



Assessment of Vegetation along an Altitudinal Gradient in Reunsi Beat of Shikari Devi Wild Life Sanctuary of district Mandi, Himachal Pradesh

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ABSTRACT: A study was carried out in Reunsi beat of Shikari devi wild life sanctuary of district Mandi, Himachal Pradesh during 2015-16 to know the composition of vegetation along an altitudinal gradient with elevations varying from 2000-3200m. Total number of plant species was 167 belonging to 49 families and 91 genera. The dominant families were Rosaceae, Compositae, Pinaceae, Labiatae, Polygonaceae and Leguminosae. The number of tree species at 2000-2400m, 2400-2800m and 2800-3200m elevation was 9, 11 and 4 with the dominance of *Cedrus deodara*, *Cedrus deodara* and *Quercus semecarpifolia* respectively. The number of shrub species was 12, 18 and 6 with the dominance *Sarcococca saligna*, *Sarcococca saligna* and *Cotoneaster microphyllus* at 2000-2400m, 2400-2800m and 2800-3200m elevation respectively. The number of herbs species was 35, 50 and 23 with the dominance of *Oplismenus compositus*, *Gypsophila cerastioides* and *Potentilla atrosanguinea* at 2000-2400m, 2400-2800m and 2800-3200m elevation respectively. The distribution pattern of species was mostly contiguous in all altitude ranges. Index of diversity for herb in different elevation ranges was 3.16, 3.41 and 2.75 respectively. Out of 56 medicinal plant species recorded from the area, 2 species i.e. *Polygonatum verticillatum* 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: Altitude, Dominance, Diversity index, Threatened plant, Distribution.

INTRODUCTION

The varied environmental conditions prevailing in the Himalayas support diverse habitat and ecosystems with diverse life forms. The variations in terms of its climate and altitudinal ranges, have created environments that are unique to the Himalayan region only. Himalayas has rich and diverse plant wealth is showing a rapid decline in population of many plant species in recent years. 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. This decline in biodiversity largely through human activities is a serious threat to our ecosystem. Therefore, attempts are essentially required to preserve this biodiversity through *in-situ* and *ex-situ*

conservation methods. Shikari Devi wildlife sanctuary was established in 1974 in Mandi district of Himachal Pradesh.

It covers an area of about 3,065 ha. Altitude of this sanctuary varies from 1800 to 3350 m above msl whereas the climate ranges from temperate to alpine. The sanctuary represents the flora of temperate to alpine climate and inhabitants of villages in and around the sanctuary have got their rights pertaining to grazing, collection of timber, fuel wood, fodder, pine needles and other minor forest produce. In addition, graziers also get permits for grazing of their cattle inside the sanctuary. In this sanctuary, continuous removal of plant species for various uses and overgrazing by migratory and other livestock infact, have resulted in loss of biodiversity.

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 these aspects in view, a study was under taken to assess the phyto-sociology in Reunsi Beat of Shikari Devi wild life sanctuary of district Mandi, Himachal Pradesh.

MATERIALS AND METHODS

The present study was conducted in Reunsi beat of Shikari Devi wild life sanctuary in district Mandi of Himachal Pradesh during, 2015-16 at an elevation of 2000-3200m. The study site was situated at N 31°30'02.9" to N 31°29'21.1" latitude and E 77°05'23.6" to E 77°08'09.8" longitudes. The whole area of the valley was divided into three altitudes i.e. 2000-2400m, 2400-2800m and 2800-3200m 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).

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

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

Dominance Index (C) was measured by Simpson's Index (Simpson, 1949).

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

Where N_i = 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

Total number of plant species was 167 belonging to 49 families and 91 genera. The dominant families were Rosaceae, Compositae, Pinaceae, Labiatae, Ploygonaceae and Leguminosae. At an elevation of 2000-2400m, the total number of tree species was 9 (Table 1). *Cedrus deodara* was the dominant species having maximum density (1000.00 ha⁻¹), abundance (10.00) and frequency (100.00%). This was followed by *Pinus roxburghii* (90.00 ha⁻¹) in terms of density. *Cedrus deodara* observed the highest value of IVI (210.78) followed by *Quercus leuchotrichophora* (17.72). At this elevation the community identified was *Cedrus deodara- Quercus leuchotrichophora*. The A/F ratio indicates that the distribution pattern of all the species was random and contiguous. The contiguous distribution is the commonest pattern in nature whereas, 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).

At this elevation, the total number of shrub species was 12 (Table 2). *Sarcococca saligna* was the dominant species having maximum density (4166.67 ha⁻¹), abundance (11.43) and frequency (52.50%) followed by *Berberis lycium* (1333.33 ha⁻¹) in terms of density. *Sarcococca saligna* observed the highest value of IVI (106.53) followed by *Daphne cannabina* (38.74). The A/F ratio indicates that the distribution pattern of all the species except *Daphne cannabina* was contiguous.

At an elevation of 2000-2400m, total number of herb species was 33 (Table 3). *Oplismenus compositus* was the dominant species having maximum density (6.70 m⁻²) and frequency (80.00%) followed by *Oxalis corniculata* (4.90 m⁻²) in term of density. In term of abundance, *Trifolium repens* recorded the highest value (20.00) followed by *Oplismenus compositus* (8.38).

Oplismenus compositus observed the highest value of IVI (35.52) followed by *Oxalis corniculata* (33.13). The A/F ratio indicates that the distribution pattern of all the species was contiguous except *Conyza stricta*. The value of diversity index for tree, shrub and herb were 1.20, 1.73 and 3.16 respectively.

Table 1: Phytosociological attributes of the Tree species in Reunsi Beat at an altitudinal zonation of 2000-2400m.

S. No.	Species	Density (ha ⁻¹)	Frequency (%)	Abundance	A/F	IVI
1	<i>Aesculus indica</i> Hook.f.	20.00	10.00	2.00	0.200	9.74
2	<i>Cedrus deodara</i> (Roxb. ex D. Don) G. Don f.	1000.00	100.00	10.00	0.100	210.78
3	<i>Juglans regia</i> Linn	10.00	10.00	1.00	0.100	5.18
4	<i>Neolitsea pallens</i> (D. Don.) Momiyama & Hara	20.00	20.00	1.00	0.050	10.19
5	<i>Picea smithiana</i> Wall (Boiss)	30.00	20.00	1.50	0.075	11.52
6	<i>Pinus roxburghii</i> Sarg	90.00	20.00	4.50	0.225	16.96
7	<i>Pyrus pashia</i> Buch.-Ham. ex D.Don.	10.00	10.00	1.00	0.100	5.12
8	<i>Quercus leucotrichophora</i> A. Camus	70.00	20.00	3.50	0.175	17.72
9	<i>Rhododendron arboreum</i> Smith	25.00	25.00	1.00	0.040	12.79

Table 2: Phytosociological attributes of the Shrub species in Reunsi Beat at an altitudinal zonation of 2000-2400m.

S. No	Species	Density (ha ⁻¹)	Frequency (%)	Abundance	A/F	IVI
1	<i>Berberis lycium</i> Royle.	1333.33	22.50	5.33	0.237	27.79
2	<i>Cedrus deodara</i> *(Roxb. ex D. Don) G. Don.f.	416.67	15.00	2.50	0.167	20.25
3	<i>Cotoneaster microphyllus</i> Wall. ex Lindley.	250.00	7.50	3.00	0.400	7.51
4	<i>Daphne cannabina</i> . Lour.ex Wall.	1166.67	52.50	2.00	0.038	38.74
5	<i>Desmodium tiliaefolium</i> D.Don	500.00	15.00	3.00	0.200	13.18
6	<i>Neolitsea pallens</i> * (D. Don.) Momiyama & Hara	833.33	22.50	3.33	0.148	24.66
7	<i>Prinsepia utilis</i> Royle	1083.33	37.50	2.60	0.069	28.11
8	<i>Quercus leucotrichophora</i> *A. Camus.	83.33	7.50	1.00	0.133	4.38
9	<i>Rabdosia rugosa</i> (Wall. ex. Benth.) Hara	416.67	7.50	5.00	0.667	7.92
10	<i>Rubus niveus</i> Thunb	500.00	15.00	3.00	0.200	12.92
11	<i>Sarcococca saligna</i> (D.Don.) Muell.Arg.	4166.67	52.50	11.43	0.218	106.53
12	<i>Taxus wallichiana</i> *Zucc.	333.33	7.50	4.00	0.533	8.02

Note: *Sapling

At an elevation of 2400-2800m, the total number of tree species was 11 (Table 4). *Cedrus deodara* was the dominant species having maximum density (775.00 ha⁻¹), abundance (8.61) and frequency (90.00%). This was followed by *Picea smithiana* (200.00 ha⁻¹) in terms of density. *Cedrus deodara* observed the highest value of IVI (173.65) followed by *Picea smithiana* (46.05) and *Abies pindrow* (22.07). At this elevation the community identified was *Cedrus deodara* -*Picea smithiana*. The A/F ratio indicates that the distribution pattern of all the species except *Picea smithiana* was contiguous. At this elevation, the total number of shrub species was 18 (Table 5). *Sarcococca saligna* was the dominant species having maximum density (13111.11 ha⁻¹) and abundance (19.67). This was followed by *Berberis*

lycium (2361.11 ha⁻¹) in terms of density. In term of frequency *Daphne cannabina* recorded the highest value (72.50%) followed by *Sarcococca saligna* (60.00%). *Sarcococca saligna* recorded the highest value of IVI (122.74) followed by *Daphne cannabina* (31.72). The A/F ratio indicates that the distribution pattern of all the species except *Daphne cannabina* was contiguous.

At an elevation of 2400-2800m, total number of herb species was 49 (Table 6). *Trifolium repens* was the dominant species having maximum density (6.08 m⁻²) and abundance (17.38) followed by *Gypsophila cerastioides* (5.57 m⁻²) in term of density. In case of frequency, *Fragaria vesca* observed the highest value (71.67%) followed by *Viola canescens* (56.67%).

Table 3: Phytosociological attributes of the herb species in Reunsi Beat at an altitudinal zonation of 2000-2400m.

S. No	Species	Density (m ⁻²)	Frequency (%)	Abundance	A/F	IVI
1	<i>Achyranthes aspera</i> Linn.	1.00	30.00	3.33	0.111	7.90
2	<i>Anaphalis triplinervis</i> (Sims) C. B. Clarke	0.20	10.00	2.00	0.200	2.05
3	<i>Ainsliaea latifolia</i> (D. Don) Sch. Bip.	0.50	30.00	1.67	0.056	5.09
4	<i>Boenninghausenia albiflora</i> (Hook.) Reichb. ex Meissner	0.80	30.00	2.67	0.089	5.36
5	<i>Cedrus deodara</i> ** (Roxb. ex D. Don) G. Don.f.	0.70	30.00	2.33	0.078	6.26
6	<i>Conyza stricta</i> Willd.	1.00	50.00	2.00	0.040	9.11
7	<i>Fragaria vesca</i> Coville.	2.90	40.00	7.25	0.181	13.66
8	<i>Galium asperifolium</i> Wall. ex Roxb.	1.80	30.00	6.00	0.200	11.95
9	<i>Geranium wallichianum</i> D. Don ex Sweet	0.70	20.00	3.50	0.175	5.81
10	<i>Girardiana diversifolia</i> (Link.) Friis	0.60	40.00	1.50	0.038	7.00
11	<i>Gypsophila cerastioides</i> D. Don	0.40	10.00	4.00	0.400	2.68
12	<i>Hedychium spicatum</i> Buch-Ham ex J.E.Smith.	0.80	20.00	4.00	0.200	5.13
13	<i>Impatiens sulcata</i> Wall	0.60	20.00	3.00	0.150	4.39
14	<i>Lactuca dissecta</i> D.Don.	0.10	10.00	1.00	0.100	1.46
15	<i>Micromeria biflora</i> (Buch-Ham ex D.Don.) Benth.	2.90	30.00	9.67	0.322	17.82
16	<i>Nepeta erecta</i> Benth.	0.60	20.00	3.00	0.150	5.53
17	<i>Oplismenus compositus</i> (Linn.) Beauv.	6.70	80.00	8.38	0.105	35.52
18	<i>Oxalis corniculata</i> Linn.	4.90	70.00	7.00	0.100	33.13
19	<i>Phytolacca decandra</i> Linn.	0.30	20.00	1.50	0.075	3.45
20	<i>Pilea scripta</i> (Buch.-Ham. ex D.Don.) Wedd.	1.20	40.00	3.00	0.075	8.17
21	<i>Pteracanthus urticifolius</i> (Kuntze) Bremek.	0.50	10.00	5.00	0.500	3.24
22	<i>Rumex hastatus</i> D. Don	0.80	10.00	8.00	0.800	4.54
23	<i>Rumex nepalensis</i> Spreng	0.50	20.00	2.50	0.125	3.48
24	<i>Salvia nubicola</i> Wall. ex Sweet	0.30	20.00	1.50	0.075	4.03
25	<i>Senecio graciliflora</i> (Wall.) DC.	0.30	10.00	3.00	0.300	2.70
26	<i>Skimmia laureola</i> ** (Candolle) Siebold & Zucc	2.00	10.00	20.00	2.000	10.77
27	<i>Smilax aspera</i> Linn.	1.00	40.00	2.50	0.063	8.03
28	<i>Solanum xanthocarpum</i> Schrad & Wendel	0.20	10.00	2.00	0.200	2.05
29	<i>Thalictrum foliosum</i> .DC.	0.20	10.00	2.00	0.200	1.85
30	<i>Trifolium repens</i> Linn.	2.00	10.00	20.00	2.000	15.04
31	<i>Urtica dioica</i> Linn.	0.50	20.00	2.50	0.125	4.24
32	<i>Valeriana jatamansii</i> Jones	3.80	50.00	7.60	0.152	25.23
33	<i>Viola canescens</i> Wall. ex Roxb.	4.10	70.00	5.86	0.084	21.24

Note: ** Regeneration

Table 4: Phytosociological attributes of the tree species in Reunsi Beat at an altitudinal zonation of 2400-2800m.

S. No	Species	Density (ha ⁻¹)	Frequency (%)	Abundance	A/F	IVI
1	<i>Abies pindrow</i> Royle.	75.00	30.00	2.50	0.083	22.07
2	<i>Acer acuminatum</i> Wall. ex. D. Don	20.00	10.00	2.00	0.200	5.03
3	<i>Alnus nitida</i> (Spach) Endl. Gen.	10.00	10.00	1.00	0.100	4.24
4	<i>Aesculus indica</i> (Wall. ex Cambess.) Hook	10.00	10.00	1.00	0.100	7.22
5	<i>Cedrus deodara</i> (Roxb. ex D. Don) G. Don f.	775.00	90.00	8.61	0.096	173.65
6	<i>Neolitsea pallens</i> (D.Don) Momiy. ex Hara	60.00	25.00	2.40	0.096	13.59
7	<i>Picea smithiana</i> (Wall.) Boiss.	200.00	70.00	2.86	0.041	46.05
8	<i>Quercus dilatata</i> Lindl.	60.00	25.00	2.40	0.096	13.81
9	<i>Rhododendron arboreum</i> Smith	20.00	10.00	2.00	0.200	5.03
10	<i>Salix tetrasperma</i> Roxb.	20.00	10.00	2.00	0.200	5.05
11	<i>Taxus wallichiana</i> Zucc.	10.00	10.00	1.00	0.100	4.26

Table 5: Phytosociological attributes of the Shrub species in Reunsi Beat at an altitudinal zonation of 2400-2800m.

S. No	Species	Density (ha ⁻¹)	Frequency (%)	Abundance	A/F	IVI
1	<i>Berberis lycium</i> Royle	2361.11	20.00	10.63	0.531	21.64
2	<i>Cedrus deodara</i> * (Roxb. ex D. Don) G. Don f.	305.56	27.50	1.00	0.036	11.50
3	<i>Cotoneaster microphyllus</i> Wall. ex Lindley.	250.00	7.50	3.00	0.400	3.89
4	<i>Daphne cannabina</i> Lour.ex Wall.	2333.33	72.50	2.90	0.040	31.72
5	<i>Desmodium tiliaefolium</i> D. Don	555.56	12.50	4.00	0.320	6.26
6	<i>Hypericum oblongifolium</i> Choisy	83.33	7.50	1.00	0.133	2.63
7	<i>Ilex dipyrrena</i> *Wall.	222.22	12.50	1.60	0.128	4.69
8	<i>Indigofera heterantha</i> Wall ex Brandis	333.33	7.50	4.00	0.533	4.04
9	<i>Lonicera quinquelocularis</i> Hardw.	333.33	7.50	4.00	0.533	4.14
10	<i>Neolitsea pallens</i> * (D. Don) Momiyama & Hara	2138.89	27.50	7.00	0.255	30.38
11	<i>Prinsepia utilis</i> Royle	583.33	20.00	2.63	0.131	8.94
12	<i>Rosa macrophylla</i> Lindley	416.67	12.50	3.00	0.240	7.10
13	<i>Rosa moschata</i> Miller	166.67	7.50	2.00	0.267	3.59
14	<i>Rubus niveus</i> Wall.	416.67	12.50	3.00	0.240	5.89
15	<i>Sarcococca saligna</i> (D. Don.) Muell.Arg	13111.11	60.00	19.67	0.328	122.74
16	<i>Skimmia laureola</i> * (Candolle) Siebold & Zucc	666.67	7.50	8.00	1.067	5.68
17	<i>Spiraea canescens</i> D.Don.	1250.00	7.50	15.00	2.000	10.59
18	<i>Viburnum erubescens</i> Wall. ex DC	1138.89	27.50	3.73	0.136	14.56

Note: *Sapling

Gypsophila cerastioides observed the highest value of IVI (37.27) followed by *Anaphalis triplinervis* (29.66) and *Trifolium repens* (19.54). The A/F ratio indicates that the distribution pattern of all the species was contiguous except *Galium asperifolium*. The value of diversity index for tree, shrub and herb were 1.49, 2.17 and 3.41 respectively.

At an elevation of 2800-3200m, the total number of tree species was 4 (Table 7). *Quercus semecarpifolia* was

the dominant species having maximum density (1540.00 ha⁻¹), abundance (17.11) and frequency (90.00%). This was followed by *Picea smithiana* (280.00 ha⁻¹) in terms of density. *Quercus semecarpifolia* observed the highest value of IVI (206.40) followed by *Picea smithiana* (64.18) and *Cedrus deodara* (20.84). At this elevation the community identified was *Quercus semecarpifolia* - *Picea smithiana*. The A/F ratio indicates that the distribution pattern of all the species was contiguous.

Table 6: Phytosociological attributes of the Herb species in Reunsi Beat at an altitudinal zonation of 2400-2800m.

S.No	Species	Density (m ⁻²)	Frequency(%)	Abundance	A/F	IVI
1.	<i>Ajuga bracteosa</i> Wall.ex Benth	0.23	15.00	1.56	0.104	2.25
2.	<i>Anaphalis triplinervis</i> (Sims) C. B.Clarke	3.03	43.33	7.00	0.162	29.66
3.	<i>Ainsliaea latifolia</i> (D. Don.) Sch. Bip.	1.08	43.33	2.50	0.058	7.63
4.	<i>Arisaema intermedium</i> Blume	0.07	6.67	1.00	0.150	0.95
5.	<i>Bergenia ciliata</i> (Haw.)Sternb.	0.27	6.67	4.00	0.600	2.53
6.	<i>Boenninghausenia albiflora</i> (Hook.) Reichb ex Meissner.	0.15	15.00	1.00	0.067	2.85
7.	<i>Calanthe tricarinata</i> Lindl.	0.13	6.67	2.00	0.300	1.23
8.	<i>Chenopodium album</i> Linn.	0.27	6.67	4.00	0.600	1.90
9.	<i>Cirsium wallichii</i> (DC.) C. B. Clarke	0.42	35.00	1.19	0.034	6.56
10.	<i>Conyza stricta</i> Willd.	0.27	6.67	4.00	0.600	1.62
11.	<i>Cynoglossum furcatum</i> Wall. ex Roxb	0.07	6.67	1.00	0.150	1.00
12.	<i>Cyperus rotundus</i> Linn.	1.13	15.00	7.56	0.504	6.05
13.	<i>Desmodium triflorum</i> (Linn.) DC.	1.13	15.00	7.56	0.504	5.39
14.	<i>Eragrostis viscosa</i> (Retzius) Trin.	0.53	6.67	8.00	1.200	2.40
15.	<i>Euphorbia cognata</i> (Klotzsch & Garcke) Boiss.	0.75	15.00	5.00	0.333	4.27
16.	<i>Fragaria vesca</i> Coville.	3.80	71.67	5.30	0.074	19.82
17.	<i>Galium asperifolium</i> Wall. ex Roxb.	0.22	21.67	1.00	0.046	3.10
18.	<i>Galium rotundifolium</i> Linn.	0.45	15.00	3.00	0.200	3.62
19.	<i>Geranium wallichianum</i> D.Don ex Sweet	2.07	50.00	4.13	0.083	12.01
20.	<i>Girardinia diversifolia</i> (Link.) Friis.	0.27	6.67	4.00	0.600	2.44
21.	<i>Geum elatum</i> Wall. ex G. Don	0.47	6.67	7.00	1.050	2.36
22.	<i>Gypsophila cerastioides</i> D. Don.	5.57	50.00	11.13	0.223	37.27
23.	<i>Impatiens sulcata</i> Wall.	0.68	15.00	4.56	0.304	3.92
24.	<i>Impatiens urticifolia</i> Wall.	0.20	6.67	3.00	0.450	1.52
25.	<i>Indigofera heterantha</i> ** Wall. ex Brandis.	0.27	6.67	4.00	0.600	2.18
26.	<i>Inula cappa</i> (Buch.-Ham. ex D.Don) DC.	0.27	6.67	4.00	0.600	2.11
27.	<i>Jasminum humile</i> Linn	0.07	6.67	1.00	0.150	1.17
28.	<i>Lactuca dissecta</i> D.Don.	0.27	6.67	4.00	0.600	2.18
29.	<i>Nepeta erecta</i> Benth	0.07	6.67	1.00	0.150	0.95
30.	<i>Oplismenus compositus</i> (Linn.) Beauv.	0.13	6.67	2.00	0.300	1.46
31.	<i>Oxalis corniculata</i> Linn.	0.93	6.67	14.00	2.100	5.50
32.	<i>Phytolacca decandra</i> Linn.	0.60	15.00	4.00	0.267	3.22
33.	<i>Pilea scripta</i> (Buch.-Ham. ex D.Don.)Wedd.	0.60	15.00	4.00	0.267	4.91
34.	<i>Poa alpina</i> Linn.	0.53	6.67	8.00	1.200	2.02
35.	<i>Polygonatum verticillatum</i> (Linn.) All.	0.33	6.67	5.00	0.750	2.03
36.	<i>Polygonum capitata</i> Buch.-Ham. ex D. Don	0.75	15.00	5.00	0.333	4.91
37.	<i>Potentilla atrosanguinea</i> Lodd.	2.45	21.67	11.31	0.522	12.99
38.	<i>Primula denticulata</i> Smith.	0.50	21.67	2.31	0.107	4.15
39.	<i>Rumex nepalensis</i> Spreng.	1.13	28.33	4.00	0.141	15.45
40.	<i>Salvia nubicola</i> Wall. ex Sweet	0.72	43.33	1.65	0.038	7.61

S. No	Species	Density (m ⁻²)	Frequency(%)	Abundance	A/F	IVI
41.	<i>Silene conoidea</i> Linn.	0.13	6.67	2.00	0.300	1.18
42.	<i>Smilax aspera</i> Linn.	0.15	15.00	1.00	0.067	2.97
43.	<i>Stellaria media</i> (Linn.)Vill.	0.67	6.67	10.00	1.500	3.79
44.	<i>Taraxacum officinale</i> F. H. Wigg	0.23	15.00	1.56	0.104	2.94
45.	<i>Thalictrum foliolosum</i> DC.	0.07	6.67	1.00	0.150	1.07
46.	<i>Trifolium repens</i> Linn.	6.08	35.00	17.38	0.497	19.54
47.	<i>Urtica dioica</i> Linn.	0.45	15.00	3.00	0.200	3.97
48.	<i>Valeriana jatamansii</i> Jones	1.88	15.00	12.56	0.837	8.94
49.	<i>Viola canescens</i> Wall ex Roxb	3.18	56.67	5.62	0.099	14.52

Table 7: Phytosociological attributes of the Tree species in Reunsi Beat at an altitudinal zonation of 2800-3200m.

S. No	Species	Density (ha ⁻¹)	Frequency (%)	Abundance	A/F	IVI
1	<i>Cedrus deodara</i> (Roxb. ex D. Don) G. Don f.	30.00	20.00	1.50	0.075	20.84
2	<i>Picea smithiana</i> (Wall.) Boiss.	280.00	40.00	7.00	0.175	64.18
3	<i>Quercus semecarpifolia</i> Sm.	1540.00	90.00	17.11	0.190	206.40
4	<i>Taxus wallichiana</i> Zucc.	30.00	10.00	3.00	0.300	8.57

At this elevation, the total number of shrub species was 6 (Table 8). *Cotoneaster microphyllus* was the dominant species having maximum density (4083.33 ha⁻¹) and frequency (37.50%). This was followed by *Berberis lycium* (1666.67 ha⁻¹) in terms of density. In case of abundance *Berberis lycium* recorded the highest value (10.00) followed by *Cotoneaster microphyllus* (9.80). *Cotoneaster microphyllus* observed the highest value of IVI (105.04) followed by *Quercus semecarpifolia* (66.60). The A/F ratio indicates that the distribution pattern of all the species was contiguous.

At an elevation of 2800-3200m, total number of herb species was 23 (Table 9). *Anaphalis triplinervis* was the dominant species having maximum density (9.17m⁻²) and frequency (90.00%). This was followed by *Potentilla atosanguinea* (4.00 m⁻²) in term of density. In case of abundance, *Trifolium repens* observed the highest value (24.33) followed by *Thymus linearis* and *Berginia ciliata* (15.00). *Potentilla atosanguinea*

observed the highest value of IVI (43.75) followed by *Anaphalis triplinervis* (41.58) and *Gypsophila cerastioides* (41.42). The A/F ratio indicates that the distribution pattern of all the species was contiguous. The value of diversity index for tree, shrub and herb were 0.87, 1.57 and 2.75 respectively. The value of dominance index (C), index of diversity (H), richness index (R), Evenness Index (E) for trees, shrubs and herbs at different altitudes is given in Table 10.

The higher the value of dominance index, the greater is the homogenous nature of the community and vice-versa. In other words, such communities are dominated by single species (Kohli *et al.*, 2004). The lower value of dominance shows that dominance of plant 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.

Table 8: Phytosociological attributes of the Shrub species in Reunsi Beat at an altitudinal zonation of 2800-3200m.

S. No	Species	Density (ha ⁻¹)	Frequency (%)	Abundance	A/F	IVI
1	<i>Berberis lycium</i> Royle	1666.67	15.00	10.00	0.667	48.27
2	<i>Cedrus deodara</i> * (Roxb. ex D. Don) G. Don f.	166.67	15.00	1.00	0.067	18.15
3	<i>Cotoneaster microphyllus</i> Wall. ex Lindley.	4083.33	37.50	9.80	0.261	105.04
4	<i>Daphne cannabina</i> Lour.ex Wall.	166.67	7.50	2.00	0.267	8.51
5	<i>Quercus semecarpifolia</i> Sm	1166.67	30.00	2.80	0.093	66.60
6	<i>Viburnum erubescens</i> Wall.ex DC	1333.33	25.00	3.20	0.128	53.43

Table 9: Phytosociological attributes of the Herb species in Reunsi Beat at an altitudinal zonation of 2800-3200m.

S. No	Species	Density (m ⁻²)	Frequency (%)	Abundance	A/F	IVI
1	<i>Anaphalis triplinervis</i> (Sims) C. B. Clarke	9.17	90.00	10.19	0.113	41.58
2	<i>Anemone obtusiloba</i> D. Don	2.20	40.00	5.50	0.138	10.86
3	<i>Bergenia stracheyi</i> (Hook. f. & Thoms.) Engl.	1.50	10.00	15.00	1.500	6.82
4	<i>Carex nubigena</i> D. Don	1.00	10.00	10.00	1.000	4.98
5	<i>Cirsium wallichii</i> DC	0.30	20.00	1.50	0.075	3.73
6	<i>Cynoglossum micranthum</i> Desf.	0.70	20.00	3.50	0.175	10.09
7	<i>Cyperus rotundus</i> Linn.	1.00	10.00	10.00	1.000	3.86
8	<i>Fragaria vesca</i> Coville.	2.00	40.00	5.00	0.125	9.01
9	<i>Galium rotundifolium</i> Linn.	1.20	40.00	3.00	0.075	9.16
10	<i>Geum elatum</i> Wall. ex G. Don	2.00	30.00	6.67	0.222	10.05
11	<i>Gypsophila cerastioides</i> D. Don.	6.40	60.00	10.67	0.178	41.42
12	<i>Plantago lanceolata</i> Linn.	1.40	20.00	7.00	0.350	8.09
13	<i>Poa alpina</i> Linn.	5.40	40.00	13.50	0.338	26.32
14	<i>Polygonum polystachya</i> (Wall. ex Meissn.) Gross	0.40	10.00	4.00	0.400	3.18
15	<i>Potentilla atrosanguinea</i> Lodd.	8.70	90.00	9.67	0.107	43.75
16	<i>Primula denticulata</i> Smith.	1.20	50.00	2.40	0.048	9.04
17	<i>Ranunculus arvensis</i> Linn.	0.20	10.00	2.00	0.200	1.82
18	<i>Rumex nepalensis</i> Sprengel	1.00	30.00	3.33	0.111	5.99
19	<i>Salvia nubicola</i> Wall. ex Sweet	0.30	20.00	1.50	0.075	3.73
20	<i>Tanacetum longifolium</i> Wall. ex DC	0.30	10.00	3.00	0.300	2.08
21	<i>Taraxacum officinale</i> F. H. Wigg.	1.00	40.00	2.50	0.063	7.67
22	<i>Thymus linearis</i> Benth. ex Benth.	6.00	40.00	15.00	0.375	17.55
23	<i>Trifolium repens</i> Linn.	7.30	30.00	24.33	0.811	18.89

Table 10: Dominance Index (C), Diversity index (H), Richness Index (R) and Evenness Index (E) for tree, shrub and herb at different elevations in Reunsi Beat of the Sanctuary.

Name of the Site	Altitude	Plant Category	Dominance Index (C)	Diversity Index (H)	Richness Index (R)	Evenness Index (E)
Reunsi Beat	2000-2400m	Tree	0.51	1.20	1.44	0.54
		Shrub	0.30	1.73	1.83	0.69
		Herb	0.06	3.16	4.17	0.89
	2400-2800m	Tree	0.37	1.49	1.80	0.62
		Shrub	0.20	2.17	2.47	0.75
		Herb	0.05	3.41	6.17	0.87
	2800-3200m	Tree	0.52	0.87	0.50	0.62
		Shrub	0.23	1.57	0.87	0.87
		Herb	0.08	2.75	2.68	0.87

The higher the value of index of diversity indicates the variability in the type of species and heterogeneity in communities, whereas, the lesser value points to the homogeneity in the community. The higher value of richness index indicates higher diversity of the species. The altitudinal ranges having high evenness indicates that species are evenly distributed in those elevations.

MEDICINAL AND THREATENED PLANTS

The important plants of medicinal value found in Reunsi beat of Shikari Devi wild life sanctuary in district Mandi of Himachal Pradesh were compiled following Chopra *et al* (1956), Kirtikar and Basu (1987) and Kala (2002).

These include; *Acer acuminatum*, *Achyranthes aspera*, *Aesculus indica*, *Anaphalis triplinervis*, *Ajuga bracteosa*, *Boenninghausenia albiflora*, *Berberis lycium*, *Bergenia ciliata*, *Calanthe tricarinata*, *Conyza stricta*, *Cotoneaster microphylla*, *Chenopodium album*, *Cirsium wallichii*, *Cynoglossum furcatum*, *Cyperus rotundus*, *Daphne cannabina*, *Desmodium tiliacifolium*, *Desmodium triflorum*, *Euphorbia cognata*, *Eragrostis viscosa*, *Fragaria vesca*, *Galium asperifolium*, *Geum elatum*, *Geranium wallichianum*, *Girardiana diversifolia*, *Gypsophila cerastioides*, *Hedychium spicatum*, *Inula cappa*, *Indigofera heterantha*, *Juglans regia*, *Jasminum humile*, *Lactuca dissecta*, *Nepeta erecta*, *Oxalis corniculata*, *Polygonum capitata*, *Polygonatum verticillatum*, *Potentilla atosanguinea*, *Primula denticulata*, *Pteracanthus urticifolius*, *Rhododendron arboreum*, *Rosa macrophylla*, *Rosa moschata*, *Rubus niveus*, *Rumex hastatus*, *Rumex nepalensis*, *Salvia nubicola*, *Sarcococca saligna*, *Senecio graciliflorus*, *Smilax aspera*, *Solanum xanthocarpum*, *Taraxacum officinale*, *Taxus wallichiana*, *Thalictrum foliosum*, *Trifolium repens*, *Urtica dioica*, *Valeriana jatamansi*, and *Viola canescens*.

Out of 56 medicinal plant species recorded from the area, 2 species i.e. *Polygonatum verticillatum* 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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