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Phytosociological Study of Trees at Various Habitats of High - Altitude Forests of Garhwal Himalaya

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Abstract: ***This study analyzed the vegetation of four habitats: stream bank, dry, ridge, and moist, at elevations between 2200 and 2500 meters in the Garhwal Himalayas. A total of 28 tree species were recorded in this area. Tree species were recorded most in stream bank, moist and dry habitats (16 tree species in each habitat), and least in ridge habitat (14 tree species). Lyonia ovalifolia, Quercus leucotrichophora, Rhododendron arboreum, and Myrica esculenta were the four dominant tree species in the study area, while Quercus floribunda and Cinnamomum tamala were the least dominant species in the study area. Soil samples were collected from all the four habitats and their physical properties were determined. Density, frequency abundance, relative density, relative frequency, relative abundance and species diversity were calculated for tree species. The total tree density was higher on the stream bank habitat, while the total density of saplings and seedlings was higher on dry habitat. The total basal area for trees was higher on stream bank habitat. The total basal area for saplings was recorded maximum on dry habitat, similarly cover of seedlings were maximum on moist habitat and minimum on stream habitat. The study concluded that the pattern of distribution and species composition in the region largely depends on the altitude of the study area and climatic variables like rainfall, temperature and humidity. This paper is based on primary data which was collected, documented and analyzed by surveying trees in the study area.***

Keywords: Garhwal Himalaya, Habitat, Tree, Sapling, Seedling and Species diversity

1. Introduction

The phytosociological study incorporates mainly the description of the vegetation of the terrain because it provides detailed information about composition of trees, shrubs and herbs communities and their functional aspect. It is assumed that the dominating plant species actually determine the structure of a community. A community or a vegetation unit is an assemblage of the plant population living in a prescribed area or physical habitat i.e., an aggregation of organisms in space and time which forms a distinct ecological unit. The species which exert the major controlling influence within a community by virtue of their numbers, size, production or other activities are described as ecological dominants [1]. There is a direct connection between structure and work within a community. Various components of nature form the ecosystem consisting of the structure and number of plant species and their habitats. The species of plant of the Garhwal Himalayan region are invariably affected by the altitudes of hills. With the increase in the altitudes, the number and structure of the flora species changes and a special variety is seen in the floristic pattern. The study region shows an abundance of oak mixed forest. These forests help many plants species to flourish making the area diverse. The diversity in the vegetation of Garhwal Himalayas is influenced by topography, aspect, isolation, soil, climate, wind, temperature, rainfall, water sources and humidity. Chamoli district is a hotspot area in terms of biodiversity. The present study is an attempt to describe the qualitative and quantitative analysis of forests present in different habitats between 2200-2500m elevation range in the western Pinder region of Badrinath forest division of Garhwal Himalaya. The study area has low disturbances by grazing, lopping, fodder, fuel-wood and other human activities.

2. Methodology

The various habitats located between 30°2'43" N and 30°3'27" N latitude and 79°24'43" and 79°26'46" longitude in Garhwal Himalaya. To determine the physical properties of the soil, three replicates of 50 grams each were collected from each habitat at three depths of soil from the ground level: 0-10 cm (surface layer), 10-20 cm (middle layer), and 20-30 cm (deep layer). The soil samples were packed in polythene bags and brought to the laboratory for analysis. The soil was oven-dried, and three samples from different depths in each habitat were mixed to create a composite sample. To determine soil texture, the dried soil samples were passed through multiple sieves with different hole sizes, and the amount of soil particles were determined by weight, and the amount was expressed as a percentage. Particle size was classified as follows:

Particles	Size Class
Sand	0.02 mm - 2.0 mm
Silt	0.002 mm- 0.02 mm
Clay	smaller than 0.002 mm

The vegetation of different habitats was analyzed for trees, sapling and seedling. Trees were considered to be individuals >30 cm cbh (circumference at breast height), saplings, 10-30 cm cbh and seedlings, <10 cm, circumference [2]. Tree layer was analyzed by sampling thirty quadrates of 10x10 m randomly in each habitat. The size and number of samples was determined by method of Sexena and Singh [3]. The vegetation data were quantitatively analyzed for density, frequency and abundance [4]. The distribution pattern of different species was studied using the ratio of abundance to frequency [5]. The Importance Value Index (IVI) for the tree layer was determined as the sum of the relative frequency, relative density and relative dominance [6]. Diversity is

measured as the number of species occurring within an area of a given size [7]. It therefore, measures the richness of a potentially interactive assemblage of species. The diversity index for trees, saplings and seedlings was computed by using Shannon-Wiener information index [8] and concentration of dominance (CD) was computed by Simpson's index [9]. The dominance-diversity curve was drawn by a co-ordinate point of its IVI on the y-axis and its position in the sequence of species from highest to lowest IVI on the x-axis for tree layer [10].

3. Result

3.1 Soil

Table 1: Soil texture of the study area at different habitats

Habitats	Soil depth (cm)	Sand (%)	Silt (%)	Clay (%)
Stream bank	0-10	31.66	60.42	7.92
	10-20	40.12	51.27	8.61
	20-30	31.35	54.32	14.33
Moist	0-10	44.69	46.92	8.39
	10-20	41.42	46.22	12.36
	20-30	32.54	50.64	16.82
Dry	0-10	40.09	48.15	11.76
	10-20	36.17	47.05	16.77
	20-30	39.44	46.36	14.20
Ridge	0-10	32.38	54.71	12.91
	10-20	41.91	45.92	12.17
	20-30	40.25	46.16	13.59

On examination of the soil texture, it was found that, at all depths of all the habitats, the highest quantity of silt, medium quantity of sand and minimum quantity of clay were recorded in the soil particles. The maximum 44.69% quantity of sand was found at moist habitat in 0-10 cm depth while minimum 31.35% was found on stream bank habitat in depth 20-30 cm. The maximum 60.42 % quantity of silt was recorded on stream bank habitat in 0-10 cm depth and minimum 45.92% in 10-20 cm depth on ridge habitat. The maximum 16.82% quantity of clay was recorded on moist habitat in 20-30 cm depth and minimum 7.92% quantity was recorded on stream bank habitat in 0-10 cm depth (Table-1).

3.2 Trees

A total of 28 species of trees were recorded on the study area, out of which a maximum of 16 species were recorded on stream bank, moist and dry habitats whereas only 14 species were recorded in ridge habitat. Based on IVI *Quercus leucotrichophora*(IVI=70.79) was the most dominant species in the study area, recorded on dry habitat, below which *Lyonia ovalifolia* (IVI=63.45) and *Rhododendron arboreum* (IVI= 63.33) were recorded on ridge habitat. The IVI of *Cornus macrophylla, Quercus floribunda, Litsea umbrosa* and *Rhus wallichii* were recorded up to or below 1.44 on various habitats. Total tree density was varied between 616 ind/ha - 987 ind/ha, it was maximum on stream bank habitat and minimum on moist habitat. The individual density ranged between 3 ind/ha - 250 ind/ha, it was recorded maximum of *Lyonia ovalifolia* on ridge habitat, whereas recorded minimum of *Litsea umbrosa* on stream bank, *Cornus macrophylla*, *Quercus floribunda* on dry and *Rhus wallichii* on ridge habitats. Total basal area for this region was varied between 35.63±8.03 m^2/ha - 70.01±12.56 m^2/ha, it was maximum on stream bank and minimum on moist habitats. The mean individual basal area varied between 0.04±0.00 m^2/ha - 13.23±12.52 m^2/ha, which was recorded the maximum and minimum of *Quercus semecarpifolia*, *Litsea umbrosa* on stream bank habitat (Table 2-5).

3.3 Saplings

Out of a total of 28 tree species in the study area, only 18 trees species were found to be saplings. The maximum species were recorded on stream bank and moist habitats (13 spp each) and minimum on ridge habitat (11 spp). The IVI recorded ranged between 3.50 and 68.61, which was maximum for *Cinnamomum tamala* and minimum for *Quercus semecarpifolia* on dry habitat. Total sapling density varied between 568 ind/ha (moist habitat) - 1988 ind/ha (dry habitat). The individual density ranged between 12 ind/ha - 520 ind/ha, it was maximum for *Cinnamomum tamala* on dry habitat and minimum for *Litsea umbrosa* on stream bank, *Quercus floribunda* on moist habitats. Total basal area was varied between 2.28±0.30 m^2/ha - 7.12±0.14 m^2/ha, it was maximum and minimum on dry and moist habitats respectively. Individual basal area varied from 0.03±0.00 m^2/ha -1.57±0.71 m^2/ha, it was maximum for *Quercus leucotrichophora* on dry habitat and minimum for *Cupressus torulosa* on stream bank habitat, *Abies pindrow* on moist habitat (Table 2-5).

3.4 Seedlings

Out of a total of 28 tree species in the study area, only 15 tree species were found to be seedling. The maximum species were recorded on moist habitat (10 Spp) and minimum on ridge habitat (6 spp). The IVI recorded ranged between 10.73 - 103.44, which was maximum for *Quercus leucotrichophora* on ridge habitat and minimum for *Abies pindrow* on dry habitat. Total density of seedlings was varied between 699 ind/ha (stream bank habitat) - 844 ind/ha (dry habitat). The individual density was varied from 33 ind/ha to 289 ind/ha, it was maximum for *Quercus leucotrichophora* on ridge habitat, the minimum for *Cedrus deodara*, *Cornus capitata, Machilus duthiei* and *Quercus semecarpifolia* on stream bank habitat, *Abies pindrow* and *Symplocos chinensis* on dry habitat, *Abies pindrow, Betula alnoides* and *Machsma pungens* on moist habitat. Total cover of seedlings was varied from 0.22±0.03 m^2/ha - 0.24±0.04 m^2/ha, it was maximum on moist habitat and minimum on stream bank habitat respectively. The individual cover of seedlings ranged from 0.01±0.00 m^2/ha to 0.09±0.05 m^2/ha, it was maximum for *Quercus leucotrichophora* on dry habitat (Table 2-5).

Table 2: Vegetational parameters for trees, saplings and seedlings at stream bank habitat

Trees					
S. No.	Name of Species	Density (Ind/ha)	A/F Ratio	Total Basal Area (m^2/ha)	IVI
1.	*Alnus nepalensis*	10	0.05	5.78±4.49	11.61
2.	*Carpinus viminea*	6	0.02	0.10±0.00	2.30
3.	*Cedrus deodara*	20	0.08	1.23±1.13	7.68
4.	*Eugenia cyanophylla*	6	0.07	0.24±0.16	2.51
5.	*Ilex dipyrena*	16	0.04	0.84±0.68	5.93
6.	*Litsea umbrosa*	3	0.03	0.04±0.00	1.14
7.	*Lyonia ovalifolia*	193	0.05	8.53±4.43	48.16
8.	*Machilus duthiei*	50	0.05	0.57±0.51	10.56
9.	*Myrica esculenta*	136	0.12	7.71±5.90	29.48
10.	*Pyrus pashia*	26	0.02	0.77±0.38	9.19
11.	*Quercus floribunda*	16	0.09	3.27±3.16	8.63
12.	*Quercus leucotrichophora*	163	0.03	9.70±3.75	47.48
13.	*Quercus semecarpifolia*	33	0.03	13.23±12.52	27.71
14.	*Rhododendron arboreum*	200	0.04	10.32±1.43	51.41
15.	*Symplocos chinensis*	63	0.06	1.18±0.66	15.88
16.	*Symplocos crataegoides*	46	0.03	6.51±6.04	20.21
TOTAL		**987**		**70.02±12.56**	
Saplings					
S. No.	**Name of Species**	**Density(Ind/ha)**	**A/F Ratio**	**Total Basal Area (m^2/ha)**	**IVI**
1.	*Cedrus deodara*	40	0.01	0.08±0.00	9.30
2.	*Cinnamomum tamala*	240	0.04	0.71±0.46	45.17
3.	*Cupressus torulosa*	24	0.02	0.03±0.00	5.54
4.	*Litsea umbrosa*	12	0.03	0.09±0.00	4.32
5.	*Lyonia ovalifolia*	200	0.05	0.80±0.52	42.68
6.	*Machilus duthiei*	24	0.07	0.12±0.08	7.44
7.	*Myrica esculenta*	80	0.10	0.42±0.29	24.16
8.	*Pyrus pashia*	20	0.07	0.05±0.03	5.62
9.	*Quercus floribunda*	52	0.02	0.11±0.00	10.92
10.	*Quercus leucotrichophora*	280	0.02	0.98±0.81	58.80
11.	*Quercus semecarpifolia*	40	0.05	0.16±0.09	11.01
12.	*Rhododendron arboreum*	144	0.03	0.63±0.33	34.93
13.	*Symplocos chinensis*	184	0.07	0.58±0.10	40.08
TOTAL		**1340**		**4.76±0.12**	
Seedlings					
S. No.	**Name of Species**	**Density(Ind/ha)**	**A/F Ratio**	**Total Seedling cover (m^2/ha)**	**IVI**
1.	*Cedrus deodara*	33	0.03	0.01±0.00	15.07
2.	*Cinnamomum tamala*	255	0.18	0.06±0.04	84.72
3.	*Cornus capitata*	33	0.03	0.01±0.00	14.78
4.	*Lyonia ovalifolia*	67	0.02	0.01±0.00	28.84
5.	*Machilus duthiei*	33	0.03	0.02±0.00	19.92
6.	*Quercus leucotrichophora*	178	0.03	0.06±0.03	82.69
7.	*Quercus semecarpifolia*	33	0.03	0.03±0.00	23.67
8.	*Symplocos chinensis*	67	0.07	0.02±0.01	30.28
TOTAL		**699**		**0.22±0.03**	

Table 3: Vegetational parameters for trees, saplings and seedlings at moist habitat

Trees					
S. No.	Name of Species	Density(Ind/hac)	A/F Ratio	Total Basal Area (m^2/ha)	IVI
1.	*Abies pindrow*	10	0.03	0.19±0.00	4.09
2.	*Betula alnoides*	13	0.01	1.54±0.00	10.28
3.	*Carpinus viminea*	26	0.06	2.73±0.91	18.67
4.	*Cedrus deodara*	10	0.01	0.89±0.00	6.99
5.	*Cornus capitata*	40	0.05	1.14±0.36	15.51
6.	*Cornus macrophylla*	30	0.06	1.34±0.42	12.51
7.	*Lyonia ovalifolia*	123	0.06	6.23±1.23	51.97
8.	*Machilus duthiei*	56	0.04	1.24±0.92	22.29
9.	*Myrica esculanta*	20	0.02	0.60±0.00	7.84
10.	*Pyrus pashia*	6	0.02	0.19±0.00	3.44
11.	*Quercus floribunda*	10	0.01	0.10±0.00	4.81
12.	*Quercus glauca*	13	0.03	1.25±0.12	9.46
13.	*Quercus leucotricophora*	60	0.02	6.67±1.22	39.13
14.	*Quercus semicarpifolia*	36	0.02	4.27±1.63	25.59
15.	*Rhododendron arboreum*	130	0.02	6.38±1.22	53.57
16.	*Symplocus chinensis*	33	0.01	0.91±0.00	13.74

TOTAL		**616**		**35.63±8.03**	
Seedlings					
S. No.	**Name of Species**	**Density (Ind/hac)**	**A/F Ratio**	**Total Basal Area (m^2/ha)**	**IVI**
1.	*Abies pindrow*	24	0.02	0.03±0.00	11.69
2.	*Carpinus viminea*	92	0.08	0.34±0.12	46.73
3.	*Cedrus deodara*	52	0.03	0.24±0.00	26.09
4.	*Cinnamomum tomala*	64	0.12	0.15±0.00	21.10
5.	*Cornus capitata*	52	0.02	0.22±0.00	27.95
6.	*Cornus macrophylla*	40	0.01	0.18±0.00	24.22
7.	*Machilus duthiei*	52	0.04	0.29±0.00	34.32
8.	*Machsma pungens*	52	0.03	0.15±0.00	21.75
9.	*Quercus floribunda*	12	0.03	0.07±0.00	8.87
10.	*Quercus glauca*	40	0.10	0.10±0.05	17.79
11.	*Quercus semicarpifolia*	24	0.02	0.13±0.00	16.03
12.	*Rhododendron arboreum*	24	0.03	0.14±0.00	16.51
13.	*Symplocus chinensis*	40	0.02	0.24±0.13	26.85
TOTAL		**568**		**2.28±0.30**	
Seedlings					
S. No.	**Name of Species**	**Density (Ind/ha)**	**A/F Ratio**	**Total Seedling cover (m^2/ha)**	**IVI**
1.	*Abies pindrow*	33	0.03	0.02±0.00	14.79
2.	*Betula alnoides*	33	0.03	0.02±0.00	15.14
3.	*Cinnamomum tomala*	53	0.02	0.03±0.00	32.16
4.	*Cornus macrophylla*	67	0.02	0.01±0.00	24.48
5.	*Lyonia ovalifolia*	42	0.03	0.02±0.00	16.87
6.	*Machsma pungens*	33	0.03	0.03±0.00	15.78
7.	*Quercus glauca*	65	0.07	0.02±0.00	24.45
8.	*Quercus leucotricophora*	178	0.04	0.04±0.04	70.21
9.	*Quercus semicarpifolia*	96	0.05	0.02±0.00	48.95
10.	*Rhododendron arboreum*	133	0.05	0.03±0.00	37.15
TOTAL		**733**		**0.24±0.04**	

Table 4: Vegetational parameters for trees, saplings and seedlings at dry habitat

Trees					
S. No.	Name of Species	Density (Ind/ha)	A/F Ratio	Total Basal Area (m^2/ha)	IVI
1.	*Abies pindrow*	6	0.07	0.21±0.14	2.80
2.	*Alnus nepalensis*	20	0.04	2.19±1.11	12.01
3.	*Cedrus deodara*	16	0.04	4.13±4.05	14.83
4.	*Cornus capitata*	50	0.05	0.99±0.84	13.17
5.	*Cornus macrophylla*	3	0.03	0.12±0.00	1.44
6.	*Ilex dipyrena*	13	0.03	0.30±0.00	3.87
7.	*Litsea umbrosa*	6	0.02	0.06±0.00	2.48
8.	*Lyonia ovalifolia*	176	0.12	10.66±5.40	60.73
9.	*Machilus duthiei*	20	0.08	0.81±0.77	11.52
10.	*Myrica esculenta*	13	0.07	1.65±0.00	14.05
11.	*Quercus floribunda*	3	0.03	0.12±0.00	1.43
12.	*Quercus leucotrichophora*	210	0.04	13.03±6.81	70.79
13.	*Quercus semecarpifolia*	53	0.08	3.67±3.45	20.05
14.	*Rhododendron arboreum*	130	0.06	7.50±5.16	43.42
15.	*Symplocos chinensis*	63	0.06	1.10±0.23	18.25
16.	*Symplocos crataegoides*	26	0.08	0.47±0.19	9.09
TOTAL		**808**		**47.01±5.60**	
Seedlings					
S. No.	**Name of Species**	**Density (Ind/ha)**	**A/F Ratio**	**Total Basal Area (m^2/ha)**	**IVI**
1.	*Abies pindrow*	24	0.07	0.15±0.08	5.61
2.	*Cedrus deodara*	64	0.04	0.22±0.11	10.91
3.	*Cinnamomum tamala*	520	0.05	1.54±0.55	68.61
4.	*Litsea umbrosa*	200	0.06	0.78±0.41	34.86
5.	*Lyonia ovalifolia*	80	0.01	0.35±0.00	14.76
6.	*Machilus duthiei*	40	0.05	0.13±0.07	7.28
7.	*Myrica esculenta*	172	0.03	0.60±0.45	25.19
8.	*Quercus floribunda*	40	0.03	0.21±0.00	7.27
9.	*Quercus leucotrichophora*	412	0.06	1.57±0.71	60.19
10.	*Quercus semecarpifolia*	24	0.07	0.08±0.00	3.50
11.	*Rhododendron arboreum*	92	0.05	0.35±0.28	15.83
12.	*Symplocos chinensis*	320	0.19	1.14±0.40	45.94
TOTAL		**1988**		**7.12±0.14**	
Seedlings					

S. No.	Name of Species	Density(Ind/ha)	A/F Ratio	Total Seedling cover (m^2/ha)	IVI
1.	*Abies pindrow*	33	0.03	0.01±0.00	10.73
2.	*Cinnamomum tamala*	67	0.07	0.02±0.01	26.97
3.	*Machilus duthiei*	67	0.02	0.02±0.00	27.62
4.	*Myrica esculenta*	144	0.04	0.04±0.02	47.12
5.	*Quercus leucotrichophora*	255	0.04	0.09±0.05	89.12
6.	*Quercus semecarpifolia*	67	0.02	0.03±0.00	29.33
7.	*Rhododendron arboreum*	178	0.02	0.04±0.00	52.80
8.	*Symplocos chinensis*	33	0.03	0.02±0.00	16.30
TOTAL		**844**		**0.23±0.08**	

Table 5: Vegetational parameters for trees, saplings and seedlings at ridge habitat

Trees					
S. No.	Name of Species	Density (Ind/hac)	A/F Ratio	Total Basal Area (m^2/ha)	IVI
1.	*Cedrus deodara*	20	0.01	4.52±0.00	15.41
2.	*Cornus capitata*	43	0.04	0.88±0.63	11.31
3.	*Ilex dipyrena*	10	0.03	0.48±0.00	3.50
4.	*Lyonia ovalifolia*	250	0.03	8.89±1.24	63.45
5.	*Machilus duthiei*	16	0.01	0.17±0.00	4.86
6.	*Myrica esculanta*	113	0.02	5.30±2.95	33.76
7.	*Pyrus pashia*	30	0.14	0.46±0.25	8.36
8.	*Quercus floribunda*	23	0.03	0.47±0.37	7.65
9.	*Quercus leucotricophora*	160	0.02	9.63±3.92	54.39
10.	*Quercus semicarpifolia*	23	0.01	4.74±0.00	16.19
11.	*Rhododendron arboreum*	233	0.13	9.64±1.14	63.33
12.	*Rhus wallichii*	3	0.03	0.08±0.00	1.18
13.	*Symplocus chinensis*	23	0.02	0.35±0.00	8.05
14.	*Symplocus crataegoides*	30	0.05	0.50±0.25	8.44
TOTAL		**977**		**46.11±10.75**	
Seedlings					
S. No.	**Name of Species**	**Density (Ind/hac)**	**A/F Ratio**	**Total Basal Area (m^2/ha)**	**IVI**
1.	*Cedrus deodara*	24	0.02	0.10±0.00	9.81
2.	*Cinnamomum tomala*	132	0.07	0.22±0.07	31.47
3.	*Litsea umbrosa*	40	0.01	0.17±0.00	15.96
4.	*Lyonia ovalifolia*	104	0.09	0.49±0.10	34.83
5.	*Machilus duthiei*	40	0.10	0.07±0.05	10.65
6.	*Myrica esculanta*	104	0.02	0.41±0.07	38.64
7.	*Quercus floribunda*	64	0.01	0.19±0.00	23.17
8.	*Quercus leucotricophora*	184	0.12	0.68±0.09	53.58
9.	*Quercus semicarpifolia*	40	0.01	0.15±0.00	15.37
10.	*Rhododendron arboreum*	52	0.03	0.30±0.05	23.40
11.	*Symplocus chinensis*	132	0.03	0.45±0.08	43.03
TOTAL		**916**		**3.23±0.51**	
Seedlings					
S. No.	**Name of Species**	**Density(Ind/ha)**	**A/F Ratio**	**Total Seedling cover (m^2/ha)**	**IVI**
1.	*Cedrus deodara*	67	0.02	0.02±0.00	31.22
2.	*Lyonia ovalifolia*	111	0.05	0.04±0.05	42.42
3.	*Myrica esculanta*	144	0.01	0.01±0.00	61.83
4.	*Quercus leucotricophora*	289	0.15	0.12±0.01	103.44
5.	*Quercus semicarpifolia*	67	0.02	0.02±0.01	30.55
6.	*Rhododendron arboreum*	67	0.02	0.02±0.00	30.52
TOTAL		**745**		**0.23±0.07**	

3.5 Species diversity and Concentration of dominance:

The species richness, species diversity and concentration of dominance, of different habitat are given in Table 6. Both the species richness and diversity for tree layer was decreased from high moisture to low moisture habitats on the study area. The species diversity of tree, sapling and seedling was high on moist habitat, low on ridge habitat for tree and seedling whereas saplings were low on dry habitat. The concentration of dominance is inversely proportional to the species diversity i.e. when species diversity increases, the concentration of dominance decreases.

Table 6: Species diversity and Concentration of dominance (C.D.) for different habitats

Habitats	Species Richness	Diversity	C. D.
Trees			
Stream bank	16	3.19	0.137
Moist	16	3.52	0.120
Dry	16	3.09	0.158
Ridge	14	2.99	0.177
Saplings			
Stream bank	13	3.15	0.126
Moist	13	3.52	0.093
Dry	12	2.99	0.161
Ridge	11	3.22	0.122
Seedlings			

Stream bank	8	2.51	0.225
Moist	10	3.07	0.138
Dry	8	2.66	0.187
Ridge	6	2.33	0.234

3.6 Dominance diversity curve

The dominance diversity curves were drawn for each habitat. The curves for all layers (i.e., trees, saplings and seedlings) fit for the lognormal situation (Figure a).

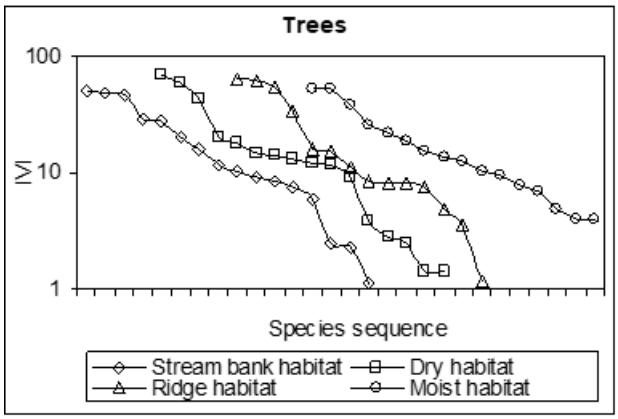

Figure A: Dominance diversity curves of the tree layer showed a geometric progression

4. Discussion

The study area is covered by oak mixed forest, with dominant tree species such as *Quercus leucotrichophora*, *Lyonia ovalifolia, Rhododendron arboreum,* and *Myrica esculenta*. The species diversity includes trees, shrubs, herbs, climbers and lower plant species. This is a young forest, with a large number of young trees present in all habitats. Diversity among plant species varies from habitat to habitat. The stream bank habitat had the highest total density and total basal area of trees compared to the other habitats. The dry habitat had higher total density and total basal area of saplings, whereas higher total density and total cover of seedlings on the same habitat. Stream bank habitat, being connected to water resources, has abundant moisture. Ram et al. [11] reported that oak forest had the highest species richness, while the dry area showed lower species richness. Segura et al. [12] also reported lower species richness in the dry area and found that tree density and basal area were highest in the oak forest. In this study, the density, basal area and species diversity of trees, saplings and seedlings were compared with data reported by [13], [11] and [14]-[21], who had studied different forest ecosystems in the Central Himalayas, belonging to similar altitudes and forest types in the region. Upon comparison, the obtained data showed similarities with their data, thus suggesting a positive correlation in the present study.

5. Conclusion

The region is minimally affected by various human activities, such as grazing of domestic animals, felling of trees for fodder and cutting of trees for fuelwood. Some trees, such as *Alnus nepalensis, Abies pindrow,* and *Cedrus deodara* were used by locals as timber for building construction. In the villages of the study area, houses are now being built with cement, sand, rebar etc. The use of some quantity LPG gas for cooking, migration of people and animal husbandry have all led to a reduction in tree cutting. We must conserve forests, which are crucial to combating global warming and pollution and protecting water sources.

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