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Status of Plant Diversity along an Altitudinal Gradient in Dankund Beat of Kalatop Khajjiar Wild Life Sanctuary of District Chamba, Himachal Pradesh

R.K. Verma
Himalayan Forest Research Institute
Conifer Campus, Panthaghati, Shimla-171013 (Himachal Pradesh)

(Corresponding author: R.K. Verma)
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ABSTRACT: A study was conducted to understand the plant diversity along an altitudinal gradient with elevations varying from 2200-2600m above msl in Dankund beat of Kalatop Khajjiar wild life sanctuary in district Chamba, Himachal Pradesh during 2011. Total number of plant species was 102 belonging to 54 families and 95 genera. The dominant families were Asteraceae, Rosaceae, and Fabaceae. The number of tree species at 2200-2400m and 2400-2600 m was 12 and 4 with dominance of *Cedrus deodara* and *Picea smithiana* respectively. The number of shrub species was 27 and 10 with the dominance of *Sorbaria tomentosa* and *Vibernum erubescens* in the elevation of 2200-2400m and 2400-2600 m respectively. The number of herb species was 52 and 53 with the dominance *of Valeriana jatamansii* and *Erigeron multiradiatus* respectively. The distribution pattern of most of the plant species was contiguous in both the altitudes. Index of diversity for herb species was 3.167 and 3.200 for 2200-2400m and 2400-2600 m elevation ranges respectively. Out of 35 medicinal plant species recorded from the area, 3 species i.e. *Dioscorea deltoidea, Paris polyphylla* and *Taxus wallichiana* fall in the category of threatened plants. The better conservation of natural resources can be done through promotion of community based conservation, *ex-situ* conservation through tissue culture, developing cultivation technologies and nurseries of medicinal plants and conducting of regular training on the procedure of medicinal plants collection and processing among the end users.

Key words: Plant diversity, Dominance, Diversity index, Conservation, Distribution.

INTRODUCTION

The diverse climate and the varied environmental conditions prevailing in the lap of Himalayas support diverse habitat and ecosystems with equally diverse life forms. Himalayas, known for its rich and diverse plant wealth is showing a rapid decline in population of many plant species in recent past. Some of them have already been lost whereas many of them are on the verge of extinction. If suitable steps to conserve the Himalayan flora not taken well in time, the delay may lead to total extinction of rare and valuable plants. The current decline in biodiversity largely through human activities is a serious threat to our ecosystem. Hence, attempts are essentially required to preserve this biodiversity *in-situ* and *ex-situ* conservation.

Kalatop Khajjiar wildlife sanctuary which covers an area of about 20.27 sq km was established in 1958 in Chamba district of Himachal Pradesh. The altitude of this sanctuary varies from 1185 to 2800 m above msl whereas the climate ranges from sub -temperate to alpine. The sanctuary represents flora of sub-temperate to alpine climate and inhabitants of villages in and around the sanctuary are utilizing the sanctuary areas for grazing, collection of timber, fuel wood, fodder and other minor forest produce. The continuous removal of plant species for various uses and overgrazing by migratory and other livestock seems to have resulted in loss of biodiversity in this sanctuary. If these naturally occurring plant resources are not conserved timely then they may soon become extinct. Accordingly, the wealth needs to be protected from further degradation so as to conserve the endemic diversity in the medicinal plants before it is completely wiped out from nature. Keeping this in view and in absence of any detailed documentation on this account attempts were made to assess the plant diversity including documentation of the medicinal plants found in Dankund Beat of Kalatop Khajjiar wild life sanctuary of district Chamba, Himachal Pradesh.

MATERIALS AND METHODS

The present study was conducted in Dankund beat of Kalatop Khajjiar wild life sanctuary in district Chamba of Himachal Pradesh during, 2011 at an elevation of 2200-2600m. The study site was situated at N 32° 33.137' to N 32° 33.920' latitude and E 76° 02.277' to E 76° 01.438' longitudes.

The whole area of the valley was divided into two altitudes i.e. 2200-2400m and 2400-2600m for conducting the phyto-sociological study. Quadrats of size 10m × 10m, 3m × 3m and 1m × 1m laid out randomly for enumerating trees, shrubs and herbs + regeneration respectively. The seedlings were considered as herbs whereas saplings as shrubs. The vegetation data was analysed for density, frequency and abundance as per Curtis and McIntosh (1950). The relative values of density, frequency and dominance were summed to get Importance Value Index (IVI) of individual species. The abundance to frequency ratio (A/F) of different species was determined for eliciting the distribution pattern of the floral elements. This ratio indicates regular (<0.025), random (0.025 to 0.050) and contiguous (>0.050) distribution (Curtis and Cottam, 1956). The plant species diversity was calculated following Shannon-Wiener diversity Index (H) (Shannon-Wiener 1963).

$$H = -\sum_{i=1}^{S} (Ni/N) \ln (Ni/N)$$

Where Ni = Number of individuals of species i and N = Total number of individuals of all the species.

Concentration of dominance (C) was measured by Simpson's Index (Simpson, 1949).

$$C = \sum_{i=1}^{S} (Ni/N)^2$$

Where Ni = Importance value of species i and N= Total importance value of all the species.

Richness Index was estimated as per Margalef (1958) *i .e.*

$$R = S-1/\ln N$$

Evenness Index was calculated as per Hill (1973) *i. e.*

$$E = H/ \ln S$$

Where S= Total number of species, N= Total number of individuals of all the species, H = Index of diversity.

RESULTS AND DISCUSSION

The total number of plant species was 102 belonging to 54 families and 95 genera. The dominant families were Asteraceae, Rosaceae, and Fabaceae. At an elevation of 2200m-2400m, the total number of tree species was 12 (Table 1). *Picea smithiana* was the dominant species having maximum density (143.33 ha^{-1}) and frequency (73.33%). This was followed by *Cedrus deodara* (113.33 ha^{-1}) and *Abies pindrow* (86.67 ha^{-1}) in terms of density. *Quercus leucotrichophora* recorded the highest value of abundance (5.00) followed by *Cedrus deodara* (2.12) and *Quercus dilatata* (2.00). On the basis of IVI, *Cedrus deodara* recorded the highest value (73.16) followed by followed by *Picea smithiana* (65.69) and *Abies pindrow* (56.32). The lowest IVI value (1.84) was recorded for *Persea duthiei*. The community identified was *Cedrus deodara- Picea smithiana.* The distribution pattern of all the species except *Aesculus indica*, *Cedrus deodara* and *Picea smithiana* was contiguous. The contiguous distribution is the commonest pattern in nature, random distribution is found in very uniform environment. The general preponderance of contiguous distribution in vegetation has been reported by several workers (Kershaw, 1973; Singh and Yadava, 1974; Kunhikannan *et al*, 1998).

Table 1: Phytosociological attributes of the tree species in Dankund beat at an altitudinal zonation of 2200m-2400m.

S. No.	Species	Density (ha^{-1})	Frequency(%)	Abund-ance	A/F	IVI
1.	*Abies pindrow* Royle.	86.67	53.33	1.62	0.030	56.32
2.	*Acer acuminatum* Wall.ex.D.Don	6.67	6.67	1.00	0.150	3.76
3.	*Aesculus indica* (Colebr. ex Cambess.)Hook.	33.33	26.67	1.25	0.047	27.79
4.	*Cedrus deodara* (Roxb. ex D. Don) G. Don f.	113.33	53.33	2.12	0.040	73.16
5.	*Celtis australis* Linn.	10.00	10.00	1.00	0.100	5.53
6.	*Neolitsea pallens* (D.Don.) Momiyama & Hara	13.33	13.33	1.00	0.075	7.48
7.	*Persea duthiei* (King ex Hook.f.) Kosterm.	3.33	3.33	1.00	0.300	1.84
8.	*Picea smithiana* (Wall.) Boiss.	143.33	73.33	1.95	0.027	65.69
9.	*Prunus cornuta* (Wall.ex.Royle)Steudel	6.67	6.67	1.00	0.150	3.74
10.	*Quercus dilatata* Lindl.	40.00	20.00	2.00	0.100	17.78
11.	*Quercus leucotrichophora* A.Camus.	33.33	6.67	5.00	0.750	16.77
12.	*Taxus wallichiana* Zucc.	43.33	23.33	1.85	0.080	20.09

Total number of shrub species was 27 at an elevation of 2200m-2400m (Table 2). *Indigofera heterantha* was the dominant species having maximum density (3305.56 ha^{-1}) and frequency (42.50%). This was followed by *Sorbaria tomentosa* (2750.00ha^{-1}) and *Viburnum erubescens* (1750.00ha^{-1}) in terms of density. In terms of abundance, *Cotoneaster microphyllus* observed the highest value (10.00) followed by *Rabdosia rugosa* (8.50) and *Indigofera heterantha* (7.00).

Sorbaria tomentosa was the dominant species having highest value of IVI (59.62) followed by *Indigofera heterantha* (46.95) and *Viburnum erubescens* (46.14). The lowest value of IVI (1.11) was recorded for *Celtis australis* sapling. The ratio of abundance to frequency indicates that the distribution pattern of the species was contiguous and random.

Table 2: Phytosociological attributes of the shrub species in Dankund beat at an altitudinal zonation of 2200m-2400m.

S. No	Species	Density (ha^{-1})	Frequency(%)	Abundance	A/F	IVI
1.	*Abies pindrow* *Royle.	55.56	2.50	2.00	0.80	1.62
2.	*Acer acuminatum* *Wall. ex D.Don.	55.56	2.50	2.00	0.80	1.61
3.	*Berberis lycium* Royle	1083.33	25.00	3.90	0.16	18.98
4.	*Cedrus deodara* *(Roxb. ex D. Don) G. Don f.	277.78	15.00	1.67	0.11	10.30
5.	*Celtis australis* *Linn.	27.78	2.50	1.00	0.40	1.11
6.	*Cotoneaster microphyllus* Wall.ex.Lindley	277.78	2.50	10.00	4.00	5.35
7.	*Daphne cannabina* Lour ex Wall.	527.78	20.00	2.38	0.12	12.71
8.	*Desmodium tiliaefolium* Don.	305.56	7.50	3.67	0.49	5.39
9.	*Hypericum oblongifolium* Choisy.	111.11	2.50	4.00	1.60	1.85
10.	*Ilex dipyrena** Wall.	111.11	7.50	1.33	0.18	4.35
11.	*Indigofera heterantha* Wall. ex Brandis.	3305.56	42.50	7.00	0.16	46.95
12.	*Neolitsea pallens* *(D.Don.) Momiyama & Hara	305.56	12.50	2.20	0.18	8.00
13.	*Persea duthiei** (King ex Hook.f.) Kosterm.	55.56	5.00	1.00	0.20	2.50
14.	*Picea smithiana* *(Wall.) Boiss	27.78	2.50	1.00	0.40	1.26
15.	*Populus ciliata** Wall.ex.Royle	55.56	2.50	2.00	0.80	1.51
16.	*Pyrus pashia** Buch.-Ham. ex D.Don.	111.11	2.50	4.00	1.60	2.41
17.	*Quercus dilatata** Lindl.	138.89	7.50	1.67	0.22	7.34
18.	*Rabdosia rugosa* (Wall.ex.Benth.) Hara.	472.22	5.00	8.50	1.70	8.54
19.	*Rhamnus purpureus* Linn.	194.44	5.00	3.50	0.70	3.64
20.	*Rhus cotinus* Linn.	27.78	2.50	1.00	0.40	1.12
21.	*Rosa macrophylla* Lindley.	111.11	2.50	4.00	1.60	1.87
22.	*Rosa moschata* Miller.	166.67	5.00	3.00	0.60	3.48
23.	*Rubus niveus* Wall.	944.44	20.00	4.25	0.21	15.50
24.	*Sarcococca saligna* (D.Don) Muell Arg.	1305.56	17.50	6.71	0.38	19.72
25.	*Sorbaria tomentosa* (Lindley) Rehder.	2750.00	37.50	6.60	0.18	59.62
26.	*Taxus wallichiana* *Zucc.	222.22	12.50	1.60	0.13	7.03
27.	*Viburnum erubescens* Wall.ex DC	1750.00	35.00	4.50	0.13	46.14

*****Saplings

At an elevation of 2200m-2400m, the total number of herb species was 52 (Table 3). *Valeriana jatamansii* was the dominant species having maximum density ($5.12m^{-2}$) followed by *Bergenia ciliata* ($3.20\ m^{-2}$) and *Rumex nepalensis* ($2.6m^{-2}$). In terms of abundance, *Bergenia ciliata* recorded the highest value (8.35) followed by *Salvia lanata* (8.00) and *Valeriana jatamansii* (7.87). *Rumex nepalensis* recorded the highest value of frequency (80%) followed by *Valeriana jatamansii* (65.00%) and *Fragaria vesca* (51.67%). *Valeriana jatamansii* observed highest value of IVI (49.34) followed by *Rumex nepalensis* (42.82) and *Bergenia ciliata* (29.34). The lowest value of IVI (0.52) was recorded for *Viburnum erubescens.* The distribution pattern of all the species except *Rumex nepalensis* and *Fragaria vesca* was contiguous.

Total number of tree species was 4 at an elevation of 2400m-2600m (Table 4). *Picea smithiana* was the dominant species having maximum density ($260.00\ ha^{-1}$), abundance (2.60) and frequency (100%). This was followed by *Abies pindrow* ($150.00\ ha^{-1}$) and *Cedrus deodara* ($90.00\ ha^{-1}$). The maximum value of IVI (182.25) was observed for *Picea smithiana* followed by *Abies pindrow* (60.81) and *Cedrus deodara* (39.29). The lowest value of IVI (17.62) was recorded for *Taxus wallichiana*. *Picea smithiana- Abies pindrow* was identified as the community. The distribution pattern of the species was mostly contiguous.

Among 10 species of shrub at an elevation of 2400m-2600m (Table 5), *Viburnum erubescens* was dominant species having maximum density ($6203.70\ ha^{-1}$) and frequency (75%). This was followed by *Sorbaria tomentosa* ($4444.44\ ha^{-1}$) and *Rosa macrophylla* ($3055.56\ ha^{-1}$) in terms of density. In terms of abundance, *Sorbaria tomentosa* recorded highest value (12.00) followed by *Cotoneaster microphyllus* (10.00) and *Rosa macromhylla* (8.25). *Viburnum erubescens* recorded the highest value of IVI (81.17) followed by *Sorbaria tomentosa* (71.27) and *Rosa macrophylla* (60.00). The lowest value of IVI (5.90) was recorded for *Indigofera heterantha*. The ratio of abundance to frequency (A/F) indicates that the distribution pattern of all the species was contiguous.

Table 3: Phytosociological attributes of the herb species in Dankund beat at an altitudinal zonation of 2200m-2400m.

S. No.	Species	Density (m^{-2})	Frequency (%)	Abundance	A/F	IVI
1.	*Abies pindrow* **Royle.	0.07	3.33	2.00	0.600	1.34
2.	*Achyranthes aspera* Linn.	0.40	16.67	2.40	0.144	3.62
3.	*Adiantum caudatum* Linn.	0.23	6.67	3.50	0.525	1.64
4.	*Ajuga bracteosa* Wall.ex.Benth.	0.83	38.33	2.17	0.057	12.88
5.	*Anaphalis triplinervis* (Sims.) C.B.Clarke.	2.10	51.67	4.06	0.079	14.89
6.	*Aquilegia pubiflora* Wall.	0.10	3.33	3.00	0.900	1.01
7.	*Arisaema intermedium* Blume.	0.03	3.33	1.00	0.300	0.74
8.	*Artemisia parviflora* Roxb.	0.63	16.67	3.80	0.228	4.99
9.	*Aster molliusculus* Wall	0.03	3.33	1.00	0.300	0.55
10.	*Bergenia ciliata* (Haw.)Sternb.	3.20	38.33	8.35	0.218	29.34
11.	*Boenninghausenia albiflora* (Hook.)Reichb. ex Meissner.	0.30	10.00	3.00	0.300	2.39
12.	*Cedrus deodara* **(Roxb. ex D. Don) G. Don f.	0.10	3.33	3.00	0.900	1.55
13.	*Cirsium wallichii* DC.	0.23	13.33	1.75	0.131	4.46
14.	*Clematis grata* Wall.	0.03	3.33	1.00	0.300	0.55
15.	*Conyza sticta* Willd.	0.07	3.33	2.00	0.600	0.66
16.	*Cynoglossum furcatum* Wall. ex Roxb.	0.13	6.67	2.00	0.300	1.40
17.	*Desmodium trifolium* (Linn.) DC.	0.33	6.67	5.00	0.750	2.19
18.	*Digitalis purpurea* Linn.	1.50	41.67	3.60	0.086	16.50
19.	*Dioscorea deltoidea* Wall.	0.03	3.33	1.00	0.300	0.55
20.	*Epilobium laxum* Royle.	0.27	10.00	2.67	0.267	2.38
21.	*Erigeron multiradiatus* Benth.	0.57	20.00	2.83	0.142	4.92
22.	*Euphorbia cognata* (Klotzsch & Garcke) Boiss.	0.10	3.33	3.00	0.900	0.97
23.	*Fragaria vesca* Coville.	0.42	51.67	0.81	0.016	7.84
24.	*Geranium wallichianum* D.Don. ex Sweet.	0.07	3.33	2.00	0.600	0.69
25.	*Girardinia diversifolia* (Link.) Friis.	0.20	6.67	3.00	0.450	3.06
26.	*Hedychium spicatum* Smith.	0.10	3.33	3.00	0.900	1.88
27.	*Ilex dipyrena* **Wall.	0.10	6.67	1.50	0.225	1.63
28.	*Impatiens sulcata* Wall.	0.10	3.33	3.00	0.900	0.92
29.	*Indigofera heterantha*** Wall. ex Brandis.	0.13	6.67	2.00	0.300	1.52
30.	*Jasminum humile* Linn.	0.20	6.67	3.00	0.450	2.07
31.	*Leucas lanata* Benth.	0.10	3.33	3.00	0.900	1.01
32.	*Medicago falcata* Linn.	0.40	10.00	4.00	0.400	2.76
33.	*Oplismenus compositus* (Linn) Beauv	0.37	10.00	3.67	0.367	2.65
34.	*Paris polyphylla* Smith.	0.10	3.33	3.00	0.900	0.91
35.	*Pilea scripta* (Buch-Ham.ex.D.Don) Wedd.	0.95	31.67	3.00	0.095	8.19
36.	*Plantago lanceolata* Linn.	0.47	13.33	3.50	0.263	3.56
37.	*Polygonum capitata* Buch-Ham.ex.D.Don	0.27	6.67	4.00	0.600	2.56
38.	*Pteracanthus urticifolius* (Kuntze) Bremek.	1.45	31.67	4.58	0.145	12.79
39.	*Quercus leucotrichophora* *A.Camus.	0.07	3.33	2.00	0.600	1.43
40.	*Rubia cordifolia* Linn.	0.17	10.00	1.67	0.167	1.95
41.	*Rumex nepalensis* Spreng.	2.65	80.00	3.31	0.041	42.82
42.	*Salvia lanata* Roxb.	0.27	3.33	8.00	2.400	3.09
43.	*Senecio graciliflorus* DC.	0.10	3.33	3.00	0.900	1.16
44.	*Smilax aspera* Linn.	0.47	13.33	3.50	0.263	4.08
45.	*Solidago virga-aurea* Linn.	1.35	45.00	3.00	0.067	10.85

43.	*Senecio graciliflorus* DC.	0.10	3.33	3.00	0.900	1.16
44.	*Smilax aspera* Linn.	0.47	13.33	3.50	0.263	4.08
45.	*Solidago virga-aurea* Linn.	1.35	45.00	3.00	0.067	10.85
46.	*Swertia purpurascens* Wall.	0.37	13.33	2.75	0.206	3.30
47.	*Taraxacum officinale* F.H.Wigg.	0.10	6.67	1.50	0.225	1.44
48.	*Trifolium repens* Linn.	1.17	28.33	4.12	0.145	8.54
49.	*Urtica dioica* Linn.	0.27	10.00	2.67	0.267	3.16
50.	*Valeriana jatamansii* Jones	5.12	65.00	7.87	0.121	49.34
51.	*Viburnum erubescens* **Wall.ex DC	0.03	3.33	1.00	0.300	0.52
52.	*Viola canescens* Wall.ex.Roxb	0.70	16.67	4.20	0.252	4.50

******Regeneration

Table 4: Phytosociological attributes of the tree species in Dankund beat at an altitudinal zonation of 2400m-2600m.

S. No.	Species	Density (ha^{-1})	Frequency(%)	Abundance	A/F	IVI
1.	*Abies pindrow* Royle.	150.00	65.00	2.30	0.036	60.81
2.	*Cedrus deodara* (Roxb. ex D. Don) G. Don f.	90.00	40.00	2.25	0.056	39.29
3.	*Picea smithiana* (Wall.)Boiss	260.00	100.00	2.60	0.026	182.25
4.	*Taxus wallichiana* Zucc.	35.00	25.00	1.40	0.056	17.62

Table 5: Phytosociological attributes of the shrub species in Dankund beat at an altitudinal zonation of 2400m-2600m.

S. No.	Species	Density (ha^{-1})	Frequency (%)	Abundance	A/F	IVI
1.	*Abies pindrow* *Royle.	92.59	8.33	1.00	0.120	4.72
2.	*Cedrus deodara** (Roxb. ex D. Don) G. Don f.	462.96	16.67	2.50	0.150	12.38
3.	*Cotoneaster microphyllus* Wall.ex Lindley	925.93	8.33	10.00	1.200	16.40
4.	*Ilex dipyrena** Wall.	277.78	8.33	3.00	0.360	7.97
5.	*Indigofera heterantha* Wall ex Brandis	370.37	8.33	4.00	0.480	5.90
6.	*Picea smithiana* *(Wall.)Boiss	555.56	25.00	2.00	0.080	17.47
7.	*Rosa macrophylla* Lindley	3055.56	33.33	8.25	0.248	60.00
8.	*Sorbaria tomentosa* (Lindley) Rehder	4444.44	33.33	12.00	0.360	71.27
9.	*Taxus wallichiana** Zucc.	925.93	25.00	3.33	0.133	21.89
10.	*Viburnum erubescens* Wall.ex DC	6203.70	75.00	7.44	0.099	81.17

*****Saplings

At an elevation of 2400m-2600m, total number of herb species was 53 (Table 6). *Erigeron multiradiatus* was the dominant species having highest value (7.00) in terms of density, frequency (77.50) and abundance (8.65). This was followed by *Gypsophila cerastioides* ($4.95m^{-2}$) and *Rumex nepalensis* ($1.75m^{-2}$) in terms of density. On the basis of IVI, *Erigeron multiradiatus* recorded highest value (33.70) followed by *Rumex nepalensis* (30.93) and *Gypsophila cerastioides* (24.00). The lowest value of IVI (0.410) was recorded for *Galium asperifolium*. The ratio of A/F indicates that the distribution pattern of all the species was contiguous.

Table 6: Phytosociological attributes of the herb species in Dankund beat at an altitudinal zonation of 2400m-2600m

S. No.	Species	Density (m^{-2})	Frequency (%)	Abundance	A/F	IVI
1.	*Achillea millefolium* Linn.	0.15	7.50	2.00	0.267	1.41
2.	*Achyranthes aspera* Linn.	0.55	22.50	2.44	0.109	4.92
3.	*Ajuga bracteosa* Wall ex Benth.	0.28	15.00	1.83	0.122	3.35
4.	*Anaphalis triplinervis* (Sims) C.B.Clarke	1.48	45.00	3.28	0.073	9.24
5.	*Androsace lanuginosa* Wall.	0.50	15.00	3.33	0.222	3.43
6.	*Anemone obtusiloba* D.Don.	0.43	7.50	5.67	0.756	2.20
7.	*Aquilegia pubiflora* Wall.	0.70	35.00	2.00	0.057	7.39
8.	*Arisaema flavum* (Forsskal) Schott	0.03	2.50	1.00	0.400	0.47

S. No.	Species	Density (m^{-2})	Frequency (%)	Abundance	A/F	IVI
9.	*Artemisia parviflora* Roxb.	0.28	7.50	3.67	0.489	1.93
10.	*Aster molliusculus* Wall	0.05	2.50	2.00	0.800	0.43
11.	*Bergenia ciliata* (Haw.)Sternb.	1.53	20.00	7.63	0.381	18.91
12.	*Bistorta amplexicaulis* (D. Don) Greene	0.38	15.00	2.50	0.167	3.25
13.	*Capsella bursa-pastoris* (Linn.) Medic.	0.35	15.00	2.33	0.156	3.17
14.	*Cedrus deodara* **(Roxb. ex D. Don) G.Don f.	0.05	2.50	2.00	0.800	1.01
15.	*Cirsium wallichii* DC.	0.08	7.50	1.00	0.133	1.65
16.	*Cynoglossum micranthum* Desf.	0.15	7.50	2.00	0.267	1.29
17.	*Digitalis purpurea* Linn.	2.68	37.50	7.13	0.190	22.75
18.	*Epilobium laxum* Royle.	0.45	20.00	2.25	0.113	3.56
19.	*Erigeron multiradiatus* Benth.	7.00	77.50	8.65	0.112	33.70
20.	*Euphorbia cognata* (Klotzsch & Garcke) Boiss.	0.65	20.00	3.25	0.163	8.11
21.	*Fragaria vesca* Coville.	0.98	30.00	3.25	0.108	6.64
22.	*Galium asperifolium* Wall. ex Roxb.	0.05	2.50	2.00	0.800	0.41
23.	*Geranium wallichianum* D.Don ex Sweet.	0.13	2.50	5.00	2.000	0.70
24.	*Geum elatum* Wall. ex G. Don	0.13	7.50	1.67	0.222	1.81
25.	*Goodyera repens* (Linn) R.Br.	0.28	15.00	1.83	0.150	2.58
26.	*Gypsophila cerastioides* D.Don.	4.95	57.50	8.61	0.122	24.00
27.	*Habenaria pectinata* D. Don.	0.28	15.00	1.83	0.122	2.78
28.	*Lactuca dissecta* D.Don.	0.68	27.50	2.45	0.089	4.98
29.	*Medicago falcata* Linn.	0.80	20.00	4.00	0.200	4.86
30.	*Oplismenus compositus* (Linn.) Beauv.	0.75	20.00	3.75	0.188	4.36
31.	*Origanum vulgare* Linn.	0.73	15.00	4.83	0.322	4.73
32.	*Pedicularis punctata* Decne.	0.05	2.50	2.00	0.113	0.52
33.	*Pilea scripta* (Buch.-Ham. ex D.Don) Wedd.	0.58	22.50	2.56	0.800	4.87
34.	*Plantago lanceolata* Linn.	0.08	2.50	3.00	0.114	0.54
35.	*Podophyllum hexandrum* Royle	0.25	12.50	2.00	1.200	4.29
36.	*Primula denticulata* Smith	0.68	20.00	3.38	0.160	7.28
37.	*Pteracanthus urticifolius* (Kuntze) Bremek.	0.05	2.50	2.00	0.169	0.52
38.	*Ranunculus diffusus* DC.	0.23	15.00	1.50	0.800	2.30
39.	*Rubia cordifolia* Linn.	0.30	22.50	1.33	0.100	3.62
40.	*Rumex nepalensis* Sperng.	1.75	65.00	2.69	0.059	30.93
41.	*Sedum trifidum* Wall	0.28	20.00	1.38	0.041	4.04
42.	*Senecio graciliflorus* DC.	0.68	12.50	5.40	0.069	4.88
43.	*Silene viscosa* (Linn.) Pers.	0.18	12.50	1.40	0.432	1.89
44.	*Smilacina purpurea* Wall.	0.03	2.50	1.00	0.112	0.35
45.	*Smilax aspera* Linn.	0.35	20.00	1.75	0.400	3.57
46.	*Swertia purpurascens* Wall.	0.08	2.50	3.00	0.088	0.53
47.	*Taraxacum officinale* .H.Wigg.	0.73	30.00	2.42	1.200	6.07
48.	*Taxus wallichianum* ** Zucc.	0.03	2.50	1.00	0.081	0.56
49.	*Urtica dioica* Linn.	0.30	12.50	2.40	0.400	4.26
50.	*Valeriana jatamansi* Jones	1.33	27.50	4.82	0.192	18.65
51.	*Verbascum thapsus* Linn.	0.03	2.50	1.00	0.175	0.78
52.	*Viola canescens* Wall. ex Roxb.	0.53	20.00	2.63	0.400	3.61
53.	*Vitis himalayana* Brandis	0.45	20.00	2.25	0.131	5.70

The value of concentration of dominance (C), diversity index (H), richness index (R) and evenness index (E) for trees, shrubs and herbs at different altitudes is given in Table 7. The higher the value of concentration of dominance, the greater is the homogenous nature of the community and vice- versa (Kohli *et al*., 2004).

Table 7: Concentration of dominance (C), diversity index (H), richness index (R) and evenness Index (E) for tree, shrub and herb at different elevations in Dankund beat of the sanctuary.

Altitude	Plant Category	Concentration of Dominance (C)	Diversity Index (H)	Richness Index (R)	Evenness Index (E)
2200m-2400m	Tree	0.163	2.055	2.361	0.801
	Shrub	0.106	2.517	4.299	0.755
	Herb	0.072	3.167	6.818	0.801
2400m-2600m	Tree	0.433	1.185	0.642	0.854
	Shrub	0.184	1.719	1.463	0.746
	Herb	0.051	3.200	7.148	0.805

The lower value of dominance shows that dominance of plants is shared by many species. The species diversity is regulated by long term factors like community stability and evolutionary time as heterogeneity of both macro and micro environment affects the diversification among different communities. The higher values of index of diversity indicate the variability in the type of species and heterogeneity in the communities, whereas, the lesser values point to the homogeneity in the community. The higher value of evenness indices indicates that species are evenly distributed in this region. The nature of plant community at a place is determined by the species that grow and develop in such environment (Bliss, 1962).

MEDICINAL AND THREATENED PLANTS

The important plants of medicinal value found in Dankund beat of Kalatop-Khajjiar wild life sanctuary in district Chamba of Himachal Pradesh were compiled following Chopra *et al* (1956), Kirtikar and Basu (1987) and Kala (2002). These include; *Achyranthes aspera, Ajuga bracteosa, Aquilegia pubiflora, Artemisia parviflora, Aster molliusculus, Aesculus indica, Berberis lycium, Bergenia ciliata, Boenninghausenia albiflora, Cirsium wallichii, Clematis grata, Digitalis purpurea, Dioscorea deltoidea, Erigeron multiradiatus, Fragaria vesca, Geranium wallichianum, Hedychium spicatum, Jasminum humile, Paris polyphylla, Persea duthiei, Plantago lanceolata, Rubia cordifolia, Rosa macrophylla, Rumex nepalensis, Salvia lanata, Senecio graciliflorus, Smilax aspera, Solidago virga-aurea, Sarcococca saligna, Taxus wallichiana, Taraxacum officinale, Trifolium repens, Urtica dioica, Valeriana jatamansii* and *Viola canescens.* Out of 35 medicinal plant species recorded from the area,3 species i.e. *Dioscorea deltoidea, Paris polyphylla* and *Taxus wallichiana* fall in the category of threatened plants when compared with the available literature like Red Data Book and CAMP Reports. The rarity in these medicinal plants is due to habitat alteration, narrow range of distribution along with other factors. A major threat is for the species those are uprooted and their underground parts such as rhizomes, tubers, bulbs and roots are used in medicine. The habitat of most of the plant species have shrunk due to expansion of human population and environmental degradation primarily due to heavy live stock grazing, uncontrolled and unscientific harvest of species, unregulated tourism and construction of roads etc. The better conservation of natural resources can be done by inclusion of a section on the plant conservation especially of rare and endangered medicinal plants in the wild life protection act, promotion of community based conservation, *ex-situ* conservation through tissue culture, developing cultivation technologies and nurseries of medicinal plants and conducting of regular training on the procedure of medicinal plants collection, processing among the local people, traders and real stake holders.

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