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Plant Diversity in Alpine Area of Kalatop-Khajjiar Wild life Sanctuary of District Chamba, Himachal Pradesh

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Abstract

A study was conducted to understand the plant diversity along an altitudinal gradient with elevations varying from 2400–2625 m above msl in alpine area of Dainkund in Kalatop-Khajjiar wild life sanctuary in district Chamba, Himachal Pradesh during 2010. Total number of plant species was 61 belonging to 34 families and 60 genera. The dominant families were Asteraceae, Rosaceae and Ranunculaceae. The number of shrub species at 2400–2625 m elevation was 10 with dominance of *Vibernum erubescens*. The number of herb species was 53 with the dominance *of Erigeron multiradiatus*. The distribution pattern of most of the plant species was contiguous in this region. Index of diversity for shrub and herb species was 1.719 and 3.200 whereas dominance index was 0.184 and 0.051 for 2400–2625 m elevation range respectively. Richness Index for shrub and herb species was 1.463 and 7.148 whereas evenness index was 0.746 and 0.805 for 2400–2625 m elevation range respectively. Out of 36 medicinal plant species recorded from the area, 3 species i.e. *Aconitum heterophyllum, Podophyllum hexandrun* and *Taxus wallichiana* fall in the category of threatened plants.

Key words: Plant diversity, dominance, diversity index, distribution, threatened plant.

Introduction

The alpine regions mainly fall in the great Himalayan ranges, these are approximately 2400 km in length and vary from 240 to 400 km in width with a number of peaks rising well above 7200 m, constituting the most striking feature in the geography of the world and are also characterized by certain geological formations (Verma *et al*, 2008). These regions are characterized by relatively low atmospheric pressure, low temperature, intense insulation, rapid and high ultraviolet radiation alongwith other related effects as chain reactions. All these factors are closely and inseparably inter linked in a complex chain of causes and effects. The entire complex of these closely integrated and interlinked factors constitute a self regulating dynamic alpine ecosystem.

Alpine pastures in India occupy about 1.52% of the total land area in the country. The total geographical area of the Himalaya in India is 61.5 m ha, out of which 17.8 m ha area is covered by alpine pastures usually found at an altitude above 2500 m (Verma *et al*, 2008). These pastures are supposed to be the only true grasslands in India where the grazing density is very high. Western Himalayan pastures are highly affected by heavy grazing pressure. The present level of grass production in the Himalayan grasslands is even less than 25% of their possible potential. Alpine pastures in Himachal Pradesh cover around 10,052 km^2 i.e. 17% of the total geographical area of the state. For the sustained development of these resources, proper management is the only way out. Floristic composition, population size and diversity of species are most significant biological elements of an ecosystems. Phytosociological studies at the same time are also useful for comparing different communities. Due to lack of proper management practices, a large number of pastures lands have been converted or are in the process of conversion to degraded lands. Very little scientific attention has been given to the vegetation of the alpine regions. The present study was carried out to know the status of plant species diversity of alpine area, which in turn could be helpful in devising strategies for better management.

Materials and Methods

The present study was conducted in alpine area in Dainkund beat of Kalatop-Khajjair wild life sanctuary in district Chamba of Himachal Pradesh during, 2010 at an elevation of 2400–2625 m. The study site was situated at N 32^0 32.039' to 32^0 31.576' latitude and E 76^0 02.761' to 76^0 01.509' longitudes. The phyto-sociological study was conducted by laying out quadrats of size 3mx3m and 1mx1m laid randomly for enumerating shrubs and herbs + regeneration respectively. The seedlings were considered as herb while saplings as shrubs. The size of the quadrat was determined by species area curve method (Misra, 1973). The number of quadrats laid out in the study site were determined as per method given by Misra (1973). Total number of quadrats laid out for shrub and herb species were 30 and 40 respectively. The vegetation data was analysed for density, frequency and abundance according to formulas given by 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. 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 by using Shannon-Wiener diversity Index (H) (Shannon-Wiener, 1963).

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

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

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

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

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 61 belonging to 34 families and 60 genera. The dominant families were Asteraceae, Rosaceae and Ranunculaceae. In this alpine area, total number of shrub species including tree saplings was 10 at an elevation of 2400m–2625 m (Table 1). *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. 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 Phytosciological attributes of the shrub species in alpine area of Dainkund beat at an altitudinal zonation of 2400m-2625m

S. No.	Species	Density (ha^{-1})	Frequ-ency (%)	Abund-ance	A/F	IVI
Shrubs						
1.	*Cotoneaster microphyllus* Wall.ex Lindley	925.93	8.33	10.00	1.200	16.40
2.	*Indigofera heterantha* Wall ex Brandis	370.37	8.33	4.00	0.480	5.90
3.	*Rosa macrophylla* Lindley	3055.56	33.33	8.25	0.248	60.00
4.	*Sorbaria tomentosa* (Lindley) Rehder	4444.44	33.33	12.00	0.360	71.27
5.	*Viburnum erubescens* Wall.ex DC	6203.70	75.00	7.44	0.099	81.17
Saplings						
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.	*Ilex dipyrena** Wall.	277.78	8.33	3.00	0.360	7.97
4.	*Picea smithiana* *(Wall.)Boiss	555.56	25.00	2.00	0.080	17.47
5.	*Taxus wallichiana** Zucc.	925.93	25.00	3.33	0.133	21.89

Among 53 species of herb (Table 2), *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* (4.95 m^{-2}) and *Rumex nepalensis* (1.75 m^{-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 2 Phytosciological attributes of the herb species in alpine area of Dainkund beat at an altitudinal zonation of 2400m-2625m

S. No.	Species	Density (m^{-2})	Frequ-ency (%)	Abund-ance	A/F	IVI
Herbs						
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
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.	*Cirsium wallichii* DC.	0.08	7.50	1.00	0.133	1.65
15.	*Cynoglossum micranthum* Desf.	0.15	7.50	2.00	0.267	1.29
16.	*Digitalis purpurea* Linn.	2.68	37.50	7.13	0.190	22.75
17.	*Epilobium laxum* Royle.	0.45	20.00	2.25	0.113	3.56
18.	*Erigeron multiradiatus* Benth.	7.00	77.50	8.65	0.112	33.70
19.	*Euphorbia cognata* (Klotzsch & Garcke) Boiss.	0.65	20.00	3.25	0.163	8.11
20.	*Fragaria vesca* Coville.	0.98	30.00	3.25	0.108	6.64
21.	*Galium asperifolium* Wall. ex Roxb.	0.05	2.50	2.00	0.800	0.41
22.	*Geranium wallichianum* D.Don ex Sweet.	0.13	2.50	5.00	2.000	0.70
23.	*Geum elatum* Wall. ex G. Don	0.13	7.50	1.67	0.222	1.81
24.	*Goodyera repens* (Linn) R.Br.	0.28	15.00	1.83	0.150	2.58
25.	*Gypsophila cerastioides* D.Don.	4.95	57.50	8.61	0.122	24.00
26.	*Habenaria pectinata* D. Don.	0.28	15.00	1.83	0.122	2.78
27.	*Lactuca dissecta* D.Don.	0.68	27.50	2.45	0.089	4.98
28.	*Medicago falcata* Linn.	0.80	20.00	4.00	0.200	4.86
29.	*Oplismenus compositus* (Linn.) Beauv.	0.75	20.00	3.75	0.188	4.36
30.	*Origanum vulgare* Linn.	0.73	15.00	4.83	0.322	4.73
31.	*Pedicularis punctata* Decne.	0.05	2.50	2.00	0.113	0.52
32.	*Pilea scripta* (Buch.-Ham. ex D.Don) Wedd.	0.58	22.50	2.56	0.800	4.87
33.	*Plantago lanceolata* Linn.	0.08	2.50	3.00	0.114	0.54
34.	*Podophyllum hexandrum* Royle	0.25	12.50	2.00	1.200	4.29
35.	*Primula denticulata* Smith	0.68	20.00	3.38	0.160	7.28
36.	*Pteracanthus urticifolius* (Kuntze) Bremek.	0.05	2.50	2.00	0.169	0.52
37.	*Ranunculus diffusus* DC.	0.23	15.00	1.50	0.800	2.30
38.	*Rubia cordifolia* Linn.	0.30	22.50	1.33	0.100	3.62
39.	*Rumex nepalensis* Sperng.	1.75	65.00	2.69	0.059	30.93
40.	*Sedum trifidum* Wall	0.28	20.00	1.38	0.041	4.04
41.	*Senecio graciliflorus* DC.	0.68	12.50	5.40	0.069	4.88
42.	*Silene viscosa* (Linn.) Pers.	0.18	12.50	1.40	0.432	1.89
43.	*Smilacina purpurea* Wall.	0.03	2.50	1.00	0.112	0.35

Continued..

Table 2 continued

44.	*Smilax aspera* Linn.	0.35	20.00	1.75	0.400	3.57
45.	*Swertia purpurascens* Wall.	0.08	2.50	3.00	0.088	0.53
46.	*Taraxacum officinale* F.H.Wigg.	0.73	30.00	2.42	1.200	6.07
47.	*Urtica dioica* Linn.	0.30	12.50	2.40	0.400	4.26
48.	*Valeriana jatamansi* Jones	1.33	27.50	4.82	0.192	18.65
49.	*Verbascum thapsus* Linn.	0.03	2.50	1.00	0.175	0.78
50.	*Viola canescens* Wall. ex Roxb.	0.53	20.00	2.63	0.400	3.61
51.	*Vitis himalayana* Brandis	0.45	20.00	2.25	0.131	5.70
Seedlings						
1.	*Cedrus deodara* **(Roxb. ex D. Don) G.Don f.	0.05	2.50	2.00	0.800	1.01
2.	*Taxus wallichianum* ** Zucc.	0.03	2.50	1.00	0.081	0.56

The value of concentration of dominance (C), diversity index (H), richness index (R) and evenness index (E) for shrubs and herbs is given in Table-3. The higher the value of concentration of dominance, the greater is the homogenous nature of the community and vice- versa (Kohli *et al*., 2004). 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).

Table 3 Concentration of dominance (C), diversity index (H), richness index (R) and evenness Index (E) for shrub and herb in alpine area of Dainkund beat of the sanctuary

Altitude	Plant Category	Concentration of Dominance (C)	Diversity Index (H)	Richness Index (R)	Evenness Index (E)
2400m-2625m	Shrub	0.184	1.719	1.463	0.746
	Herb	0.051	3.200	7.148	0.805

The lower value of dominance index and higher value of diversity index was observed by Santvan (1993) in the alpine vegetation near Rahla in Kullu, Himachal Pradesh. Similar findings were also reported by Verma *et al* (2008) while studied alpine pasture of Talra wild life sanctuary of Himachal Pradesh.

Medicinal Plants

The important plants of medicinal value found in alpine area of Dainkund in 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; *Achillea millefolium, Achyranthes aspera, Aconitum heterophyllum, Ajuga bracteosa, Anaphalis triplinervis, Androsace lanuginosa, Anemone obtusiloba,*

Aquilegia pubiflora, Artemisia parviflora, Aster molliusculus, Bergenia ciliata, Capsella bursa-pastoris, Cirsium wallichii, Cynoglossum micranthum, Digitalis purpurea, Erigeron multiradiatus, Euphorbia cognata, Fragaria vesca, Galium asperifolium, Geranium wallichianum, Geum elatum, Lactuca dissecta, Pedicularis punctata, Plantago lanceolata, Podophyllum hexandrum, Ranunculus diffuses, Rosa macrophylla, Rubia cordifolia, Rumex nepalensis, Sedum trifidum Smilax aspera, Taraxacum officinale, Taxus wallichiana, Urtica dioica ,Valeriana jatamansii, Verbascum thapsus and *Viola canescens.*

Threatened Plants

Out of 36 medicinal plant species recorded from the area, 3 species i.e. *Aconitum heterophyllum* (Critically Endengered), *Podophyllum hexandrum* (Endengered) and *Taxus wallichiana* (Endengered) fall in the category of threatened plants when compared with the available literature like Red Data Book and CAMP Reports (Ved *et al*, 2003). 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 like, *Aconitum heterophyllum, Podophyllum hexandrun* which are uprooted and their underground parts such as tubers and roots are used in medicine (Verma and Kapoor, 2009). 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.

It can be concluded from the present study that the dominance of non-leguminous forbs such as *Erigeron multiradiatus, Rumex nepalensis, Geum elatum* and *Gypsophila cerastioides* is more than grasses and leguminous forbs. It may be due to heavy grazing pressure. These dominant non-leguminous forbs are not preferred by the animals for eating. The results are in conformity with the earlier studies made by Ellison (1960), Singh (1967), Santvan (1993) and Verma *et al* (1008). The overgrazing results in changes in botanical composition which however, varies with the type of vegetation cover, its palatability, forage productivity, the way it is utilized and sequence of climate events (Shankaranarayan, 1977; Kapoor and Singh, 1991) which necessitate suitable strategies for management by regulating the grazing. If suitable steps are not taken well in times, there could be further decline in the density of preferred species of leguminous and non-leguminous forbs.

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