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INVENTORYING AND MONITORING OF ALPINE SPECIFIC GENERA AND SPECIES OF HARAMOSH AND BAGRAOTE VALLEYS., (KARAKORAM RANGE) GILGIT-BALTISTAN, PAKISTAN

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Inventorying and monitoring work on alpine specific flora of Haramosh and Bagrote valleys (Gilgit-Baltistan) was done for fourteen years from 2001-2014. The fourteen years inventorying revealed a rich alpine exclusive species consisting of 105 species in 52 genera and 21 families of Angiosperms. The Alpine zone had 13 genera with 3 or more alpine exclusive species; *Potentilla* and *Carex* with 9 species each were the largest genera of this zone, followed by and *Draba* (8 species) *Rhodiola* 5 species etc. Genera containing 9 or 10 species occurred only in Alpine zone which are specific to extreme alpine habitat. The exclusive Alpine flora of both valleys formed 45.25% of the total alpine flora. Although the total number of species was the highest in the Sub-alpine zone, but in the species specific to any one zone, the Alpine zone had the highest number, that is, 105 of the total 232 species were exclusively found in this zone only. Like species, 22 genera out of 52 were exclusively found in alpine zone only. The Alpine zone was characterized by herbs and low shrubs, with *Potentilla* species as the dominants. A clear trend of migration of certain species both from lower to higher latitudes and altitudes was observed. *Bistorta affinis* and *Potentilla* species were observed that are grazing resistant and drought resistant species of the alpine zone were upward shifted from subalpine zone in both valleys during the last fourteen years. Beside these dominant and grazing resistant species some other species like *Saussurea simpsoniana*, *Corydalis* spp., *Pulsatilla wallichiana*, *Anemone rupicola*, *Allium* spp., *Silene gonosperma*, *Aconogonon* spp., *Primula* spp., were upward shifted within the alpine zone and some are completely shifted from subalpine zone. *Anemone rupicola*, *Pulsatilla wallichina* and *Aconogonon* spp. were completely shifted from lower zone to alpine zone of both valleys. The species richness index of Alpine zone however showed increasing trend probably due to species migrations towards the alpine zone.

Keywords: Karakoram Range, alpine species, floristic survey, biodiversity, ecosystems.

INTRODUCTION

Both valleys are the part of the Karakoram range that lying in the north-eastern side of the capital city Gilgit (Fig. 1) between 35.50 - 36.5° N latitude and 74.54° E longitude, covering an area of 2340 sq.km (Khan and Khatoon, 2007). The alpine zone has a fragmental and highly scattered distribution over the mountain system of the Karakoram Range. The large alpine areas are concentrated in the upper villages of both valleys with more than 60 mountain peaks acceding 4000m. The area is surrounded by high mountains of the Karakoram, Himalayas and Hindukush Ranges (Perkin, 2003). Both valleys are the part of the Eastern Irano-Turanian sub-region. This sub-region is confined to the northern mountainous region of Pakistan and Kashmir between 35°-36° NL (Ali and Qaiser, 1986). The alpine zone includes the upper most reaches of the entire region from 3500m to permanent snow line. The word "Alpine" is normally used to denote a mountainous region above the tree-line or timber-line, lacking tree habitation (Noroozi *et al.*, 2008), but abounding in low herbs and a few shrubs. Inventorying of biodiversity is the baseline study for the exploration of the earth surface and conservation, sustainable use, and management of the biodiversity elements and monitor changes over the passage of time, (Stork and Samways, 1995). Thus, baseline inventorying and monitoring information is a necessary first step in conservation of biodiversity elements. During an inventory of a region the collected voucher specimens are crucial to obtain accurate identification of plants present in a study area (Dugan *et al*., 2007). All living beings obtain their life support material from their environment. The twentieth century was the warmest century, and 1990 to 2000 was the warmest decade, of the past millennium (Hardy, 2003) and warming trends have been

observed in the elevated regions such as the Himalayan-Tibetan region, leading to the retreat of glaciers (Ramanathan, 2007). During just the last 150 years, the earth's global average temperature has increased by about 0.8°C and at higher latitudes has increased by several degrees Celsius (Dodd, 1994). In fact, the last decade of the twentieth century was the warmest in the entire global instrumental record. Changes in species diversity occur naturally overtime in all communities and ecosystems. Species based monitoring documents to establish a baseline data for understanding the impact of natural disturbance on species composition and abundance in ecosystem (Watson and Novelly, 2004). The floristic inventories play a significant role in increasing our understanding and information level on availability of resources and its relationship with the mankind. This study aims at finding out the exclusive alpine plant species and genera of the both valleys of district Gilgit and enumerates the dominant alpine specific genera and species in alpine zones of the area. The documentation of alpine species and characterization of their altitudinal ranges is based on Flora of Pakistan and our own field surveys.

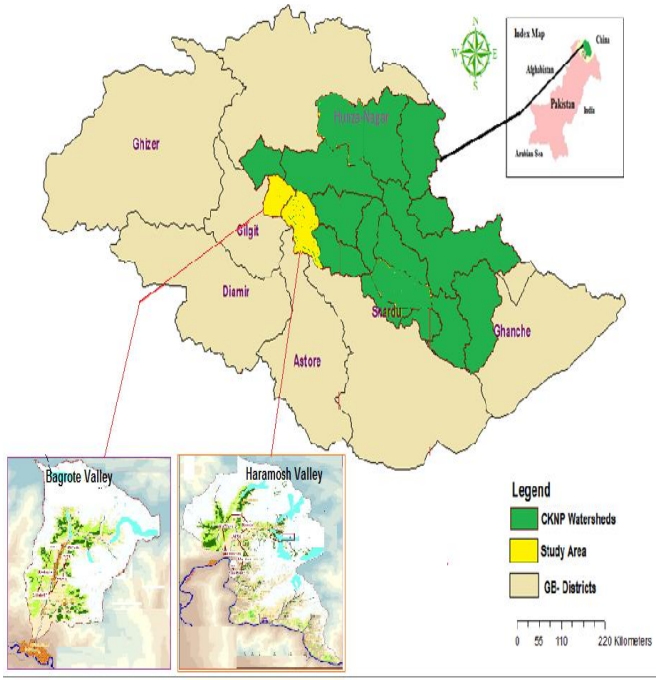

Figure1. Map of the study area.

MATERIALS AND METHODS

The present study was mainly focused on the extreme alpine ecosystem and habitats of Haramosh and Bugrote valleys of Gilgit–Baltistan, Pakistan. An intensive floristic survey was carried out during the summer months i.e. from April to September 2001-2014, for the collection and identification of plants in various habitats between the altitudinal ranges of 3500-4800m. The area surveyed including various alpine pastures, stream and spring banks, late lying snow patch areas and moist alpine rocky places etc. Extensive field information was collected based on habit, habitat, altitude and abundance. To collect the maximum information on aspects of flora, field notes regarding the plant distribution pattern, composition, altitudinal aspect and topographic condition were noted down. For the study of herbaceous communities and their altitudinal distribution of different species, the altitude of every species was recorded with the help of GPS. The collected plant specimens from various localities of both valleys were identified with the help of Flora of Pakistan (Nasir and Ali, 1970-89; Ali and Nasir, 1989-1991; Ali and Qaiser, 1993-2012), Stewart (1972), some other relevant Floras of the neighboring countries, and also by comparing with the authentic specimens available in the Karachi University Herbarium. After identification voucher specimens have been housed in the Karachi University Herbarium (KUH) and newly established Karakoram International University Herbarium. During the first two years, i.e. 2001 and 2002, an inventory of plant species was prepared on the basis of thorough collection of specimens in the study area; to serve as the base-line for monitoring. Monitoring was done during 2003 to 2007 through random sampling by quadrat method. Twenty quadrats from the selected sites were taken each year in alpine zone. Square-shaped quadrats of 1 x 1 m were taken in the selected sites of Alpine zones. The number of individuals of each species in each quadrat was counted and their basal area measured. From above information the following attributes were calculated: relative frequency (RF), relative density (RD), relative cover (RC) and importance value index (IVI) = RC+RD+RF. Life- form categories of Raunkiaer's system (Raunkiaer, 1934), as presented by Ellenberg *et al.* (1991) were accepted.

RESULTS

A total of 103 exclusively alpine species including 22 monocot and 81 dicot species were identified from alpine zone of both valleys representing 52 genera and 21 families of Angiosperms (Table 1). The habits of these 103 plant species comprised 2 annuals, 2 small shrubs and 99 perennial herbs. The alpine specific species diversity comprised 45.25% of alpine flora and 18.75% of the entire flora 560 species reported from both valleys. High altitude regions are characterized by cold and arid climate and landscapes of many microhabitats, exhibiting a vegetation of specific adaptation results in a peculiar life form of alpine species (Kumar and Sharma, 2013). Both valleys with temperate and alpine climate provide a suitable habitat for the growth of alpine plant species. The dominant families with more than 5 exclusive alpine species in both valleys of Karakoram range were Asteraceae with 16 species) followed by Ranunculaceae

(with 11 species), Brassicaceae, Rosaceae and Cyperaceae (with 10 species each), Scrophulariaceae (7 species), Crassullaceae and Apiaceae (with 5 species each) whereas the dominant exclusive alpine genera were *Potentilla* and *Carex*

Table 1. Distribution of Alpine specific plants, their, life form, habit, altitude and palatability.

S#	Family	Name of species	Habit	Life form	Altitude	Remarks	Medicinal value	Palatability
1	Alliaceae	*Allium carolinianum* DC.	P	G	3600m	C	Low medicinal value	LP
2	Alliaceae	*Allium oreoprasum* Schrenk	P	G	3700m	Inf.	Not known	LP
3	Apiaceae	*Pleurospermum candollei* (DC.) C.B.Clarke.	P	H	4000m	C	High medicinal value	HP
4	Apiaceae	*Pleurospermum hookeri* var. *thomsonii* Clarke	P	H	4000m	C	Low medicinal value	HP
5	Apiaceae	*Pleurospermum stellatum* Benth. var. *lindleyanum* (Kl.) C.B.Clarke	P	H	4000m	C	Not known	HP
6	Apiaceae	*Pleurospermum stylosum* Clarke	P	H	3600m	C	Not known	HP
7	Apiaceae	*Vicatia coniifolia* DC.	P	H	4000m	C	Not known	LP
8	Asteraceae	*Achillea millefolium* L ssp. *Millefolium*	P	H	3700m	Inf.	Low medicinal value	NP
9	Asteraceae	*Allardia glabra* Decne.	P	H	3900m	C	Not known	NP
10	Asteraceae	*Allardia nivea* Hook.f.& Thomson ex C.B. Clarke	P	Ch	4100m	Inf.	Not known	NP
11	Asteraceae	*Allardia stoliczkae* C.B.Clarke	P	H	4200m	Inf.	Not known	NP
12	Asteraceae	*Allardia tridactylites* (Kar.& Kir.) Schultz-Bip.	P	Ch	4200m	Inf.	Not known	NP
13	Asteraceae	*Aster peduncularis* Wall.ex Nees	P	H	4000m	C	Not known	LP
14	Asteraceae	*Cicerbita* sp. nov.	P	H	4000m	C (endemic)	Not known	LP
15	Asteraceae	*Cremanthodium decaisnei* Clarke	P	H	4400m	C	Not known	LP
16	Asteraceae	*Doronicum falconeri* Clarke	P	H	3800m	RR	Not known	LP
17	Asteraceae	*Erigeron alpinum* L.	P	H	3600m	C	Not known	LP
18	Asteraceae	*Hippolytia.dolichophylla* (Kitam.) Bremer & Humphries	P	H	3600m	Inf.	Not known	LP
19	Asteraceae	*Saussurea falconeri* Hook.f.	P	H	4000m	Inf.	Highly medicinal value	LP
20	Asteraceae	*Saussurea jacea* (Klotz.) Clarke	P	H	3900m	Inf.	High medicinal value	LP
21	Asteraceae	*Saussurea simpsoniana* (Field & Gardner) Lipschitz.	P	H	4800m	Inf.	highly medicinal value	NP
22	Asteraceae	*Senecio graciliflorus* DC.	P	H	4000m	Inf.	Not known	LP
23	Asteraceae	*Tanacetum falconeri* Hook.f.	P	H	3600m	C	Highly medicinal value	LP
24	Brassicaceae	*Arabidopsis mollissima* (C.A Mey.) N.Busch	P	H	4000m	C	Not known	LP
25	Brassicaceae	*Draba altaica* (C.A.Mey.)Bunge	P	H	4200m	C	Not known	LP
26	Brassicaceae	*Draba cachemirica* Gandoger	P	H	4000m	C	Not known	LP
27	Brassicaceae	*Draba lanceolata* Royle	P	H	4000m	Inf.	Not known	LP
28	Brassicaceae	*Draba melanopus* Komarov	P	H	4000m	C	Not known	LP
29	Brassicaceae	*Draba oreades* Schrenk	P	H	4200m	C	Not known	LP
30	Brassicaceae	*Draba setosa* Royle	P	H	4200m	C	Not known	LP
31	Brassicaceae	*Draba stenocarpa* Hook.f. & Thoms.	P	H	4200m	C	Not known	LP
32	Brassicaceae	*Draba tibetica* Hook.f. & Thoms. var. *chitralensis* (Schultz) Jafri	P	H	4000m	C	Not known	LP
33	Brassicaceae	*Thlaspi andersonii* (Hook. f. & Thom.) O. E. Schulz+	P	H	4000m	R	Not known	LP
34	Campanulaceae	*Adenophora himalayana* Feer	P	H	3700m	C	Not known	NP
35	Caryophyllaceae	*Silene gonosperma* (Rupr.) Bocquet ssp. *himalayensis* (Rohrb.) Bocquet	P	H	4000m	Inf.	Not known	NP
36	Crassulaceae	*Rhodiola heterodonta* (Hook. f. & Thom.) Boriss.	P	H	4000m	C	Not known	NP
37	Crassulaceae	*Rhodiola quadrifida* (Pallas) Schrenk	P	H	4000m	C	Not known	NP
38	Crassulaceae	*Rhodiola recticaulis* Boriss.	P	H	4000m	C	Not known	NP
39	Crassulaceae	*Rhodiola tibetica* (Hook.f. & Thom.) S.H.Fu	P	H	3800m	C	Not known	NP
40	Crassulaceae	*Rhodiola wallichiana* (Hook.f.) S.H.Fu	P	H	3700m	C	Not known	NP
41	Cyperaceae	*Carex canescens* L.	P	H	4000m	CC	Not known	HP
42	Cyperaceae	*Carex cardiolepis* Nees	P	H	4000m	C	Not known	HP
43	Cyperaceae	*Carex cruenta* Nees	P	H	4300m	C	Not known	HP
44	Cyperaceae	*Carex divisa* Huds.	P	H	4000m	C	Not known	HP
45	Cyperaceae	*Carex melanantha* C. A. Mey.	P	H	3800m	C	Not known	HP
46	Cyperaceae	*Carex nivalis* Boott	P	H	4100m	C	Not known	HP
47	Cyperaceae	*Carex obscura* Nees	P	H	4300m	C	Not known	HP
48	Cyperaceae	*Carex oligocarya* C.B.Clarke	P	H	4000m	C	Not known	HP
49	Cyperaceae	*Carex pseudofoetida* ssp. *afghanica* Kukkonen	P	H	4100m	C	Not known	HP
50	Cyperaceae	*Eleocharis quinqueflora* (F.X.Hartm.) O.Schwarz	P	H	3800m	CC	Not known	HP
51	Ericaceae	*Rhododendron hypenanthum* Balf. f.	Sh	Ph	3600m	C	Low medicinal value	NP
52	Fumariaceae	*Corydalis falconeri* Hook.f. & Thoms.	P	Ch	4000m	C	Low medicinal value	LP
53	Fumariaceae	*Corydalis gortschakovii* Schrenk	P	Ch	4000m	C	Low medicinal value	LP
54	Liliaceae	*Gagea lowariensis* Pascher	P	G	3800m	C	Not known	LP
55	Liliaceae	*Gagea spumosa* Levichev	P	G	4200m	C	Not known	LP
56	Liliaceae	*Lloydia serotina* (L.) Rchb.	P	G	4000m	C	Not known	LP
57	Papaveraceae	*Papaver nudicaule* L.	A	Th	4000m	C	Not known	LP
58	Poaceae	*Agrostis gigantea* Roth	P	Ch	3650m	C	Not known	HP
59	Poaceae	*Alopecurus himalaicus* Hook.f.	P	H	4000m	Inf.	Not known	HP
60	Poaceae	*Festuca alaica* Drobov	P	H	4000m	C	Not known	HP
61	Poaceae	*Festuca alatavica* (St.-Yves) Rozhev.	P	H	4000m	C	Not known	HP
62	Poaceae	*Phleum alpinum* L.	P	H	4000m	C	Not known	HP
63	Poaceae	*Poa alpina* L.	P	H	4000m	C	Not known	HP
64	Polygonaceae	*Aconogonon coriarium* (Grig.) Sojak.	P	Ch	4000m	C	Not known	LP
65	Polygonaceae	*Aconogonon tortuosum* (D.Don) Hara var. *tibetanum* (Meisn.)S.-P.Hong	P	Ch	4000m	Inf.	Not known	LP
66	Polygonaceae	*Aconogonon tortuosum* (D.Don) Hara var. *tortuosum*	P	H	4000m	Inf.	Not known	LP
67	Primulaceae	*Cortusa brotheri* Pax ex Lipsky	A	Th	3600m	C	Not known	LP

S#	Family	Name of species	Habit	Life form	Altitude	Remarks	Medicinal value	Palatability
68	Primulaceae	*Primula reptans* Hook.ex Watt	P	H	4200m	C	Not known	NP
69	Ranunculaceae	*Aconitum violaceum* Jacq. ex Stapf var. *weileri* (Gilli) H.Riedle	P	G	3700m	Inf. (endemic)	High medicinal value	LP
70	Ranunculaceae	*Aconitum violaceum* Jacq.ex Stapf var. *violaceum*	P	G	3600m	Inf.	High medicinal value	LP
71	Ranunculaceae	*Aquilegia moorcroftiana* Wall.ex Royle var. *moorcroftiana*	P	H	3600m	C	Not known	LP
72	Ranunculaceae	*Anemone rupicola* Camb.	P	H	3650m	C	Not known	LP
73	Ranunculaceae	*Callianthemum pimpinelloides* (D.Don ex Royle) Hook.f. & Thoms.	P	H	4200m	C	Not known	LP
74	Ranunculaceae	*Delphinium brunonianum* Royle	P	H	4000m	C	High medicinal value	LP
75	Ranunculaceae	*Delphinium pyramidale* Royle	P	Ch	4200m	C	High medicinal value	LP
76	Ranunculaceae	*Delphinium vestitum* Wall.ex Royle	P	H	4300m	Inf.	High medicinal value	LP
77	Ranunculaceae	*Isopyrum anemonoides* Kar. & Kir.	P	H	4000m	C	Not known	NP
78	Ranunculaceae	*Paraquilegia anemonoides* (Willd.) Ulbr.	P	H	3600m	Inf.	Not known	NP
79	Ranunculaceae	*Ranunculus stewartii* H.Riedl	P	H	4000m	Inf.	Not known	NP
80	Rosaceae	*Cotoneaster uniflora* Bunge	Sh	Ph	3600m	R	Not known	LP
81	Rosaceae	*Potentilla anserina* L.	P	H	3700m	CC	Not known	LP
82	Rosaceae	*Potentilla argyrophylla* Wall.ex Lehm.	P	H	3600m	C	Not known	HP
83	Rosaceae	*Potentilla atrosanguinea* Lodd.	P	H	3600m	C	Not known	HP
84	Rosaceae	*Potentilla doubjouneana* Camb.	P	H	3700m	C	Not known	HP
85	Rosaceae	*Potentilla eriocarpa* Wall.ex Lehm.	P	H	3600m	C	Not known	HP
86	Rosaceae	*Potentilla gelida* C.A.Mey.	P	H	3600m	C	Not known	HP
87	Rosaceae	*Potentilla gerardiana* Lindl.ex Lehm.	P	H	3700m	C	Not known	HP
88	Rosaceae	*Potentilla multifida* L.	P	H	3600m	C	Not known	HP
89	Rosaceae	*Potentilla turezainowiana* Stesh.	P	H	3700m	Inf.	Not known	HP
90	Saxifragaceae	*Saxifraga flagellaris* Willd.ex Sternb ssp. *stenophylla* (Royle) Hulten.	P	H	4000m	C	Not known	LP
91	Saxifragaceae	*Saxifraga jacquemontiana* Decne.	P	H	4200m	Inf.	Not known	LP
92	Saxifragaceae	*Saxifraga pulvinaria* H. Smith	P	H	4200m	Inf.	Not known	LP
93	Saxifragaceae	*Saxifraga sibirica* L.	A-B	Th	3700m	Inf.	Not known	LP
94	Scrophulariaceae	*Lagotis kunawurensis* (Royle) Rupr.	P	H	3800m	C	Not known	LP
95	Scrophulariaceae	*Pedicularis albida* Penn.	P	H	3700m	C	Not known	LP
96	Scrophulariaceae	*Pedicularis multiflora* Pennell	P	H	3600m	C	Not known	LP
97	Scrophulariaceae	*Pedicularis pyramidata* Royle	P	H	3600m	C	Not known	LP
98	Scrophulariaceae	*Pedicularis tenuirostris* Benth.	P	H	3700m	C	Not known	HP
99	Scrophulariaceae	*Veronica alpina* L.	P	H	4400m	C	Not known	HP
100	Scrophulariaceae	*Veronica macrostemon* Bunge ex Ledeb.	P	H	4000m	Inf.	Not known	HP
101	Valerianaceae	*Valeriana hardwickii* Wall.var. *hoffmeisteri* (KI.) Clarke	A	Th	4000m	C	High medicinal value	LP
102	Valerianaceae	*Valeriana jaeschkei* C.B.Clarke	P	H	4000m	C	High medicinal value	LP
103	Valerianaceae	*Valeriana pyrolifolia* Decne.	A	Th	4200m	C	High medicinal value	LP

Abbriviation: T= Tree, Sh =Shrub, P =Perennial, B = Biennial, A = Annual, Ph = Phanaerophytes, Ch = Chamaephyte, H = Hemicryptophyte, Th = Therophyte, G = Geophyte, Hy = Hydrophyte, CC = Very common, C = Common, Inf. = Infrequent, R = Rare, RR = Very Rare, HP= High palatable, LP= low Palatable, NP= Non palatable

Table 2. The dominant families of exclusively alpine species and dominant exclusive alpine genera and the life-form categories in the alpine zone of both valleys.

Sr.	Families	No. of Spp.	Genera	No. of Spp.	Life-form	%
1	Asteraceae	16	*Carex*	9	Hemicryptophyte	85 (80.95%)
2	Ranunculaceae	11	*Draba*	8	Therophyte	5 (4.76%)
3	Rosaceae	10	*Rhodiola*	5	Phanaerophytes	2 (1.90%)
4	Cyperaceae	10	*Pleurospermum*	4	Geophyte	5 (4.76 %)
5	Brassicaceae	10	*Delphinium*	3	Chamaephyte	8 (7.61%)
6	Scrophulariaceae	7	*Aconitum*	2		
7	Poaceae	6	*Pseudomertensia*	2		
8	Crassulaceae	5	*Gagea*	2		
9	Apiaceae	5	*Festuca*	2		
10	Saxifragaceae	4				
11	Polygonaceae	3				
12	Liliaceae	3				
13	Valarianaceae	3				

(with 9 species each), followed by *Draba* (8 species) and *Rhodiola* (with 5 species) (Table 2). The flora of the both valleys has close affinities with the flora of Himalayas. The altitudinal distribution of exclusively alpine species in both valleys shows highest number of 80 species in the lower habitats from 3600-4000m of alpine zone and 25 species were distributed in the high altitudes habitats more than 4000m. Out of 103 species identified 20 and more species were being used to cure different diseases. These 20 species have highly medicinally importance among the peoples of both valleys.

The area is belongs to the Irano-Turanian region where the rate of endemism is generally high in upper areas, where 3 exclusively alpine endemic and 25 infrequent species were found, while the rate of endemism is low in lower areas of this zone. *Rhododendron* is the only species being widespread in north and west facing slopes of alpine zone. A very rare species *Doronicum falconeri* was also found in this zone. During last 13 years only few individuals of this species were seen in the alpine zone of Haramosh valley. Thus, the topography and micro-climate of a particular region may determine the vegetation pattern. In such cases, the herbaceous flora is a helpful aid in recognizing the alpine zone.

DISCUSSION

The present study was focused only on the alpine exclusive species and genera of Haramosh and Bagrote valleys of the Karakoram Range above tree line. During the study we identified 103 exclusively alpine species belongs to 52 genera and 21 families of Angiosperms. Among the 21 families, 4 families were represented by only one species each, 12 families had 2 to 7 species each, while only 5 families contained 10 or more species. Collectively these 5 larger families had 57 species (52.28% of the total species) and 25 genera of Alpine flora belonged to these families. Like species genera were also found to exclusive in alpine zone. The study revealed that herbs appear to be dominant with 103 species i.e. 98.09%; shrubs are represented by 2 species (1.90%). The ratio of Monocots was found 20.95% while dicots 79.04% found at species level. This shows that the diversity of Dicots in comparison to that of monocots is much higher in the study area. The dominant species found in this region are those which can tolerate the grazing pressure and grow in dry habitats in open sunny slopes of alpine pastures. The widely distributed species of alpine zone are mostly belongs to the families like Asteraceae Rosaceae, Gentianaceae, Scrophulariaceae, Polygonaceae, Cyperaceae, Brassicaceae, and Poaceae, etc. Therefore, the present study has revealed that the area provides suitable habitat for the species of *Potentilla*, *Bistorta*, *Pedicularis*, *Geranium*, *Gentianoides* and *Aster*, etc. The alpine meadows of both valleys are dominated by members of family Cyperace, such as *Carex divisa*, *Eleocharis quinqueflora, Kobresia laxa and Carex pseudofoetida* in all the moist and open meadows of alpine zone up to snow belt. The Cyperaceae mats play a vital environmental role of protecting large alpine areas against erosion (Miehe *et al.,* 2008). In the Alpine zone Asteraceae was floristically rich family containing 16 alpine exclusive species, followed by Ranunculaceae with 11 alpine specific species and Brassicaceae, Rosaceae and Cyperaceae were floristically the third large families with 10 species each. Like the larger families, the larger genera also showed a tendency to be more concentrated towards the higher altitudes. In the Alpine zone, 37 species belonged to 9 of these alpine exclusive larger genera, constituting 35.23% of the total alpine exclusive species of this zone. Similarly, Hemicryptophytes were found to dominant in Alpine specific flora. The alpine zones are frequently rich in species of hemicryptopytes (Naroozi *et al.,* 2008). The perennial herbs formed 93.33% of the Alpine flora while Anuual/Biennial herbs formed 4.76% and Phanerophytes were only 1.90% of the Alpine exclusive flora. In the Alpine zone, species of *Potentilla, Carex, Eleochris* etc. were dominant. It was observed that *Potentilla* species were not only grazing-resistant but also efficient in reproduction, and so were the *Bistorta* species. Therefore, these species seem to increase in response to grazing pressure by the livestock. Due to rising temperature, the migration of species from Subalpine to Alpine zone has been recorded, while some Alpine species like *Saussurea simpsoniana* have now become restricted to the upper most part of their distributional ranges. It was observed that the species of lower margins such as *Corydalis* spp. *Veronica alpina, Cremanthodium decaisnei* etc. were migrating upwards and dislodging *Saussurea simpsoniana* from its habitat continuously. There is a proof of an ongoing upward migration, a decline of subnival–nival species at their lower range limits in the Alps (Pauli *et al*., 2007) and the lower elevations may support an upward migration motivated by climate change (Noroozi, *et al.* 2011). According to fourteen years observation *Potentilla atrosanguinea*, *Potentilla anserina, Bistorta affinis, Aconogonon alpinum, Silene gonosperma, Papaver nudicaule, Anemone rupicola, Primula elliptica, Allium oreoprasum, Pulsatilla wallichiana,* were found to upward shift from sub alpine to alpine zone. The accumulation of larger genera and zone-specific species into the Alpine zone had been due to their gradual migration from the lower altitudes over the decades. Such type of studies from the other parts of the world have documented or predicted the migration of species in response to global warming. Lenior *et al*. (2008) reported 171 forest species of W. Europe upward shifted an average 29 meter per decade from 1986 to 2005. As observed in the present study, there is a high number of genera and species that are exclusively found in the Alpine zone of the study area. Climate change has strongly influenced distribution and abundance of plants at range margins both in latitude and elevation (Tryjanowski, 2005; Hickling *et al.,* 2006). In the five years of monitoring, some species, particularly the dominant ones, continued to increase their IVI values, but several others decreased and some disappeared from their habitats. The alpine zone was dominated by *Potentilla atrosanguinea, Potentilla anserina Carex divisa, Geranium pratense* and *Eleocharis quinqueflora.* The first three species increased their IVI over the years, while *Geranium pratense* decreased and *Eleocharis quinqueflora* remained more or less same. Two other species *Alchemilla ypsilotoma* and *Nepeta nervosa* were not found during the first one and two years of monitoring, respectively.

However, after their appearance they continued to increase their IVI values. *Primula denticulata, Allardia glabra, Euphorbia micractina, Pyrola rotundifolia, Pusatilla wallichiana* and *Anemone rupicola* showed sharp decrease, and the last two were not found in the fifth year of monitoring (Table 3). Loarie *et al.* (2008) suggest that climate change has the potential to break up local floras resulting in new species mixes, with consequent novel patterns of competition and other biotic interactions. Similarly, the distribution of larger genera (those with 5 or more species each) also showed greater concentration towards higher altitudes.

Table 3. Comparison of IVI values from 2003-2007 in Alpine zone of Haramosh and Bugrote Valley.

Sr.	Name of Species	2003	2004	2005	2006	2007
		IVI	IVI	IVI	IVI	IVI
1	*Potentilla atrosanguinea*	19.41	21.45	23.60	26.67	28.59
2	*Potentilla anserine*	21.14	22.80	24.12	24.63	24.64
3	*Carex divisa*	13.18	13.29	14.53	16.32	20.01
4	*Geranium pretense*	25.44	26.34	26.96	22.92	18.37
5	*Eleocharis quinqueflora*	12.45	14.74	15.63	15.76	15.78
6	*Bistorta affinis*	8.01	9.27	10.61	10.69	13.96
7	*Kobresia laxa*	11.56	11.21	12.78	13.44	13.46
8	*Oxytropis immerse*	9.32	8.90	9.43	10.47	10.85
9	*Astragalus hendersonii*	8.98	8.55	9.05	9.29	10.62
10	*Carex pseudofoetida*	10.04	9.24	8.32	8.48	9.75
11	*Gentianodes tianschanica*	7.63	7.83	7.58	7.70	8.95
12	*Alchemilla ypsilotoma*	0.00	4.09	2.17	4.01	8.95
13	*Poa alpine*	7.81	7.38	7.37	7.92	8.33
14	*Aconogonon alpinum*	6.89	6.34	5.98	10.15	8.11
15	*Poa stapfiana*	5.50	5.78	6.12	7.04	7.40
16	*Elymus dahuricus*	7.19	6.72	7.126	6.13	6.53
17	*Festuca alaica*	7.03	5.95	5.25	5.28	6.50
18	*Nepeta nervosa*	0.00	0.00	2.32	2.84	6.33
19	*Swertia petiolate*	6.73	8.35	6.89	5.87	6.23
20	*Erigeron alpinum*	5.44	4.53	4.80	5.68	6.03
21	*Silene gonosperma*	5.07	4.56	4.83	4.83	5.60
22	*Aster peduncularis*	8.07	7.22	5.90	5.01	5.41
23	*Rhodiola wallichiana*	5.55	6.72	7.11	7.08	4.35
24	*Sibbaldia procumbens*	3.87	3.77	3.54	3.54	3.93
25	*Senecio tibeticus*	6.43	3.70	3.92	3.91	3.86
26	*Rhodiola heterodonta*	4.85	5.15	5.46	5.43	3.86
27	*Aster falconeri*	5.97	5.46	5.23	3.84	3.39
28	*Gentianodes eumarginata*	6.11	7.29	6.37	7.30	3.35
29	*Phleum alpinum*	4.97	4.05	3.93	3.90	3.27
30	*Pedicularis staintonii*	4.26	0.00	3.10	2.64	3.04
31	*Primula denticulate*	7.58	7.11	7.08	0.00	3.01
32	*Tanacetum falconeri*	3.09	3.75	3.98	3.90	2.99
33	*Papaver nudicaule*	3.30	2.68	2.84	0.00	2.81
34	*Valeriana himalayana*	4.57	5.22	5.33	2.98	2.68
35	*Allardia glabra*	4.49	3.50	3.71	3.24	2.51
36	*Chorispora macropoda*	3.16	2.93	2.47	2.46	2.21
37	*Euphorbia micractina*	3.77	3.58	0.00	2.18	2.18
38	*Pedicularis albida*	3.61	3.85	4.08	4.05	2.00
39	*Pyrola rotundifolia*	3.11	3.34	0.00	1.30	1.26
40	*Pulsatilla wallichiana*	9.54	8.22	6.97	6.69	0.00
41	*Anemone rupicola*	4.68	4.94	3.34	4.22	0.00*

*Abbreviation: Important value index (IVI); Zero in the IVI column shows absence

The current study revealed that in the Alpine zone, 105 exclusive alpine species belonged to 52 genera, which constituted 45.6% of total 232 species of Alpine zone. The alpine slopes provide an array of microclimates with differences in temperature, precipitation and solar radiation. Giriraj *et al*. (2008) demonstrated the distribution of species assemblages along an altitudinal gradient, and the occurrence of certain species unique to a particular altitude or habitat. The two valleys, Haramosh and Bagrote had quite similar flora with a high value of Similarity Index. However, the alpine zone of Haramosh valley was floristically richer than the Bagrote valley. The up-to-date information on biodiversity is critical for the proper management and conservation of any area, thus the first step towards conservation should be to compile a species inventory or checklist (Droege and Larivee, 1998; Salafsky *et al*., 2002). The present study is the first detailed work on the alpine specific studies regarding, alpine exclusive species and genera, their distribution, and conservation which may helpful in such studies in any part of the Northern Areas of Pakistan, involving thorough inventorying and monitoring of plant biodiversity.

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