum *cermum*	Silkya	-	+	+
8.	*Jasminm humile*	Pilichameli	+	+	+
9.	*Lonicera quinquelocularis*	Bhat kukri	+	+	+
10.	*Mahonia nepaulensis*	Kaniya	+	+	+
11.	*Myrsine africana*	Ghani	-	-	+
12.	*Pyracantha crenulata*	Ghingaru	+	+	+
13.	*Rubus niveus*	Gowriphal	+	+	+
14.	*Rubus ellipticus*	Hisalu	-	+	+
15.	*Rubus biflorus*	Kala Hisalu	-	+	+
16.	*Sarcocca hookeriana*	Sukat sing	+	-	-
17.	*Smilax vaginata*	Kukardura	+	+	+
18.	*Spiraea canescens*	Kath-ruins	-	-	+
19.	*Senecio rufinervis*	Fusar patya	-	+	+
20.	*Symplocos ramosissima*	-	+	-	+
21.	*Viburmum continifolium*	Gwiya	+	+	+
22.	*Viburmum mullah*	Lal titmuliya	+	+	+
23.	*Wikstroemia canescens*	-	+	+	+
24.	*Zanthoxylum alatum*	timur	+	-	-

- Species absent + species present

Table.4 Phytosociological attribute of com. (A) of Hingla-Devi forest

SPECIES		F	A	A/F	D/h	TBC IVI
TREES-						
Cedrus deodara.	40	2.75	.068	110	4.198	35.38
Lyonia ovalifolia	40	1.25	.031	50	3.557	28.15
Myrica esculenta.	20	4.0	20	80	1.374	18.70
Quercus floribunda	60	3.83	.063	230	7.853	62.66
Q. leucotrichophora	50	7.4	.148	370	25.394	108.04
R. arborium	40	4.25	.106	170	7.015	47.03
SAPLING-						
Cedrus deodara.	40	3.25	.081	130	.641	61.43
Cornus capitata	10	3.0	.3	30	.042	10.19
Lindera pulcherrima	10	2.0	.2	20	.024	8.02
Lyonia ovalifolia	40	1.25	.031	50	.181	31.22
Myrica esculenta	50	3.75	.075	150	.677	69.94
Quercus floribunda	40	3.25	.081	130	.269	46.38
Q. leucotrichophora	20	1.5	.075	30	.070	15.50
R. arboretum	30	5.0	.166	150	.568	57.20
SEEDLING-						
Cedrus deodara.	90	9.5	.10	860	.100	78.33
Cornus capitata	10	2.0	.2	20	.008	4.977
Lindera pulcherrima	90	6.44	.07	580	.079	62.27
Lyonia ovalifolia	40	2.0	.05	80	.027	18.72
Myrica esculenta	60	5.16	.08	310	.070	42.65
Quercus floribunda	80	6.25	.07	500	.080	57.09
Q. leucotrichophora	30	1.6	.05	50	.013	11.895
R. arborium	40	3.5	.08	140	.039	23.97
SHRUBS-						
Berberis aristata	80	3.12	.039	250	.0431	13.96
Cotoneaster bacillaris	30	1.33	.044	40	.003	3.88
Daphne. cannabina	100	16.5	.165	1650	.0713	42.78
Elaeagnus. umbellate	70	4.14	.059	290	.044	13.72
Goldfusia. dalhousiana	70	9.28	.132	650	.020	19.76
Jasminium humile	30	1.33	.044	40	.009	4.047
L. quinquelocularis	50	2.6	.052	130	.277	14.96

Mahonia nepaulensis	100	3.1	.031	310	.532	30.28
Pyracantha crenulata	60	2.0	.033	120	.007	8.546
Rubus niveus	20	2.5	.125	50	.002	3.03
Sarcocco hookeriana	40	3.5	.87	140	.0058	6.83
Smilex vaginata	40	8.25	.206	330	.0022	10.26
Symplocos chinensis	90	5.55	.061	500	.6877	36.96
Viburnum cotinifolium	90	4.22	.046	380	1.729	62.75
Viburnum mullah	50	1.2	.024	60	.256	13.09
Wikstroemia canescens	30	13.33	.44	400	.023	11.12
Zanthoxylum alatum	30	1.33	.044	40	.002	3.18

Table.5 Phytosociological attribute of com. (B) of Hingla-Devi forest

SPECIES-	F	A	A/Freq	D	TBC	IVI
TREES-						
Cornus capitata	30	1.0	.033	30	.544	11.64
Lyonia ovalifolia	50	3.2	.064	160	5.637	35.8
M*yrica esculeta*	10	2.0	0.1	20	.343	4.94
Quercus floribunda	70	2.28	.032	160	5.542	41.22
Quercus lanuginose	20	1.0	.05	20	4.945	14.83
Q. leucotrichophora	100	4.2	.042	420	29.17	107.53
Rhododendron arboreum	80	5.0	.062	400	18.56	83.93
SAPLING-						
Cornus capitata	40	1.25	.031	50	.086	23.18
Lyonia ovalifolia	30	3.00	.1	90	.401	37.35
Myrica esculeta	10	1.00	.1	20	.104	09.98
Pyrus pashia	20	2.00	.1	40	.118	16.46
Quercus floribunda	60	3.66	.061	220	.687	75.42
Quercus langinosa	30	1.00	.033	30	.065	16.43
Q. leucotrichophora	60	2.33	.038	140	.443	55.49
Rhododendron arboreum	50	3.66	.072	180	.654	65.59
SEEDLING-						
Cedars deodar	10	3.00	0.3	30	.001	16.92
Cornus capitata	70	5.85	.083	410	.065	63.45
Cornus oblonga	20	1.5	.075	30	.001	6.43
Lindera pulcherrima	20	5.00	.250	100	.006	12.15

Lyonia ovalifolia	60	4.00	.066	240	.037	40.94
Myrica esculeta	10	3.00	.3	30	.004	5.41
Pyrus pashia	30	3.66	.122	110	.011	16.92
Persia duthiei	10	3.00	.3	30	.001	4.21
Quercus floribunda	90	4.55	.056	410	.076	72.32
Quercus lanuginose	30	2.66	0.88	80	.014	16.53
Q. leucotrichophora	40	1.75	.043	70	.006	15.00
Rhododendron arboreum	70	5.28	.075	370	.028	46.47
SHRUBS-						
Berberis aristata	100	5.7	.057	570	.055	22.09
Coriaria nepaulensis	30	2.0	.066	60	.033	4.93
Daphne cannabina	100	11.9	.119	1190	.046	33.45
Elaeagnusumbellate	80	6.25	.078	500	1.12	43.28
Hypericum cermum	20	2.00	.10	40	.0013	2.82
Jasminium humile	90	4.44	.049	400	.017	17.03
Lonicera quinquecularis	90	4.44	.049	400	.222	21.75
Mahonia nepalensis	10	3.00	.30	30	.0004	1.58
Pyracantha crenulata	90	2.22	.024	200	.006	13.04
Rubus niveus	70	1.71	.024	120	.003	9.44
Rubus ellipticus	50	4.6	.092	230	.003	9.45
Rubus biflorus	10	2.00	.20	20	.00014	1.39
Smilex vaginata	50	7.2	.144	360	.0013	11.83
Senecio rufinervis	50	2.0	.04	100	.0018	7.0
Viburnum continifolium	100	10.6	.106	1060	2.71	92.41
Viburnum mullah	20	1.5	.075	30	.119	5.33
Wikstroemia canescens	20	2.5	.125	50	.001	3.00

Table.6 Phytosociological attributes of com. (C) of Hingla-Devi forest

SPECIES-	F	A	A/F	D/ha	TBA	IVI
TREES						
Cedrus deodara	10	2	.2	20	1.124	8.73
Cornus capitata	40	1.25	.031	50	.687	15.00
Lyonia ovalifolia	60	2.16	.036	130	8.291	40.67
Pinus roxburghii	20	1.00	.1	20	1.124	8.73
Pyrus pashia	10	2.00	.2	20	.531	5.12
Quercus floribunda	100	3.20	.032	320	8.539	66.83
Q. leucotrichophora	100	5.6	.056	560	30.40	125.20
Rhododendron arboreum	50	2.2	.044	110	5.859	32.17
SAPLING						
Cedrus deodara	10	2.0	0.2000	20	.067	8.43
Cornus capitata	40	1.25	.031	50	.057	21.00
Cornus oblonga	10	2.00	0.2000	20	.040	7.3

Lyonia ovalifolia	40	2.00	0.05	80	.186	30.31
Myrica esculeta	20	1.00	.05	20	.073	11.71
Pyrus pashia	20	2.00	0.10	40	.116	16.12
Quercus floribunda	90	3.44	.382	310	1.265	120.69
Quercus leucotrichophora	50	3.20	.064	160	.407	53.02
Rhododendron arboreum	50	1.40	.028	70	.168	31.3
SEEDLING						
Cedrus deodara	90	12.7	.141	1150	.094	35.94
Cornus capitata	80	9.37	.117	750	.127	31.71
Cornus oblonga	80	8.12	.101	650	.095	27.50
Cupressus torulosa	10	2.00	.200	20	.002	1.68
Lindera pulcherrima	60	5.6	.093	340	.031	15.01
Lyonia ovalifolia	100	8.90	.089	890	.149	38.11
Myrica esculeta	40	5.23	.131	210	.032	10.73
Pyrus pashia	80	2.50	.031	200	.020	14.49
Quercus floribunda	80	11.25	.140	900	.218	41.17
Quercus lanuginose	20	2.00	.100	40	.003	3.30
Quercus leucotrichophora	80	11.12	.139	890	.195	39.59
Rhododendron arboreum	90	9.11	.101	820	.199	40.15
SHRUBS						
Berberis aristata	100	5.30	.053	530	.068	26.07
Coriaria nepalensis	40	2.5	.062	100	.325	39.74
Cotoneater bacillaris	30	1.33	.044	40	.0029	3.715
Daphne cannabina	100	5.9	.059	590	.0281	22.99
Elaeagnusumbellate	50	2.0	.040	100	.0078	7.13
Hypericum cernum	20	2.0	.100	40	.0007	2.59
Jasminium humile	40	6.0	.150	240	.005	8.60
Lonicera quinquelocularis	80	6.5	.081	520	.1121	28.76
Mahonia nepalensis	90	3.8	.042	350	.0260	17.34
Myrsineafricana	50	7.8	.156	390	.0100	12.87
Pyracantha crenulata	70		.079	390	.0260	16.33
		5.57				
Rubus niveus	60	4.16	.069	250	.0050	10.56
Rubus ellipticus	50	8.00	.160	400	.0190	14.01
Rubus biflorus	20	2.50	.125	50	.0010	2.81
Smilex vaginata	90	4.80	.053	440	.0015	16.45
Spirae canescans	10	5.00	.500	550	.0010	1.93
Senecio rufinervis	10	3.00	.300	30	.0004	1.49
Viburnum mullah	70	1.57	.022	110	.1840	27.70
Viburnum mullah	60	3.66	.061	220	.0567	15.45
Wikstroemia canescens	80	5.00	.0625	400	.0094	15.65

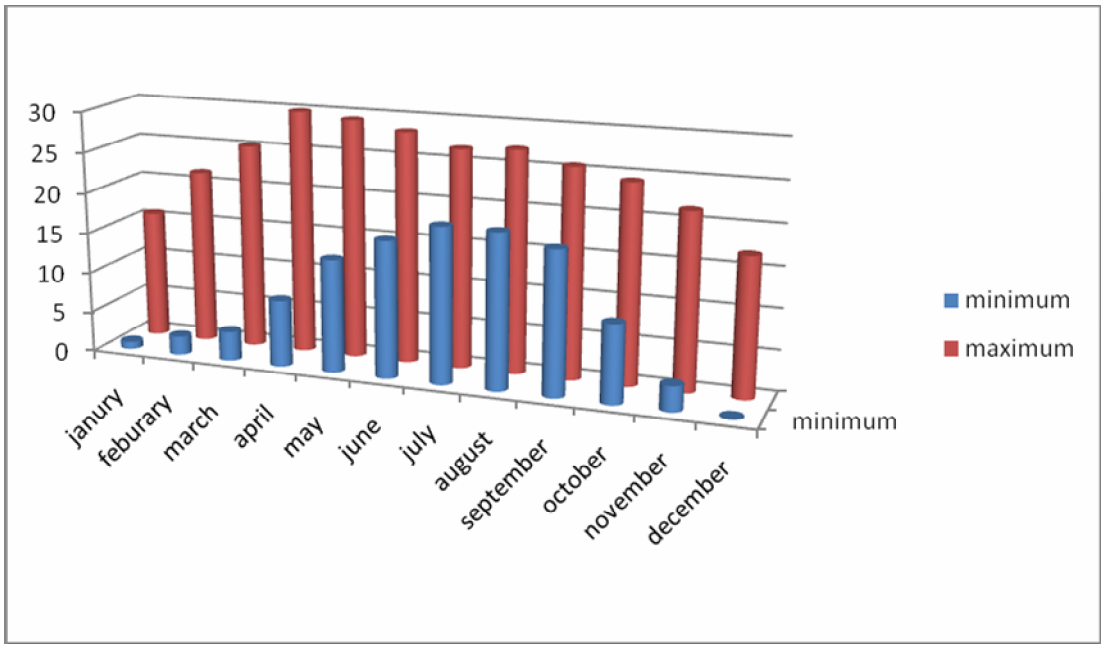
Fig.1

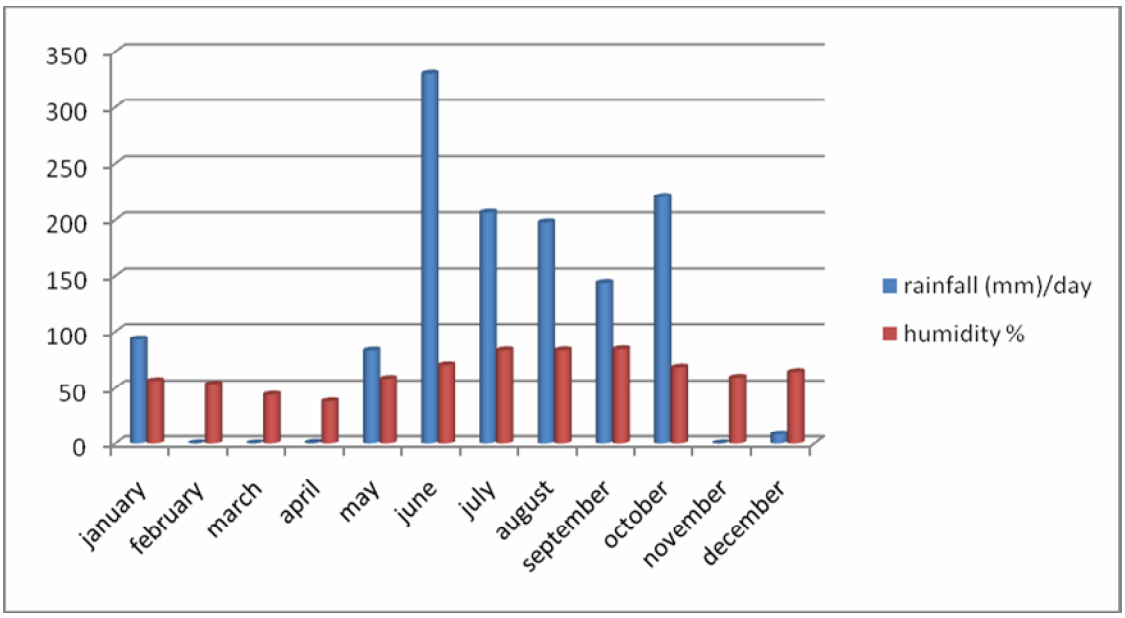

भारत
INDIA
उत्तराखण्ड
UTTARAKHAND
उत्तरकाशी
UTTARKASHI
देहरादून
DEHRADUN
Dehradun
टिहरी
TEHRI
रुद्रप्रयाग
RUDRAPRAYAG
चमोली
CHAMOLI
पिथौरागढ़
PITHORAGARH
गैरसैंण
Gairsain
हरिद्वार
HARIDWAR
पौड़ी
PAURI
बागेश्वर
BAGESHWAR
अल्मोड़ा
ALMORA
नैनीताल
NAINITAL
चम्पावत
CHAMPAWAT
उधम सिंह नगर
UDHAM SINGH NAGAR
Almora
Pithoragarh
Bageshwar
Chhira
2721
Lohaghat
Devidhura
Dhunaghat
CHAMPAWAT
CHAMPAWAT
Swala
Nanital
Gayuri
Puntagiri Ocw
Dinla
Danda
Thulgad
Tanakpur
NEPAL
Banbasa
Chakarpur
Udham Singh Nagar

Table.7 Species diversity (H) in different forest Strata and beta diversity

Compartments	Shannon Wiener Index Of Diversity. (H)	Beta Diversity.			
COMPARTMENTA					
Tree	2.3014				
Tree sapling	2.6783	**TREE**	**SAPLING**	**SEEDLING**	**SHURBS**
Tree seedling	2.3992				
Shrubs	3.3537				
COMPARTMENT B					
Tree	2.156				
Tree sapling	2.611				
Tree seedling	2.917				
Shrubs	3.326	1.42	1.32	1.16	1.30
COMPARTMENT C					
Tree	2.323				
Tree sapling	2.539				
Tree seedling	3.201				
Shrubs	3.944				

Fig.2 Maximum and minimum temperature in study area





In Hingla-Devi forest species richness is very high in shrub layers. High species richness in shrub layer may be due to relatively less developed canopy in these young forests which permit sufficient sunlight to reach the ground resulting in the luxuriant growth of shrub species (Table 3).
A/F ratio was used to assess the distribution pattern of the species. Distribution pattern indicates the most of plots species distribution contagiously (clumped) followed by randomly. Regular as well as random distribution pattern of trees did not correspond with the distribution pattern of shrubs. Odum (1971) described that in natural conditions, contagious (clumped) distribution is the most common type of distribution and performed due to small but significant variation in the environmental condition preponderance of random distribution in tree sapling and seedling layers as compared to shrub layer reflects the dimension of biotic interference in these strata.

Diversity is a combination of two factors, the number of species present, referred to as species richness and the distribution of individuals among the species, referred to as evenness or equitability. Single species population is defined as having a diversity zero, regardless of the index used. Species diversity therefore, refers to the variation that exists among the different form. In the present study Shannon – Wiener index of diversity has been used.

The value of diversity ranges from 2.156 to 2.323, 2.53 -2.67, 2.39 – 3.20 and 3.32 – 3.94 respectively, for tree sapling, seedling, and shrub. The range of diversity in the present community forest stand is certainly higher than any other broad leaved forest of central Himalaya (Ralhan *et al.*, 1982) however it is lower than as reported for tropical forest (Knight, 1975/). Moderate amount of anthropogenic pressure on the Hingla-Devi is helpful in maintaining the higher species diversity. The value of beta diversity was 1.42, 1.32, 1.16 and 1.30 for tree, sapling, and seedling and shrub layer respectively. Small differences in Beta diversity indicate that the growth forms among different stands respond in similar fashion (Adhikari *et al.*, 1991). Low value of beta diversity shows that the species

composition does not very significantly across the slope.

Anthropogenic disturbance first decreases the tree diversity with increasing intensity of disturbance decreased trees and shrubs diversity and increased herb diversity. The diversity of disturbances decreased the overall richness and diversity of the ecosystem. In all the compartments regeneration potential of *Quercus floribunda* is high as compared to other species but co-dominance of *Lyonia ovalifolia* and *Cedrus deodara* with *Q. leucotrichophora* (particularly in compartment A of Hingla-Devi forest) is an indication that if anthropogenic pressure will increase in that stand then oak will be replaced by these co – dominant species.

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