

Floristic Composition and Biological Spectrum of Vegetation in Alpine Meadows of Kedarnath: Garhwal Himalaya

Kusum Pharswan *, J. P. Mehta and Subodh

Department of Botany, Post Box-22, H. N. B. Garhwal University, Srinagar (Garhwal), 246174, India

*kkusumpharswan@gmail.com, Research fellow

Abstract: The present paper gives an account of flora of Kedarnath which have very harsh climatic conditions. 80 species, belonging 36 families were estimated from the study area. Notes on phenological pattern, life form (biological spectrum), plant type and uses have also been studied. Asteraceae was the dominant family (11.25%) recorded under present investigation. The genus and species are arranged alphabetically with in a family with correct nomenclature. The major class of life form was found to be Chamaephytic. Besides Chamaephytes (36.25%), the other life forms enumerated were Therophytes (28.75%), Cryptophytes (18.75%), Hemicryptophytes (11.25%) and Phenerophytes (5%). Most of the plant species had flowering and fruiting in rainy season, followed by summer season and very few species in winter season. [Nature and Science 2010;8(7):109-115]. (ISSN: 1545-0740).

Key words: Kedarnath, life forms, biological spectrum, floristic list, altitude.

Introduction:

Himalaya is a mega diversity centre of world. It supports about 18,440 species of plants, of which 25.3% are endemic to Himalaya (Singh and Hajra, 1997, Samant *et.al.*, 1998). In which most of the plant species are used as medicine and food. High mountain ecosystem are comparatively thrilling and sensitive at least at the upper elevation levels, and are determined by abiotic climate related ecological factors (Gaur *et.al.*, 2005). Species richness increases remarkably partially due to the invasion of plant species from alpine belt (Gottfried, 1998). The well known cause for declining plant species diversity are habitat loss, narrow distribution range, low population size, fragmentation degradation of population and genetic variation (Allen and Allen, 1990; Weekly and Rau, 2001; Vergar *et.al.*, 2003; Kala, 2000, 2005a). To save this precious natural wealth, protected areas have been established and within the Indian Himalaya there are many protected areas that contain rich medicinal plant diversity (Kala, 2005a). KWLS (Kedanath Wild Life Sanctuary) in Uttarakhand state of India is one of the protected area which have a lot of traditional knowledge of medicinal plants and a very high diversity. The flora and its ecological characters such as life forms were studied in this paper. Life form etc. indicates climate and human disturbance of a particular area (Cain & Castro, 1959). Very little work is available on this aspect.

The climatic conditions of alpine zones of India include dense frost, fog, heavy hailstorms, extremely low temperature, high intensity of light and high wind velocity and lower oxygen and carbon dioxide concentration. There is sharp fluctuation regarding these weather conditions, even in the same day. Monthly max and minimum temperature ranges between 24-14 c and 7.5-3 c respectively (Maikhuri *et.al.*, 1998). Comparatively very high rainfall was observed in this area. Average annual rainfall (1475mm) occurs over a short period of two months (July-Aug), featuring a strong monsoonic influence.

The diverse topographic features of the Himalayas sustain an enormous perennial reservoir of vegetation resources (Gaur *et al.*, 1995). The high altitude of this region have unique vegetation due to their diverse geo-morphology which provides different microhabitats for specific plant growth. The alpine vegetation of this part has many characteristic features in connection with the separation zone from timber line, seasonal succession and distributional pattern. On the basis of distribution the alpine plants represent distinct habitats. They are found on exposed dry rocks crevices, ravines and on much fertile loamy soils constituting the alpine meadows (Semwal & Gaur, 1981).

The well known species of this alpine meadow are *Hypericum hookerianum*, *Thalictrum alpinum*, *Angeleca glauca*, *Primula denticulate*, *Gentiana* spp., *Caltha palustris*, *Gagea lutea*, *Anemone*

obtusiloba and species of *Potentilla*, *Polygonum*, *Delphinium* and *Taraxacum officinale* are observed.

Material and Methods:

Study area:

KWLS in Uttarakhand that are situated in central Himalayan region, covers an area of 975 km², which lies between 29° 26' and 31° 38' N latitude and 77° 49' and 80° 6' E, longitude, at an elevation of 1160m to 7068 m.asl in district Rudraprayag (Figure-1). The elevation of study area between 2500m to 4000 m.asl. The slope of the study area is lies between 30-60° and towards the South-East aspect .

The region is rich in bioresources and fascinating folk culture as well as diverse flora and fauna due to its distinct meteorological, geographical,

geological and ecological patterns (Gairola and Biswas, 2008).The alpine habitat usually starts at timberline or the tree line i.e. 3500 m.asl and are characterized by the complete absence of tree. The soil of the Kedarnath valley is dark brown to brown at surface and brown to yellowish brown in the sub soil and endodynamorphic (Singh and Singh, 1992).

For the estimation of vegetation structure and composition random sampling was done taking 0.5 m² quadrates. The size of the sampling plot was arrived at by the method given by Misra (1968). After counting the number of individual species, they were clipped at the ground level and identified. Classification was done as per the Raunkiaer (1934) and species belonging to respective life-form were arranged.

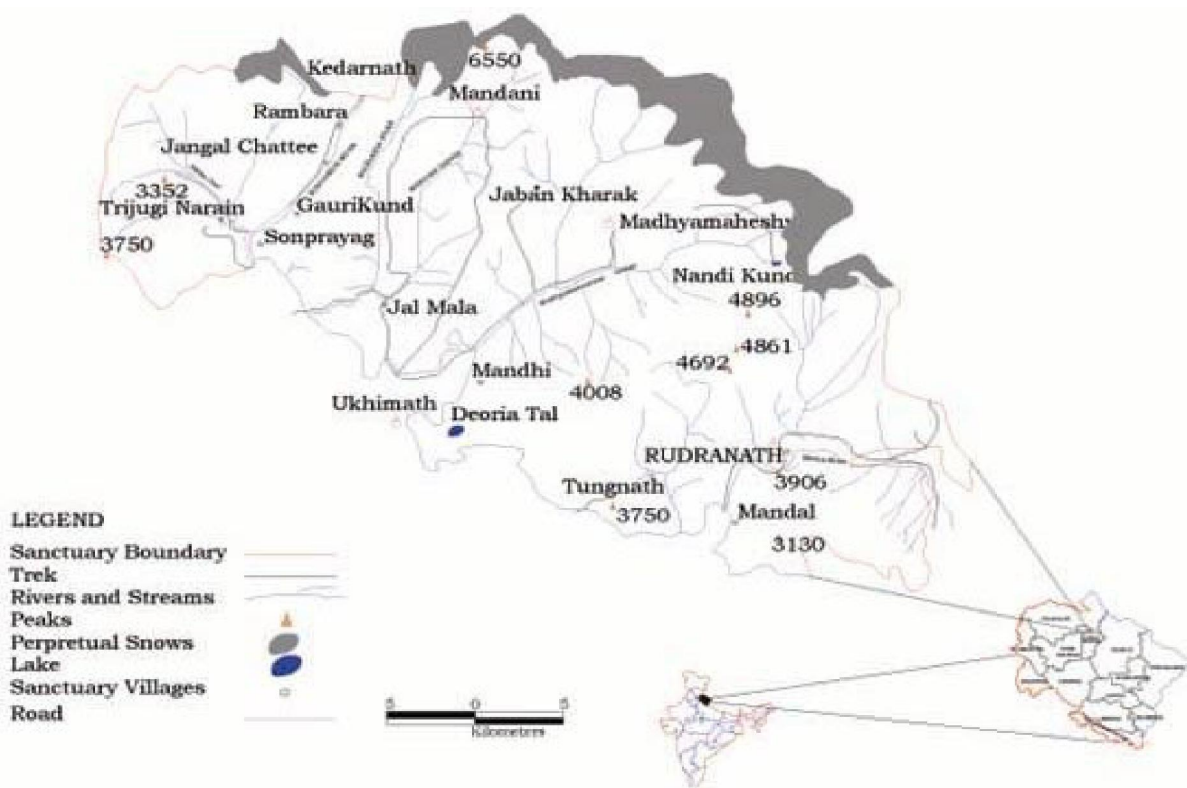


Figure-1. Complete map of KWLS by Semwal *et.al.*

Occurrence of plant species on the study site from May 2009 to October 2009 were recorded and assigned to various life-form classes following Raunkiaer (1934). The percentage life form was calculated as follows :

$$\% \text{ Life-form} = \frac{\text{Number of species in any life form}}{\text{Total number of species of all life forms}} \times 100$$

Result:

A complete list of the plant species encountered in the study area Kedarnath is given in Table-1. There are 80 plant species recorded which belong to 36 families. Monocots represented by six families (Liliaceae, Poaceae, Orchidaceae, Araceae, Amaryllidaceae and Dioscoreaceae) while the remaining thirty families represented the dicots. The dominated families were Asteraceae, 9 spp.(11.25%), Ranunculaceae, 8 spp.(10%), Apiaceae and Poaceae were represented by 5 spp.(6.25%) each, Lamiaceae and Polygonaceae had 4 spp. each. The majority of the species ,67.5% were recorded from 2500 to 4000m. altitude, 17.5% species from below to 2500m. and 15% of the total species have a broad range of occurrence, recorded from 1000 to 4000m. altitude.

The biological spectrum (Figure-2) showed that Chamaephytes, 29spp. (36.25%) and Therophytes, 23spp. (28.75%) were the dominant followed by Hemicryptophytes, 9spp. (11.25%), Cryptophytes, 15spp. (18.75%) and Phanerophytes, 4spp. (5%). The annuals, biennials, perennials and annual-perennials were 13.75%, 1.25%, 72.5% and 12.5% respectively, of the total plant species. There are three distinct climatic season of Kedarnath, rainy season, summer season and winter season. Majority of the plant species having flowering and fruiting in rainy season (50spp., 62.5%), summer season is represented by lesser no plants (18spp., 22.5%) than rainy season and the rest and very low plant species are represent to winter season (12 spp., 15%).

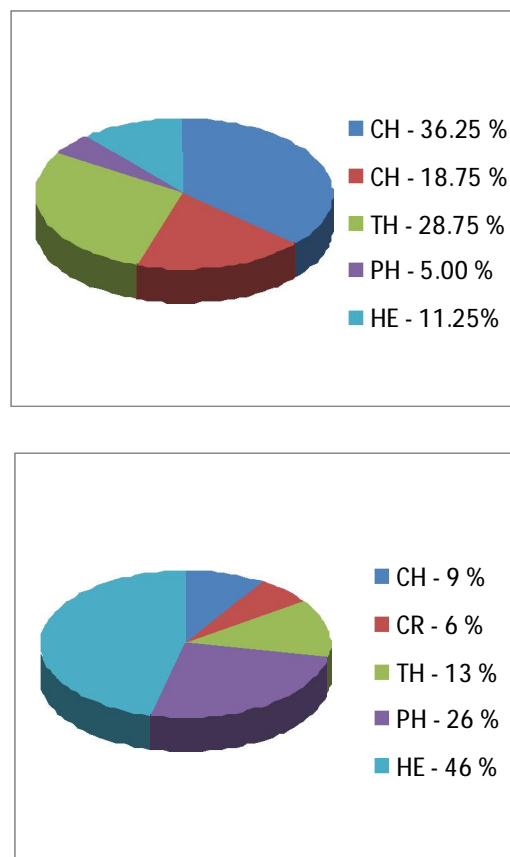


Figure-2. Biological Spectra of Kedarnath Raunkiaer's Normal Spectra

Table 1: List of plant species, life forms, plant type, phenology and medicinal uses encountered in the study area of Kedarnath

S.No	Plants Name	Vern. Name	Family	Altitude	Life-form	Plant Type	Fl-Fr	Part used	Uses
1	<i>Allium corolianum</i>	Faran	Amaryllidaceae	3000-4000	CR	Ann	Jun-Sept	BB, LF	Indigestion, joint pain
2	<i>Allium humile</i>	Faran	-	3000-4000	CR	Pere	June-Aug	LF, BB	Asthma, Jaundice
3	<i>Angelica glauca</i>	Choru	Apiaceae	3000-4000	CH	Pere	Jul-Oct	RT, FR, ST	Flatulence, constipation, bronchitis, gastric, dyspepsia
4	<i>Bupleurum longicaule</i>		-	2800-4900	CH	Pere	July-Sept	RT	RAMP
5	<i>carum carvi</i>	Jangli dhaniya	-	2500-4500	CH	Pere	Jul-Sept	SD	Cold, fever, cough
6	<i>Foeniculum vulgare</i>	Saunf	-	2500-3400	TH	Ann/Pere	Feb-Jun	WP	Vomiting
7	<i>Arisaema flavum</i>	Meen	Araceae	2400-3800	TH	Pere	May-Aug	BB	Skin diseases
8	<i>Arisaema jacquemontii</i>	Khaprya	-	2000-3000	CR	Pere	May-Aug	BB	Ringworm-killer, snakebite
9	<i>Anaphalis lineasis</i>		Asteraceae	3500	TH	Ann	May-Sept		
10	<i>Artemisia capillaries</i>	Marva	-	2400-5600	TH	Pere	Jul-Dec	WP	Hypertension, Typhoid, dyspepsia

11	<i>Artemisia maritima</i>	Pati	-	3000-4000	CH	Pere	Jun-Oct	LF,WP	Cuts, gastric, anthelmintic
12	<i>Artemisia nilagirica</i>	Kunjo	-	3000-3500	CH	Pere	Aug-Oct	LF,WP, AP	Ulcer, Wound, cut
13	<i>Doronicum falconeri</i>		-	3300-4800	TH	Pere	Aug-Sept		
14	<i>Echinops cornigerus</i>	Kandala	-	1000-2500	CH	Pere	Sept-Oct	RT	Urinary trouble, fever
15	<i>Inula cuspidata</i>	Jhuri	-	2000-3400	CH	Pere	Sept-Dec	RT	Dyspepsia, colic
16	<i>Jurinea dolomiacea</i>	Bis-kandara, guggul	-	3200	CH	Pere	Aug-Oct	RT	Colic, sores, antiseptic
17	<i>Taraxacum officinale</i>	Kanphuliya Karatu	-	1800-4200	TH	Pere	Feb-Oct	WP, LF,RT	Blisters, tonic, blood purifier, kidney disorder, migraines,
18	<i>Impatiens scarbida</i>	Ban-til, tillua	Balsaminaceae	2700-3000	TH	Ann/Pere	Jul-Oct	SD	Hair tonic, abortion
19	<i>Cynoglossum glochidiatum</i>	Kuri	Boraginaceae	1500-4000	TH	Pere	Jul-Nov	RT,LF	Wound, Ulcer
20	<i>Arabis amplexinule</i>	Ban-sarsaun	Brassicaceae	2500-3000	TH	Pere	Mar-May	LF	Burns, scratches
21	<i>Cyanthus lobatus</i>		Campanulaceae	3200-4200	CH	Pere	Jul-Oct	RT	Liniment in chronic rheumatism
22	<i>Arenaria orbiculata</i> ,		Caryophyllaceae	1500-3200	HE	Ann/Pere	Mar-Aug		
23	<i>Cerastium cerastoides</i>	Pangein	-	2400-4700	TH	Pere	Apr-Sept	WP	Body ache, Headache, cough
24	<i>Chenopodium ambrasioides</i>	Kirmiri	Chenopodiaceae	2600-3200	TH	Ann/Pere	Aug-Oct		Hook-worm killer, piles
25	<i>Dioscorea deltoidea</i>	Gethi	Dioscoreaceae	Up to 3100	CR	Ann	Jul-Sept	RZ	Rheumatism, spermatorrhoea
26	<i>Goltheria tricophyla</i>	Goltheria (Bhuinla)	Ericaceae	2700-4600	TH	Ann	May-Jul	OL, LF, RT	Rheumatism, simulative, carminative, cough
27	<i>Euforbia stracheyi</i>	Dudhibish	Euforbiaceae	3500	TH	Ann	Jun-Jul	LT	RAMP
28	<i>Androchne cordifolia</i>	Bhatia	-	1000-2500	PH	Pere	Jan-Dec		
29	<i>Indigofera heterontha</i>	Sakina	Fabaceae	1500-3000	NP	Pere	May-Oct	LF,SD	Diarrhea, dysentery
30	<i>Trifolium repens</i>	Tipatiya	-	2300-3500	CR	Pere	Apr-Jul	LF	As astringent
31	<i>Corydalis govaniana</i>	Bhut-keshi	Fumariaceae	3000-4000	CH	Pere	Jul-Sept	RT	Diuretic, liver trouble
32	<i>C.cornuta</i>	Indra-jatta	-	2500-3700	CH	Pere	Jun-Oct	RT	Veterinary medicines
33	<i>Swertia ciliata</i>	Sfed Chirota	Gentianaceae	2000-4000	CH	Ann/Pere	Jul-Oct	WP, RT	Malaria, fever, vermifuge
34	<i>Gentiana argentea</i>		-	Up to 3300	CH	Pere	May-Sept	LF,FL	Sore throat
35	<i>Geranium wallichianum</i>	Ratanjot	Geraniaceae	1800-4200	CH	Pere	Jul-Oct	RT, FL	Dysentery, cough, eye trouble, toothache, ophthalmia
36	<i>Geranium nepalense</i>	Lal jhari	-	1500-4000	HE	Pere	Aug-Nov	WP	Jaundice, ulcer, eczema
37	<i>Hypericum oblongifolium</i>	Peali	Hypericaceae	1500-2500	PH	Pere	Mar-Jul	FL	Wounds, boils, facilitate delivery
38	<i>Hypericum elodeoides</i>	Basanti	-	3200	PH	Pere	Aug-Oct	LF	Tertiary fever
39	<i>Ajuga bracteosa</i>	Neelkanth	Lamiaceae	1200-5100	HE	Pere	May-Aug	LF,RT	Jaundice, malaria, tonic
40	<i>Lucas lanata</i>	Bis-kapra	-	Up to 1800	CR	Pere	Jan-Dec	LF	Wound, check bleeding, heating
41	<i>Micromeria biflora</i>	Ban-ajwain	-	1000-4000	CH	Pere	Aug-Nov	WP, LF	Eczema, cold
42	<i>Stachys sericea</i>		-	2400-3000	CH	Pere	Sept-Nov		

43	<i>Lilium polyphyllum</i>	Kandmul	Liliaceae	1500-3400	CR	Ann	Jun-Jul	BB	Diuretic, antipyretic, tonic
44	<i>Epilobium lactum</i>		Onagraceae	2500-3800	TH	Pere	Jul-Oct	RT	Ringworm
45	<i>Habenaria intermedia</i>	Ridhi-virdhi	Orchidaceae	2800-3200	CR	Pere	Jul-Sept	WP	Tonic
46	<i>Dactylorhiza hatagirea</i>	Hattazari	-	2800-4000	CR	Pere	Jun-Oct	RT, TU	Diarrhea, bone fracture, wounds
47	<i>Oxalis corniculata</i>	Khatti-ghas	Oxalidaceae	Up to 2700	CR	Pere	Feb-Nov	LT,WP	Snakebite, jaundice, wart
48	<i>Meconopsis aculeate</i>	Kalihari	Papaveraceae	3200	CH	Pere	Jun-Sept	WP, RT, LF, FR	Renal pain, fever, colic, wound
49	<i>Plantago major</i>	Isabgol	Plantaginaceae	1200-3300	CR	Pere	Mar-Dec	SD, LF	Fever, Tonic, intestinal injury
50	<i>Cynodon dactylon</i>	Doob	Poaceae	1500-3000	HE	Pere	Jun-Dec	WP	Anti-Abortive, haemostatic
51	<i>Eulatia contorta</i>		-	1500-2600	HE	Ann	Sept-Oct		
52	<i>Festuca gigantean</i>	Tall broom	-	2000-3500	CR	Pere	Aug-Dec	LF	Fodder
53	<i>Heteropogon contortus</i>	Kumra	-	Up to 2600	HE	Ann/Pere	Aug-Dec	RT	Stimulant, diuretic
54	<i>Sporobolus diander</i>	Sitya	-	Up to 1500	CR	Pere	Mar-Sept	LF	Burns, pimples
55	<i>Podophyllum hexandrum</i>	Bankakri	Podophyllaceae	3200-4000	CR	Pere	Apr-Sept	RT, FR, SD, RH	Cancer, skin disease
56	<i>Polygala crotarioides</i>		Polygalaceae	1800-3000	TH	Pere	Apr-Nov	WP,RT	Catarrhal affections, cough
57	<i>Polygonum amplexicaule</i>	Kutrya	Polygonaceae	2500-3000	CH	Ann/Pere	Jul-Sept	RT,LF	Stomach trouble, wound, cough.
58	<i>P. vacciniifolium</i>	Inuri	-	3000-3600	CH	Ann/Pere	Jul-Aug		
59	<i>P. macrophyllum</i>	Kukhri	-	3000-3400	CH	Ann	Jul-Oct	WP	RAMP
60	<i>Rheum emodii Wall.ex.</i>		-	3200	CH	Pere	Jun-Jul	RZ/RT	Asthma, abdominal pain, fever
61	<i>Androsace rotundifolia</i>		Primulaceae	2000-3000	TH	Pere	Jun-Sept	ST	Stomach pain
62	<i>Primula denticulata</i>	Jalkutra	-	3100	TH	Pere	Apr-Jul	LF, RT, FL	Urinary problems, cough, cold
63	<i>Aconitum heterophyllum</i>	Meeth Bish	Ranunculaceae	3350-4500	CH	Pere	Aug-Nov	RT, TU	Diarrhea, vomiting, digestive disorder, cough
64	<i>Aconitum balfourii</i>	Meeth bish	-	3300-4100	HE	Bi	Aug-Nov	TU	Neuralgia, paralysis, rheumatic fever
65	<i>Animone obtusiloba</i>	Kanch-phool	-	3400-4200	CH	Pere	May-Aug	RT, SD	Rheumatism, diarrhea
66	<i>Animone rivularis</i>	Mirchile Angeli	-	1600-4000	CH	Pere	Jun-Oct	LF, WP, RT	Ear pain, fever, bone fracture
67	<i>Caltha palustris</i>	Kushnya	-	2500-4200	TH	Pere	Jul-Sept	WP, FL	Warts, anemia, tincture, diuretic
68	<i>Delphinium denudatum</i>	Nirbishi	-	2000-3500	TH	Ann/Pere	Apr-Nov	RT	Ulcer, cold, cough
69	<i>Ranunculus hirtellus</i>	Simariya	-	2800-3600	CH	Ann/Pere	Jul-Sept	ST,LF	Anthelmintic, wounds
70	<i>Thalictrum alpinum</i>		-	3000-4000	CH	Pere	Jul-Aug	RT,LF	Fever
71	<i>Duchesnia indica</i>	Bhikafal	Rosaceae	Up to 2500	HE	Ann	Apr-Jun	LF,FL,RT	Leucoderma, diarrhea
72	<i>Potentilla fulgens</i>	Bajra-danti	-	1500-3000	TH	Pere	Jul-Nov	LF, RT	Toothache, urinary disorder, burns
73	<i>Potentilla nepalensis</i>		-	1800-3000	TH	Pere	Jul-Oct	RT	Burns
74	<i>Galium aparine</i>	Kuri	Rubiaceae	3000-4000	CH	Ann	Aug-Sept	WP,LF	Ant scorbutic, skin disease
75	<i>Bergenia ciliata</i>	Pashanbhed	Saxifragaceae	2000-3600	TH	Pere	Jun-Sept	RZ	Febrifuge, digestive disorder

76	<i>Saxifraga brachipoda</i>		-	3000-4500	CH	Pere	Jul-Dec		
77	<i>Valeriana jatamansi</i>	Samewa	Valerianaceae	2000-3000	CR	Pere	Mar-Jun	RT,LF,FL	Epilepsy, hysteria, mental disorder
78	<i>Nardostachys grandiflora</i>	Jata-mansi	-	3400-5000	CH	Pere	Jun-Oct	RZ, WP	Hysteria, Epilepsy, Diuretic, blood purifier
79	<i>Viola biflora</i>	Bana-ksha	Violaceae	2300-3600	HE	Ann	Jun-Aug	RT, FL, WP, LF	Emetic, constipation
80	<i>Viola betonicifolia</i>	Banfasa	-	3000	HE	Ann	Aug-Sept	LF,WP	Blood disease, diaphoretic

CH-Chamaephytes, TH-Therophytes, CR-Cryptophytes, HE-Hemicryptophytes, PH-Phanerophytes, Ann-annual, Bi-biennial, Pere-perennial, WP-whole plant, LF-leaf, FL-flower, RZ-rhizome, RT-root, TU-tuber, SD-seed, FR-fruit, BB-bulb, OL-oil.

Discussion:

The analysis of the flora of the study area indicates that the meadows are affected by intense biotic interference. The number of Chamaephytes is maximum while that of Phanerophytes is minimum. According to the biological spectrum given by Raunkiaer (1934), the flora of the present meadows may be called as the Chamaephytic. The high percentage of Chamaephytes characterized the colder climate and high altitude (Braun-Blanquet, 1932). But Hagerup (1931) explained that higher percentage of Thamaephytes is an indication of semi-desert condition at altitude. Chamaephytes were followed by Therophytes which indicate that heavy biotic pressure due to grazing and men's interference.

Nearly thirty species from the Garhwal Himalaya have been listed in various categories under threat in the Indian Red Data Book (Nayar and Sastry, 1887-90), of which 24 species are from high altitude alpine regions. Recently, Rawat *et.al.* (2001) listed 45 more species (excluding Red Data Books) which need special attention for conservation and this list also contains as many as 30 species from high altitudes, for example *Aconitum heterophyllum*, *Angelica glauca*, *Arnebia benthamii*, *Dactylorhiza hatagirea*, *podophyllum hexandrum* and *picrorhiza kurrooa*, all possessing high medicinal demands and thus are over-exploited from the wild.

Acknowledgment:

Authors are grateful to Head of the Department, Department of Botany for providing laboratory facilities and encouragement.

Corresponding to:

Kusum Pharswan
Department of Botany, Post Box-22,
H. N. B. Garhwal University,
Srinagar (Garhwal), 246174, India
Phone No- 9410952673
Emails- kkusumpharswan@gmail.com

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