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INVENTORY OF THE ALPINE FLORA OF HARAMOSH AND BAGROTE VALLEYS (KARAKORAM RANGE) DISTRICT GILGIT, GILGIT-BALTISTAN, PAKISTAN

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Abstract

Inventorying of plant biodiversity of Haramosh and Bugrote valleys (District Gilgit, Gilgit-Baltistan, Pakistan) was done for fourteen years from 2001- 2014. The fourteen years inventorying revealed a rich plant biodiversity consisting of 232 species belonging to 106 genera and 34 families of flowering plants. The Alpine zone had 18 genera with 4 or more species; *Pedicularis* with 10 species was the largest genus of this zone, followed by *Potentilla* and *Carex* (each with 9 species) and *Draba* (8 species). Genera containing 9 or 10 species occurred only in Alpine zone. In the Alpine zone, 15 of the larger families were represented by 189 species, forming 81.46% of the Alpine flora. Although the highest number of species belonging to these larger families was present in the subalpine zone, but in terms of percentage their contribution was the highest in the Alpine flora. Percentage-wise the contribution of these families gradually increased from Desert zone to Alpine zone, because of their particular distribution patterns. Although the total number of species was the highest in the Subalpine zone, but in the species specific to any one zone, the Alpine zone had the highest number, that is, 96 of the total 232 species of Alpine zone were exclusively found in this zone only. Out of these 96 species specific to the Alpine zone, 53 belonged to such 22 genera that were exclusively found in the 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. The species richness index of Alpine zone however showed increasing trend probably due to species migrations towards the alpine zone. The major threats to the plant biodiversity were recognized as the deforestation and habitat loss due to over-exploitation of species, over-grazing by livestock, and climate changes due to global warming, which were manifested as less and erratic precipitation and steadily rising temperatures over the past fourteen years.

Key wards: Haramosh and Bagrote valleys, Inventory, Alpine flora, Karakoram Range Gilgit-Baltistan

Introduction

The Haramosh and Bagrote valleys are located in the administrative unit called "Gilgit-Baltistan," Pakistan. It is a mountainous region covers 72,496 sq km bordering China, Afghanistan and Kashmir. It is surrounded by high mountains of the Karakoram, Himalayas and Hindukush Ranges. Some of the world's highest mountains, such as K-2 (8611m) Nangaparbat (8125m); and the Majestic Rakaposhi (7788m) are situated in this area (Perkin, 2003). In this "Collision zone" of the Kashmir, Pakistan and China; the Hindukush, the Karakoram and the Himalayan Ranges are knotted together (Perkin, 2003). Gilgit-Baltistan falls in the Eastern Irano-Turanian sub-region. This sub-region is confined to the northern mountainous region of Pakistan and Kashmir between 35 - 36° NL. This is characterized by extreme ranges in temperature and low precipitation (Ali & Qaiser, 1986). Haramosh and Bagrote are the valleys of the District Gilgit, that lie in the north-eastern side of the capital city Gilgit between 35.50 - 36.5 °N latitude and 74.54° E longitude, covering an area of 2340sq.km. The area has several mountains, glaciers, peaks, forests, shrub lands, alpine meadows at different elevations (Khan & Khatoon 2007). 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 & Samways, 1995). Thus, baseline inventorying 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) and provide documented proof that a plant exists in a given place at a particular time (Morgan & Overholt, 2005). Although over 12.5% of the world's flora has now been identified as globally threatened but this is likely to be an under estimation in view of lack of adequate taxonomic knowledge, lack of ground field work and other considerations (Walter & Gillet, 1997). Particularly in Pakistan, any inventorying and monitoring is lacking for the recognition of threatened species. Worldwide, diversity within species is being eroded, many species including the yet unclassified are becoming extinct, while species rich ecosystems are being destroyed or degraded (Watt, 1993). The species diverse habitat also performs valuable ecological process because of the interaction between species and the environment (Anon., 1992). The relationship between biodiversity and ecological process is neither simple nor clear, and it is not known how far biodiversity can be reduced before crucial ecological processes are affected. It has also been claimed that species extinction crisis is a threat to mankind next only to thermonuclear war (Sulaiman, 1991). All living beings obtain their life support material from their environment. Hence the well being of the individuals gets affected by the environmental factors. Thus the environment acts as a selective agent. 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. The climate change is a major consequence of deforestation (Dodd, 1994). Globally, the 1998 average annual temperature was the highest and that for 2001 the second highest since 1860. Of the 15 warmest years recorded during the last 150 years, 10 were in the 1990s (Hardy, 2003). In fact, the last decade of the twentieth century was the warmest in the entire global instrumental record. The twentieth century was the warmest century, and 1990 to 2000 was the warmest decade, of the past millennium (Hardy, 2003). In South Asia, the pattern of climate change is rather different from other parts of the world, due to the presence of the so-called "Brown Cloud of Asia." The Asian brown cloud is a layer of air pollution that covers parts of South Asia, namely the northern Indian Ocean, India and Pakistan (Srinivasan, 2002; Ramanathan, 2001). The absorption of solar radiation by Asian brown cloud contributes to atmospheric heating (Ramanathan *et al*., 2005), and also reduces the precipitation efficiency of clouds (Rosenfeld, 2000). The brown cloud of aerosols reduces solar radiation at the land surface by ≈ 10% and nearly doubles the atmospheric solar heating (Ramanathan *et al*., 2001). Although aerosol particles are generally associated with cooling effect at lower altitudes, recent studies have shown that they can actually have a warming effect in certain regions such as Himalayas. Due to this cloud there is speeding up of the melting rates of Himalayan glaciers. The large warming trends have been observed in the elevated regions such as the Himalayan-Tibetan region, leading to the retreat of glaciers (Ramanathan, 2007). In practical terms, the baseline data is valuable which relates to changes occurring in the vegetation in response to disturbance. It also tells us which species are resistant against such disturbances (Pimm, 2000). Changes in species diversity occur naturally overtime in all communities and ecosystems. Human disturbance also changes the direction of these changes. Species based monitoring documents to establish a baseline data for understanding the impact of natural disturbance on species composition and abundance in ecosystem (Watson & 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 alpine flora of the both valleys of district Gilgit and enumerates the dominant families, genera and species in alpine zones of the area.

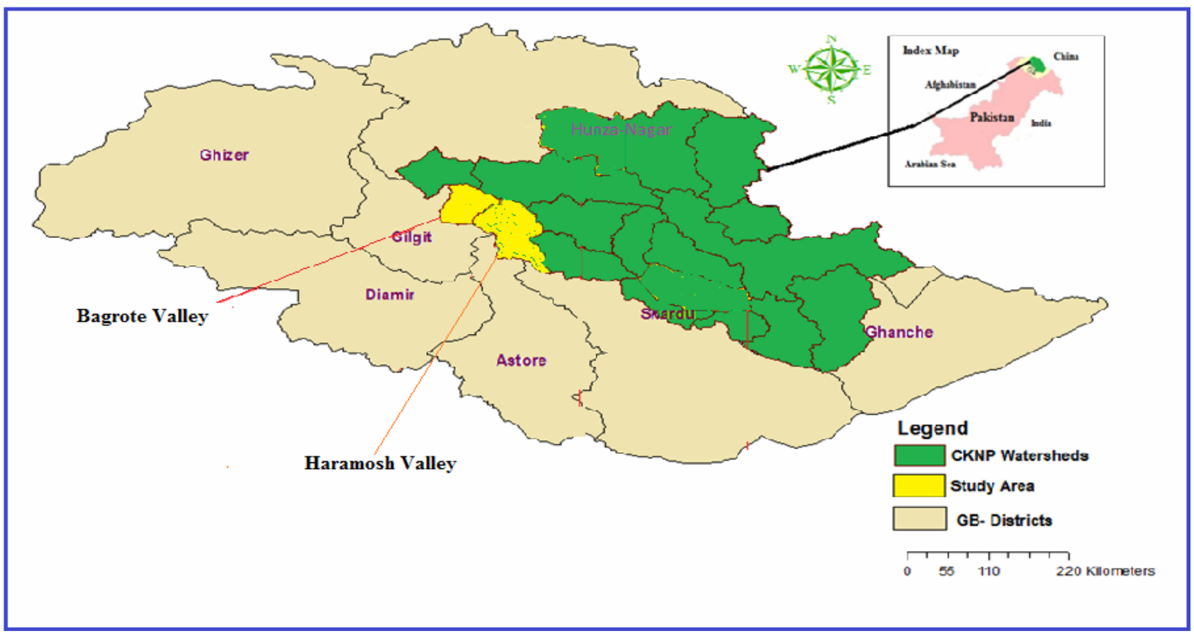


Fig. 1. Map of the study area

Materials and Methods

The present study was mainly focused on the alpine ecosystem of Haramosh and Bagrote valleys of Gilgit District (Fig.1). Plant specimens were collected during the springs of 2001-2014 from various localities of both valleys and identified with the help of Flora of Pakistan (Nasir & Ali, 1970-89; Ali & Nasir, 1989-1991; Ali & Qaiser, 1993-2015), 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. Extensive field information was collected including habit, habitat, altitude and abundance. To collect the maximum information on aspects of flora, field notes regarding the plant distribution pattern, composition, altitudal aspect and topographic condition were noted down. The plants encountered during field visits were collected as voucher specimens. Herbarium of each plant species was prepared following the standard techniques. Life- form categories of Raunkiaer's system (Raunkiaer, 1934), as presented by Ellenberg *et al*., (1991) were accepted.

Results and Observations

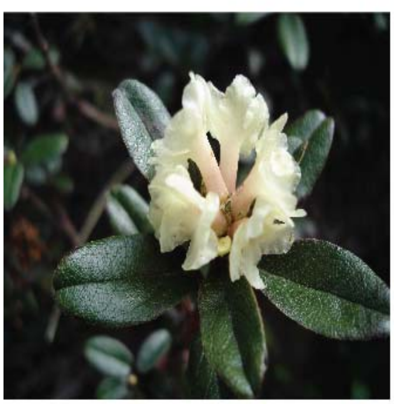
During the present study a total of 232 species belonging to 34 families and 106 genera of higher plant were recorded from the alpine zone of the study area (Table 1). Of these, 1 family, 1 genus, and 2 species belonged to Gymnosperms; 29 families, 93 genera, and 200 species belonged to dicots; and 4 families, 12 genera, 30 species belonged to monocots. That is, the dicots overwhelmingly dominated the floras of both valleys. The most dominant families are Compositae (38 species) followed by Ranunculaceae and Brassicaceae (15 species each), Rosaceae (13), Poaceae, Gentianaceae, and Scrophulariaceae (12 each), Polygonaceae, Labiatae, and Cyperaceae (10 species each) Papilionaceae, Umbelliferae, Primulaceae (9 species each).Twenty one genera that are only found in alpine zone among these genera *Pedicularis* with 10 species was the largest genus of this zone, followed by *Potentilla* and *Carex* (each with 9 species) and *Draba* (8 species) (Table 2). The number of species confined to the alpine zone is 96 belonging to 17 families. Among these families Compositse was the most dominant family having (15 species) only found in alpine zone followed by Brassicaceae, Rosaceae, Cyperaceae, and Ranunculaceae (10 species each), scrophulariaceae (9 species) (Table 3). In the Alpine zone, these larger families were represented by 189 species, forming 81.46% of the Alpine flora. The flora of the both valleys has close affinities with the flora of Himalayas.

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. Both valleys, which form a part of Karakoram Range lying between Skardu and Gilgit, abound in the alpine ranges. Due to the glaciations in the past, together with the anthropogenic factors which have resulted in a diverse climatic, topographical and soil conditions of different mountains, it is very difficult to delimit the alpine or sub alpine ranges in this area on altitudinal basis. 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. Above 4000 m, the number of the plant species decrease with increasing altitude owing to the prolonged snow cover. The alpine vegetation of this region comprises largely of perennial cryptophytic herbs, which on account of climatic conditions have very brief period of active growth. The alpine plant associations are not uniform in their composition and posses special habitats. On the basis of vegetation this zone can be divided into following habitats: Permanent snow line, Late lying snow patches, Rocky moist slopes and cliffs, Open meadows / grassy slopes, Stream banks /springs.

Allardia stoliczkae

Aquilegia fragrans var. fragrans

Delphinium brunonianum



Rhododendron hypenanthum

Saussurea simpsoniana

Pedicularis kashmiriana

Fig.4. Alpine specific highly medicinally important rare and infrequent species

Table 1. Cumulative list of plant species in Alpine zone 2001-2014.

S.No.	Family	Name of species	Habitat	Habit	Life form	Altitude	Remarks
1.	Alliaceae	*Allium carolinianum* DC.	Moist rocky place	P	G	3600m	C
2.	Alliaceae	*Allium oreoprasum* Schrenk	Open grassy slopes	P	G	3700m	Inf.
3.	Betulaceae	*Betula utilis* D.Don	Moist alpine slopes	T	Ph	3600m	C
4.	Boraginaceae	*Lindelofia stylosa* (Kar. & Kir.) Brand	Open grassy slopes	P	H	3700m	C
5.	Boraginaceae	*Pseudomertensia echioides* (Benth.) Riedl	Moist alpine place	P	H	4000m	C
6.	Boraginaceae	*Pseudomertensia moltkioides* (Royle ex Benth.) Kazmi var. *primuloides* (Decne.) Kazmi	Moist alpine place	P	H	4400m	C (endemic)
7.	Brassicaceae	*Arabidopsis mollissima* (C.A Mey.) N.Busch	Moist sandy place	P	H	4000m	C
8.	Brassicaceae	*Cardamine flexuosa* With.	Moist alpine slopes	A	Th	3700m	C
9.	Brassicaceae	*Cardamine loxostemonoides* O.E.Schulz	Moist shady place	P	H	3700m	C
10.	Brassicaceae	*Cardaria chalepense* (L.) Hand.-Mazz.	Moist shady place	P	H	3800m	C
11.	Brassicaceae	*Chorispora macropoda* Trautv.	Moist alpine place	P	H	4000m	C
12.	Brassicaceae	*Chorispora sabulosa* Camb.	Moist alpine place	P	H	4000m	C
13.	Brassicaceae	*Draba altaica* (C.A.Mey.)Bunge	Moist alpine slopes	P	H	4200m	C
14.	Brassicaceae	*Draba cachemirica* Gandoger	Moist alpine slopes	P	H	4000m	C
15.	Brassicaceae	*Draba lanceolata* Royle	Moist alpine slopes	P	H	4000m	Inf.
16.	Brassicaceae	*Draba melanopus* Komarov	Moist alpine slopes	P	H	4000m	C
17.	Brassicaceae	*Draba oreades* Schrenk	Moist alpine slopes	P	H	4200m	C
18.	Brassicaceae	*Draba setosa* Royle	Moist alpine slopes	P	H	4200m	C
19.	Brassicaceae	*Draba stenocarpa* Hook.f. & Thoms.	Moist alpine slopes	P	H	4200m	C
20.	Brassicaceae	*Draba tibetica* Hook.f. & Thoms. var. *chitralensis* (Schultz) Jafri	Moist alpine slopes	P	H	4000m	C
21.	Brassicaceae	*Thlaspi andersonii* (Hook. f. & Thom.) O. E. Schulz	Alpine slopes	P	H	4000m	R
22.	Brassicaceae	*Thlaspi cochlearioides* Hook.f. & Thoms.	Alpine moist place	P	H	4100m	C
23.	Campanulaceae	*Adenophora himalayana* Feer	Moist shady place	P	H	3700m	C
24.	Campanulaceae	*Campanula latifolia* L.	Moist alpine place	P	H	3700m	C
25.	Campanulaceae	*Codonopsis clematidea* (Schrenk) C.B.Clarke	Moist alpine place	P	H	3700m	C
26.	Caprifoliaceae	*Lonicera semenovii* Regel	Alpine sandy place	Sh	Ph	4000m	Inf.
27.	Caryophyllaceae	*Silene gonosperma* (Rupr.) Bocquet ssp. *himalayensis* (Rohrb.) Bocquet	Moist alpine rocky slopes	P	H	4000m	Inf.
28.	Caryophyllaceae	*Silene indica* Roxb.ex Otth. var. *indica*	Rocky slopes	P	H	3700m	Inf.
29.	Caryophyllaceae	*Silene moorcroftiana* Wall.ex Benth.	Rocky slopes	P	H	3600m	C
30.	Caryophyllaceae	*Silene staintonii* S.A. Ghazanfar	Open grassy slopes	P	Ch	3600m	C
31.	Caryophyllaceae	*Stellaria monosperma* Buch.-Ham. ex D.Don	Moist alpine slopes	P	H	3600m	C
32.	Compositae	*Achillea millefolium* L ssp. *millefolium*	Moist alpine slopes	P	H	3700	Inf.
33.	Compositae	*Allardia glabra* Decne.	Moist place	P	H	3900m	C
34.	Compositae	*Allardia nivea* Hook.f.& Thomson ex C.B. Clarke	Alpine moist place	P	Ch	4100m	Inf.
35.	Compositae	*Allardia stoliczkae* C.B.Clarke	Alpine moist place	P	H	4200m	Inf.
36.	Compositae	*Allardia tomentosa* Decne.	Sandy place	P	H	3600m	C
37.	Compositae	*Allardia tridactylites* (Kar.& Kir.) Schultz-Bip.	Alpine sandy place	P	Ch	4200m	Inf.
38.	Compositae	*Anaphalis nepalensis* (Spreng.) Hand.-Mazz. var. *nepalensis*	Alpine sandy place	P	H	3700m	C
39.	Compositae	*Aster falconeri* (Clarke) Hutch.	Alpine grassy slopes	P	H	3800m	C

Table 1. (Cont'd.).

S.No.	Family	Name of species	Habitat	Habit	Life form	Altitude	Remarks
40.	Compositae	*Aster peduncularis* Wall.ex Nees	Alpine grassy slopes	P	H	4000m	C
41.	Compositae	*Cicerbita* sp. nov.	Alpine grassy slopes	P	H	4000m	C (endemic)
42.	Compositae	*Cremanthodium decaisnei* Clarke	Along stream bank	P	H	4400m	C
43.	Compositae	*Crepis flexuosa* (DC.) Benth. & Hook.f.	Dry sandy place Near glaceir	A	Th	3700m	CC
44.	Compositae	*Doronicum falconeri* Clarke	Moist place	P	H	3800m	RR
45.	Compositae	*Erigeron acer* L. var. *multicaulis* (Wall.ex DC.) Clarke	Moist alpine slopes	P	H	3600m	C
46.	Compositae	*Erigeron alpinum* L.	Alpine grassy slopes	P	H	3600m	C
47.	Compositae	*Erigeron himalayensis* Vier.	Moist alpine place	P	H	3700m	C
48.	Compositae	*Hieracium prenanthoides* Vill.	Alpine grassy slopes	P	H	3600m	C
49.	Compositae	*Hieracium vulgatum* Fries	Alpine grassy slopes	P	H	3600m	C
50.	Compositae	*Hippolytia dolichophylla* (Kitam.) Bremer & Humphries	Alpine moist place	P	H	3600m	Inf.
51.	Compositae	*Inula rhizocephala* Schrenk	Moist place	P	H	3600m	CC
52.	Compositae	*Inula royleana* DC.	Moist place	P	H	4000m	C
53.	Compositae	*Lactuca lessertiana* (Wall. ex DC.) Clarke	Alpine grassy slopes	P	H	3800m	C
54.	Compositae	*Lactuca lessertiana* ssp. *lyrata* Stebb.	Alpine grassy slopes	P	H	3600m	C
55.	Compositae	*Leontopodium jacotianum* Beauv.	Dry stony place	P	H	3600m	C
56.	Compositae	*Leontopodium leontopodinum* (DC.) Hand.-Mazz.	Alpine grassy slopes	P	Ch	3600m	C
57.	Compositae	*Picris hieracioides* L.	Alpine grassy slopes	P	Ch	3700m	C
58.	Compositae	*Picris nuristanica* Bornm	Alpine grassy slopes	P	Ch	3650m	C
59.	Compositae	*Saussurea candolleana* (Wall.ex DC.) Clarke	Alpine moist place	P	H	3600m	R
60.	Compositae	*Saussurea ceratocarpa* Decne. var. *ceratocarpa*	Moist shady place	P	H	3600m	Inf.
61.	Compositae	*Saussurea falconeri* Hook.f.	Alpine grassy slopes	P	H	4000m	Inf.
62.	Compositae	*Saussurea jacea* (Klotz.) Clarke	Alpine sandy place	P	H	3900m	Inf.
63.	Compositae	*Saussurea simpsoniana* (Field & Gardn.) Lipschitz.	Extreme alpine stony place	P	H	4800m	Inf.
64.	Compositae	*Senecio graciliflorus* DC.	Alpine grassy slopes	P	H	4000m	Inf.
65.	Compositae	*Senecio korshinski* Krasch.	Alpine slopes	P	H	4000m	C
66.	Compositae	*Senecio tibeticus* Hook.f.	Alpine grassy slopes	P	H	4000m	C
67.	Compositae	*Solidago virga-aurea* L.	Alpine grassy slopes	P	H	3700m	Inf.
68.	Compositae	*Tanacetum falconeri* Hook.f.	Alpine grassy slopes	P	H	3600m	C
69.	Compositae	*Taraxacum aereum* V.Soest.	Shady place	P	H	3700m	C
70.	Compositae	*Taraxacum nasiri* V.Soest.	Alpine grassy slopes	P	H	3600m	C
71.	Crassulaceae	*Hylotelephium ewersii* (Ledeb.) H.ohba	Alpine grassy slopes	P	H	3800m	CC
72.	Crassulaceae	*Rhodiola heterodonta* (Hook. f. & Thom.) Boriss.	Alpine grassy slopes	P	H	4000m	C
73.	Crassulaceae	*Rhodiola quadrifida* (Pallas) Schrenk	Alpine grassy slopes	P	H	4000m	C
74.	Crassulaceae	*Rhodiola recticaulis* Boriss.	Alpine grassy slopes	P	H	4000m	C
75.	Crassulaceae	*Rhodiola tibetica* (Hook.f. & Thom.) S.H.Fu	Alpine grassy slopes	P	H	3800m	C
76.	Crassulaceae	*Rhodiola wallichiana* (Hook.f.) S.H.Fu	Alpine grassy slopes	P	H	3700m	C
77.	Cupressaceae	*Juniperus communis* L.	Open grassy slopes	Sh	Ph	3600m	C
78.	Cupressaceae	*Juniperus excelsa* M. Bieb.	Rocky slopes	T	Ph	3650m	C

Table 1. (Cont'd.).

S.No.	Family	Name of species	Habitat	Habit	Life form	Altitude	Remarks
79.	Cyperaceae	*Carex canescens* L.	Moist alpine slopes	P	H	4000m	CC
80.	Cyperaceae	*Carex cardiolepis* Nees	Moist alpine slopes	P	H	4000m	C
81.	Cyperaceae	*Carex cruenta* Nees	Moist alpine slopes	P	H	4300m	C
82.	Cyperaceae	*Carex divisa* Hudson	Moist alpine slopes	P	H	4000m	C
83.	Cyperaceae	*Carex melanantha* C. A. Mey.	Moist alpine slopes	P	H	3800m	C
84.	Cyperaceae	*Carex nivalis* Boott	Moist alpine slopes	P	H	4100m	C
85.	Cyperaceae	*Carex obscura* Nees	Moist alpine slopes	P	H	4300m	C
86.	Cyperaceae	*Carex oligocarya* C.B.Clarke	Moist alpine slopes	P	H	4000m	C
87.	Cyperaceae	*Carex pseudofoetida* Kuk.ssp. *afghanica* Kuk.	Moist alpine slopes	P	H	4100m	C
88.	Cyperaceae	*Eleocharis quinqueflora* (F.X.Hartm.) O.Schwarz	Moist alpine slopes	P	H	3800m	CC
89.	Cyperaceae	*Kobresia laxa* Nees	Moist alpine slopes	P	H	3650m	C
90.	Ericaceae	*Rhododendron hypenanthum* Balf. f.	Alpine grassy slopes	Sh	Ph	3600m	C
91.	Euphorbiaceae	*Euphorbia micractina* Boiss.	Alpine grassy slopes	P	H	3600m	C (endemic)
92.	Fumariaceae	*Corydalis falconeri* Hook.f. & Thoms.	Alpine stony place	P	Ch	4000m	C
93.	Fumariaceae	*Corydalis gortschakovii* Schrenk	Moist alpine slopes	P	Ch	4000m	C
94.	Gentianaceae	*Aloitis smithii* Omer	Alpine grassy slopes	P	H	3600m	C (endemic)
95.	Gentianaceae	*Comastoma borealis* (Bunge) T.N.Ho	Alpine grassy slopes	A-B	Th	3600m	Inf.
96.	Gentianaceae	*Comastoma falcatum* (Turcz.ex Kar. & Kir.) Toyokuni	Alpine grassy slopes	P	H	3700m	C
97.	Gentianaceae	*Comastoma pedunculata* (D.Don) Holub	Alpine grassy slopes	P	H	3600m	C
98.	Gentianaceae	*Comastoma pseudopulmonarium* Omer	Alpine grassy slopes	A-B	Th	3650m	C
99.	Gentianaceae	*Comastoma pulmonarium* (Turcz.)Toyokuni	Alpine grassy slopes	A	Th	3600m	C
100.	Gentianaceae	*Gentianodes eumarginata* Omer var. *scabromarginata* Omer	Alpine grassy slopes	A	Th	3700m	C
101.	Gentianaceae	*Gentianodes eumarginata* Omer. var. *eumarginata*	Alpine grassy slopes	A	Th	3600m	C
102.	Gentianaceae	*Gentianodes tianschanica* (Rupr.ex Kusn.) Omer, Ali & Qaiser	Alpine grassy slopes	P	H	3700m	CC
103.	Gentianaceae	*Lomatogonium brachyantherum* (Clarke) Fernald	Alpine grassy slopes	P	H	3600m	C
104.	Gentianaceae	*Lomatogonium spathulatum* (Kern.) Fernald	Alpine grassy slopes	A	Th	3600m	C
105.	Gentianaceae	*Swertia petiolata* D.Don	Alpine grassy slopes	P	H	3700m	C
106.	Geraniaceae	*Geranium pratense* L. ssp. *stewartianum* var. *schimidii* Y.Nasir	Alpine grassy slopes	P	H	3700m	C
107.	Labiatae	*Clinopodium vulgare* L.	Alpine grassy slopes	P	H	3800m	C
108.	Labiatae	*Nepeta connata* Royle ex Benth.	Open grassy slopes	P	H	3600m	C
109.	Labiatae	*Nepeta erecta* (Royle ex Benth.) Benth.	Open grssy slopes	P	H	3600m	C
110.	Labiatae	*Nepeta nervosa* Royle ex Benth.	Moist alpine slpoes	P	H	3800m	C
111.	Labiatae	*Phlomis bracteosa* Royle ex Benth.	Moist place	P	H	3600m	Inf.
112.	Labiatae	*Thymus linearis* Benth. ssp. *linearis*	Alpine grassy slopes	P	H	3700m	CC
113.	Liliaceae	*Gagea lowariensis* Pascher	Moist alpine slopes	P	G	3800m	C
114.	Liliaceae	*Gagea spumosa* Levichev	Moist alpine slopes	P	G	4200m	C
115.	Liliaceae	*Lloydia serotina* (L.) Rchb.	Moist alpine slopes	P	G	4000m	C
116.	Onagraceae	*Epilobium angustifolium* L.	Moist place	P	H	3600m	C
117.	Onagraceae	*Epilobium latifolium* L. ssp. *Latifolium* L.	Moist sandy place	P	H	3800m	C

Table 1. (Cont'd.).

S.No.	Family	Name of species	Habitat	Habit	Life form	Altitude	Remarks
118.	Onagraceae	*Epilobium laxum* Royle	Moist place	P	H	3600m	C
119.	Onagraceae	*Epilobium leiophyllum* Hausskn.	Moist place	P	H	3700m	C
120.	Papaveraceae	*Papaver nudicaule* L.	Alpine grassy slopes	A	Th	4000m	C
121.	Papilionaceae	*Astragalus frigidus* (L.) A.Gray	Alpine moist place	P	H	4000m	Inf.
122.	Papilionaceae	*Astragalus hendersonii* Baker	Alpine grassy slopes	P	Ch	3700m	C
123.	Papilionaceae	*Astragalus rhizocephalus* Baker ex Aitch.	Alpine grassy slopes	P	H	3600m	C
124.	Papilionaceae	*Caragana brevifolia* Komarov	Alpine grassy slopes	Sh	Ph	3700m	C
125.	Papilionaceae	*Cicer microphyllum* Benth.	Dry sandy place	P	H	3600m	C
126.	Papilionaceae	*Hedysarum falconeri* Baker	Moist sandy place	P	H	3700m	C
127.	Papilionaceae	*Oxytropis cachemiriana* Camb.	Alpine grassy slopes	P	H	4000m	C
128.	Papilionaceae	*Oxytropis immersa* (Baker. ex Aitch.) Bunge ex Fed.	Alpine grassy slopes	P	H	3600m	C
129.	Papilionaceae	*Oxytropis lapponica* (Wahl.) Gay	Alpine grassy slopes	P	H	3700m	C
130.	Papilionaceae	*Oxytropis mollis* Royle ex Benth.	Alpine grassy slopes	P	H	3600m	C
131.	Poaceae	*Agrostis gigantea* Roth	Dry sandy place	P	Ch	3650m	C
132.	Poaceae	*Alopecurus himalaicus* Hook.f.	Moist alpine slopes	P	H	4000m	Inf.
133.	Poaceae	*Elymus caninus (*L.) L.	Moist alpine slopes	P	H	3700m	C
134.	Poaceae	*Elymus cognatus* (Hack.)T. A. Cope	Moist alpine slopes	P	H	3650m	C
135.	Poaceae	*Elymus dahuricus* Turcz.ex Griseb.	Open grassy slopes	P	H	4000m	C
136.	Poaceae	*Elymus nutans* Griseb.	Open grassy slopes	P	H	4100m	C
137.	Poaceae	*Festuca alaica* Drobov	Open grassy slopes	P	H	4000m	C
138.	Poaceae	*Festuca alatavica* (St.-Yves) Rozhev.	Open grassy slopes	P	H	4000m	C
139.	Poaceae	*Phleum alpinum* L.	Moist alpine slopes	P	H	4000m	C
140.	Poaceae	*Poa alpina* L.	Open grassy slopes	P	H	4000m	C
141.	Poaceae	*Poa Pratensis* L.	Open grassy slopes	P	H	4000m	C
142.	Poaceae	*Poa stapfiana* Bor	Alpine meadows	P	H	3700m	C
143.	Poaceae	*Poa supina* Schrad.	Open grassy slopes	P	H	3600m	C
144.	Polygonaceae	*Aconogonon alpinum* (All.) Schur	Alpine grassy slopes	P	Ch	4000m	C
145.	Polygonaceae	*Aconogonon coriarium* (Grig.) Sojak.	Alpine grassy slopes	P	Ch	4000m	C
146.	Polygonaceae	*Aconogonon tortuosum* (D.Don) Hara var. *tibetanum* (Meisn.)S.-P.Hong	Alpine grassy slopes	P	Ch	4000m	Inf.
147.	Polygonaceae	*Aconogonon tortuosum* (D.Don) Hara var. *tortuosum*	Alpine grassy slopes	P	H	4000m	Inf.
148.	Polygonaceae	*Bistorta affinis* (D.Don) Green	Alpine grassy slopes	P	Ch	3600m	CC
149.	Polygonaceae	*Bistorta vivipara* (L.) S.F.Gray	Alpine grassy slopes	P	H	3600m	CC
150.	Polygonaceae	*Rheum spiciforme* Royle	Moist sandy place	P	Ch	3800m	C
151.	Polygonaceae	*Rheum tibeticum* Maxim.ex Hook.f.	Moist sandy place	P	Ch	3800m	C
152.	Polygonaceae	*Rheum webbianum* Royle	Moist alpine slopes	P	Ch	3700m	CC
153.	Polygonaceae	*Rumex acetosa* L.	Moist alpine slopes	P	H	3600m	C
154.	Polygonaceae	*Rumex nepalensis* Spreng.	Moist place	P	Ch	3600m	CC
155.	Primulaceae	*Androsace baltistanica* Y.Nasir	Alpine grassy slopes	A	Th	3600m	C
156.	Primulaceae	*Androsace septentrionalis* L.	Alpine grassy slopes	A	Th	3600m	C

Table 1. (Cont'd.).

S.No.	Family	Name of species	Habitat	Habit	Life form	Altitude	Remarks
157.	Primulaceae	*Androsace thomsonii* (Watt) Y.Nasir	Alpine grassy slopes	P	H	3600m	C
158.	Primulaceae	*Cortusa brotheri* Pax ex Lipsky	Moist shady place	A	Th	3600m	C
159.	Primulaceae	*Primula denticulata* Smith	Moist alpine slopes	P	H	4000m	C
160.	Primulaceae	*Primula duthieana* Balf.f. &.W. W.Smith	Moist alpine slopes	P	H	3600m	C
161.	Primulaceae	*Primula elliptica* Royle	Alpine grassy slopes	P	H	3600m	C
162.	Primulaceae	*Primula macrophylla* D. Don var. *macrophylla*	Moist alpine slopes	P	H	4000m	C
163.	Primulaceae	*Primula macrophylla* var. *moorcroftiana* (Wall.ex Klatt) W.W.Smith. & Fletcher	Moist alpine slopes	P	H	4000m	R
164.	Primulaceae	*Primula reptans* Hook.ex Watt	Moist alpine slopes	P	H	4200m	C
165.	Pyrolaceae	*Pyrola rotundifolia* L. ssp. *karakoramica* (Krisa.)Y.Nasir	Alpine grassy slopes	P	H	3800m	C
166.	Ranunculaceae	*Aconitum violaceum* Jacq. ex Stapf var. *weileri* (Gilli) H.Riedle	Alpine grassy slopes	P	G	3700m	Inf. (endemic)
167.	Ranunculaceae	*Aconitum violaceum* Jacq.ex Stapf var. *violaceum*	Alpine grassy slopes	P	G	3600m	Inf.
168.	Ranunculaceae	*Anemone rupicola* Camb.	Moist place	P	H	3650m	C
169.	Ranunculaceae	*Aquilegia fragrans* Benth. var. *fragrans*	Moist rocky place	P	H	3700m	C (endemic)
170.	Ranunculaceae	*Aquilegia moorcroftiana* Wall.ex Royle var.*moorcroftiana*	Alpine grassy slopes	P	H	3600m	C
171.	Ranunculaceae	*Callianthemum pimpinelloides* (D.Don ex Royle) Hook.f. & Thoms.	Moist alpine slopes	P	H	4200m	C
172.	Ranunculaceae	*Delphinium brunonianum* Royle	Alpine stony place	P	H	4000m	Inf
173.	Ranunculaceae	*Delphinium pyramidale* Royle	Alpine stony place	P	Ch	4200m	C
174.	Ranunculaceae	*Delphinium vestitum* Wall.ex Royle	Alpine stony place	P	H	4300m	Inf.
175.	Ranunculaceae	*Isopyrum anemonoides* Kar. & Kir.	Alpine moist place	P	H	4000m	C
176.	Ranunculaceae	*Paraquilegia anemonoides* (Willd.) Ulbr.	Alpine slopes	P	H	3600m	Inf.
177.	Ranunculaceae	*Pulsatilla wallichiana* (Royle) Ulbr.	Alpine grassy slopes	P	H	3600m	C
178.	Ranunculaceae	*Ranunculus glacialiformis* Hand.-Mazz.	Moist place	P	H	3700m	C
179.	Ranunculaceae	*Ranunculus hirtellus* Royle	Moist place	P	H	3700m	C
180.	Ranunculaceae	*Ranunculus membranaceous* Royle	Moist sandy place	P	H	4000m	C
181.	Ranunculaceae	*Ranunculus stewartii* H.Riedl	Alpine moist place	P	H	4000m	Inf.
182.	Rosaceae	*Alchemilla ypsilotoma* Rothm.	Moist shady place	P	H	3700m	C
183.	Rosaceae	*Cotoneaster uniflora* Bunge	Moist alpine place	Sh	Ph	3600m	R
184.	Rosaceae	*Potentilla anserina* L.	Alpine grassy slopes	P	H	3700m	CC
185.	Rosaceae	*Potentilla argyrophylla* Wall.ex Lehm.	Moist place	P	H	3600m	C
186.	Rosaceae	*Potentilla atrosanguinea* Lodd.	Alpine grassy slopes	P	H	3600m	C
187.	Rosaceae	*Potentilla doubjouneana* Camb.	Alpine grassy slopes	P	H	3700m	C
188.	Rosaceae	*Potentilla eriocarpa* Wall.ex Lehm.	Alpine moist place	P	H	3600m	C
189.	Rosaceae	*Potentilla gelida* C.A.Mey.	Moist place	P	H	3600m	C
190.	Rosaceae	*Potentilla gerardiana* Lindl.ex Lehm.	Alpine grassy slopes	P	H	3700m	C
191.	Rosaceae	*Potentilla multifida* L.	Alpine grassy slopes	P	H	3600m	C
192.	Rosaceae	*Potentilla turezainowiana* Stesh.	Moist place	P	H	3700m	Inf.
193.	Rosaceae	*Sibbaldia cuneata* Horne.ex Kunt.	Alpine grassy slopes	P	H	4000m	CC
194.	Rosaceae	*Sibbaldia procumbens* L.	Alpine grassy slopes	P	H	3600m	C
195.	Rosaceae	*Sibbaldia tetrandra* Bunge	Moist shady place	P	H	3600m	C

Table 1. (Cont'd.).

S.No.	Family	Name of species	Habitat	Habit	Life form	Altitude	Remarks
196.	Rubiaceae	*Galium boreale* L.	Alpine grassy slopes	P	H	3700m	CC
197.	Rubiaceae	*Galium verum* L.	Alpine grassy slopes	A	Th	3600m	C
198.	Salicaceae	*Salix flabellaris* Andersson	Moist alpine sandy place	Sh	Ph	3600m	C
199.	Salicaceae	*Salix karelinii* Turcz.	Moist alpine slopes	Sh	Ph	3600m	C
200.	Saxifragaceae	*Bergenia stracheyi* (Hook. f. & Thoms.) Engl.	Moist alpine slopes	P	Ch	3800m	CC
201.	Saxifragaceae	*Saxifraga flagellaris* Willd.ex Sternb ssp. *stenophylla* (Royle) Hulten.	Moist alpine slopes	P	H	4000m	C
202.	Saxifragaceae	*Saxifraga jacquemontiana* Decne.	Moist alpine slopes	P	H	4200m	Inf.
203.	Saxifragaceae	*Saxifraga pulvinaria* H. Smith	Moist alpine slopes	P	H	4200m	Inf.
204.	Saxifragaceae	*Saxifraga sibirica* L.	Alpine rocky place	A-B	Th	3700m	Inf.
205.	Scrophulariaceae	*Lagotis kunawurensis* (Royle) Rupr.	Moist alpine place	P	H	3800m	C
206.	Scrophulariaceae	*Pedicularis albida* Penn.	Moist alpine slopes	P	H	3700m	C
207.	Scrophulariaceae	*Pedicularis bicornuta* Klotzsch.	Moist alpine slopes	P	H	3600m	Inf.
208.	Scrophulariaceae	*Pedicularis kashmiriana* Pennell	Moist alpine slopes	P	H	3600m	C
209.	Scrophulariaceae	*Pedicularis multiflora* Pennell	Moist alpine slopes	P	H	3600m	C
210.	Scrophulariaceae	*Pedicularis pectinata* Wall.ex Benth.	Moist alpine slopes	P	H	3800m	Inf.
211.	Scrophulariaceae	*Pedicularis punctata* Decne.	Moist alpine slopes	P	H	3600m	C
212.	Scrophulariaceae	*Pedicularis pycnantha* Boiss.	Moist alpine slopes	P	H	3700m	C
213.	Scrophulariaceae	*Pedicularis pyramidata* Royle	Alpine grassy slopes	P	H	3600m	C
214.	Scrophulariaceae	*Pedicularis staintonii* R.R. Mill	Alpine grassy slopes	P	H	3600m	C
215.	Scrophulariaceae	*Pedicularis tenuirostris* Benth.	Moist alpine slopes	P	H	3700m	C
216.	Scrophulariaceae	*Veronica alpina* L.	Moist alpine place	P	H	4400m	C
217.	Scrophulariaceae	*Veronica macrostemon* Bunge ex Ledeb.	Moist alpine place	P	H	4000m	Inf.
218.	Umbelliferae	*Aegopodium alpestre* Ledeb.	Moist shady place	P	H	3600m	C
219.	Umbelliferae	*Aegopodium burttii* E.Nasir	Moist shady place	P	H	3700m	C
220.	Umbelliferae	*Anthriscus nemorosa* (M.Bieb.) Spreng.	Moist shady place	P	H	3600m	C
221.	Umbelliferae	*Bupleurum thomsonii* C.B.Clarke	Alpine grassy slopes	P	H	3800m	C
222.	Umbelliferae	*Pleurospermum candollei* (DC.) C.B.Clarke.	Alpine grassy slopes	P	H	4000m	C
223.	Umbelliferae	*Pleurospermum hookeri* var. *thomsonii* Clarke	Alpine grassy slopes	P	H	4000m	C
224.	Umbelliferae	*Pleurospermum stellatum* Benth. var. *lindleyanum* (Kl.) C.B.Clarke	Alpine grassy slopes	P	H	4000m	C
225.	Umbelliferae	*Pleurospermum stylosum* Clarke	Moist place	P	H	3600m	C
226.	Umbelliferae	*Selinum candollei* DC.	Moist place	P	H	3700m	C
227.	Umbelliferae	*Vicatia coniifolia* DC.	Alpine grassy slopes	P	H	4000m	C
228.	Valerianaceae	*Valeriana hardwickii* Wall.var. *hoffmeisteri* (Kl.) Clarke	Moist alpine slopes	A	Th	4000m	C
229.	Valerianaceae	*Valeriana himalayana* Grubov	Moist alpine slopes	A	Th	3800m	C
230.	Valerianaceae	*Valeriana jaeschkei* C.B.Clarke	Moist alpine slopes	P	H	4000m	C
231.	Valerianaceae	*Valeriana pyrolifolia* Decne.	Moist alpine slopes	A	Th	4200m	C
232.	Violaceae	*Viola biflora* L.	Alpine grassy slopes	A-B	Th	3600m	C

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

Table 2. Genera confine to alpine zone only.

S.No.	Family	Genus	No. of species
1.	Boraginaceae	*Pseudomertensia*	1
2.	Brassicaceae	*Arabidopsis*	1
3.	Brassicaceae	*Draba*	8
4.	compositae	*Achillea*	1
5.	compositae	*Doronicum*	1
6.	compositae	*Rhodiola*	5
7.	Ranunculaceae	*Aconitum*	2
8.	Ranunculaceae	*Delphinium*	3
9.	Ranunculaceae	*Isopyrum*	1
10.	Ranunculaceae	*Paraquilegia*	1
11.	Scrophulariaceae	*Lagotis*	1
12.	Scrophulariaceae	*Veronica*	2
13.	Umbelliferae	*Pleurospermum*	2
14.	Umbelliferae	*Vicatia*	1
15.	Cyperaceae	*Carex*	9
16.	Cyperaceae	*Eleocharis*	1
17.	Liliaceae	*Gagea*	2
18.	Liliaceae	*Lloydia*	1
19.	Poaceae	*Festuca*	2
20.	Poaceae	*Phleum*	1
	Total		**49 species**

Table 3. Number of species confine to Alpine Zone only.

S.No.	Family	No. of species
1.	Boraginaceae	2
2.	Brassicaceae	10
3.	Compositae	15
4.	Crassulaceae	5
5.	Fumariaceae	2
6.	Labiatae	1
7.	Polygonaceae	3
8.	Primulaceae	3
9.	Ranunculaceae	10
10.	Rosaceae	10
11.	Saxifragaceae	3
12.	Scrophulariaceae	9
13.	Umbelliferae	5
14.	Valerianaceae	2
15.	Cyperaceae	10
16.	Liliaceae	3
17.	Poaceae	3
	Total	**96 species**

Permanent snow line: This line is characterized by vast glaciers, boulder fields and sheer cliffs, which predominate at high altitudes, around the major peaks of the Karakoram Range. It covers northern side of both valleys.

Late lying snow patches: All these habitats are covered by snow for most of the year; sometimes the snow does not melt throughout the year. After melting of snow the rocky cliffs become exposed. Only few plant species are found there, such as *Saussurea simpsoniana*, *Corydalis falconeri, Veronica alpina*, C*remanthodium decaisnei* and *Carex nivalis*.

Rocky moist slopes and cliffs: The frequent species of this habitat were *Hylotelephium ewersii*, *Pseudomertensia moltkioides*, *Draba* spp*.*, *Saussurea falconeri*, *Delphinium brunonianum*, *Aquilegia fragrans* var. *fragrans* , *Saxifraga flagellaris* and *Primula reptans.* This is the main habitat of *Allium carolianum.*

Open meadows and grassy slopes: In the mountains of both valleys, there are many meadows and grassy slopes which experience a set of severe climatic and edaphic conditions, contain diverse temperate and alpine grasses and other small herbaceous species such as *Gagea lowariensis, Lloydia serotina, Nepeta* spp*., Gentianodes tianschanica, Carex divisia, Lagotis kunawurensis, Solidago virga-aurea*, *Geranium pratense Senecio tibeticus, Aster falconeri, Aconitum* spp*., Erigeron* spp*., Pedicularis* spp*., Primula* spp*., Rhodiola heterodonta*. Besides these, some shrubs like *Salix flabellaris, Rhododendron hypenanthum, Lonicera semenovii*, *Juniperus communis* and *Betula utilis* were common. A very rare species *Doronicum falconeri* was also found in this habitat. During last 10 years only few individuals of this species were seen in this area. These alpine meadows are used as summer pastures by the local people.

Stream and spring banks: This habitat was dominated by *Salix karelinii*, *Carex divisia, Cremanthodium decaisnei, Pedicularis* spp*., Primula macrophylla, Aster falconeri,* and *Rhododendron hypenanthum.*, Besides these, some grasses such as *Phleum alpinum, Poa alpina, Elymus* spp. and some other plants like *Potentilla* spp*., Valeriana* spp*., Erigeron* spp*., Bistorta affinis, Crepis flexuosa* , *Anaphalis nepalensis* var. *nepalensis*, *Cortusa brotheri, Aconogonon alpinum, Epilobium latifolium* ssp. *Latifolium*, *Rheum webbianum* , *Allardia glabra* and *Primula* spp. were found. Besides these, *Potentilla dryadanthoides* was also found in this habitat, which is a rare species for the study area.

Discussion and Conclusion

The cumulative number of species collected during 2001-2014 from both valleys (Haramosh and Bagrote) came to be 560 in 68 families and 258 genera. Of these, 3 families, 4 genera, and 9 species belonged to Gymnosperms; 57 families, 226 genera, and 490 species belonged to dicots; and 8 families, 28 genera, 61 species belonged to monocots. Among the ecological zones of both valleys; the Sub alpine zone was the richest with 332 species in 158 genera and 53 families; followed by the Alpine zone with 232 species in 106 genera and 34 families. Among the 68 families, 16 families were represented by only one species each, 36 families had 2 to 9 species each, while only 16 families contained 10 or more species. Collectively these 16 larger families had 178 genera (68.99% of the total genera) and 397 species (70.89% of the total species) and 82 genera of Alpine flora belonged to these families. In the Alpine zone, 15 of these larger families were represented by 189 species, forming 81.46% of the Alpine flora. Although the highest number of species belonging to these larger families was present in the Sub alpine zone, but in terms of species percentage their contribution was the highest in the Alpine flora. Percentage-wise the contribution in terms of number of species belonging to these larger families gradually increased from lower reaches to upper alpine zone, because of their particular distribution patterns. Only one of the larger families, i.e. Chenopodiaceae showed greater number of species in Desert and Temperate zone; while 6 of them showed greater concentration in Temperate to Alpine zone, and 9 were more concentrated in the Subalpine to Alpine zone, with Gentianaceae being totally absent from Desert and Temperate zones. Floristically Compositae was the largest family in all the four ecological zones. In the Alpine zone however, Ranunculaceae and Brssicaceae were floristically the second large families, followed by Rosaceae at third position. This indicates the changing composition of flora with the altitudinal gradient. Like the larger families, the larger genera also showed a tendency to be more concentrated towards the higher altitudes. In the Alpine zone, 104 species belonged to 25 of these larger genera, constituting 44.06% of the total species of this zone. Nine of these larger genera were more concentrated in the Subalpine zone, 8 were more concentrated in the Alpine zone with three (*Draba, Rhodiola* & *Carex*) being exclusively Alpine; six were more or less equally distributed in Temperate and Subalpine zones, one (*Allium*) was more or less equally distributed from Temperate to Alpine zone, and one (*Ranunculus*) was more or less equally distributed in all the four zones. The Alpine zone had 18 genera with 4 or more species; *Pedicularis* with 10 species was the largest genus of this zone, followed by *Potentilla* and *Carex* (each with 9 species) and *Draba* (8 species). Genera containing 9 or 10 species occurred only in Alpine zone. Among the species, the highest number (38) belonged to Compositae, followed by Ranunculaceae and Brassicaceae (15 species each), Rosaceae (13), Poaceae, Gentianaceae, and Scrophulariaceae (12 each), Polygonaceae, Labiatae, and Cyperaceae (10 species each) Papilionaceae, Umbelliferae, Primulaceae (9 species each). Of the 96 species confined to Alpine zone, 53 belonged to genera found only in the Alpine zone. Compositae was floristically the largest family (Shedayi *et al*., 2016) in all the ecological zones, with Papilionaceae and Poaceae the other two larger families from Desert to Subalpine zones; however in the Alpine zone the floristic composition substantially changed with Brassicaceae, Ranunculaceae and Rosaceae as the larger families after Compositae. Like floristic composition, the habit categories and life-forms also showed a drastic change from Desert to Alpine zone. The perennial herbs constituted 88.4% of the Alpine flora compared with 54.54% of the Desert flora. Similarly, Hemicryptophytes were 77.16% in Alpine flora compared to Desert flora (Fig. 3). The alpine zones are frequently rich in species of hemicryptopytes (Naroozi *et al.*, 2008; Ali *et al*., 2016). Therophytes are particularly numerous in arid ecosystems and deserts, where these ephemerals provide a considerable element of seasonality to the landscape (Dugan *et al.*, 2007). However, the low percentage of Therophytes (14.2%) in Desert zone recorded in the present study is apparently due to persistant low rainfall in the study years that resulted in the low frequency of therophytes. The perennial herbs formed 88.4% of the Alpine flora. The Anuual /Biennial herbs formed 14-19% of Desert to Subalpine zone floras, but only 7.75% of the Alpine flora. Tree and shrub species collectively formed 12% of the Subalpine flora, and only 3.86% of the Alpine flora and dominated by perennial herb (88.36% of total alpine flora (Fig. 2). The Alpine zone contained 3 Rare and one Very Rare species. In terms of the percentage of the flora of a particular zone, Very Common species percentage was the highest in Temperate zone, Common species percentage was the highest in Alpine zone, Infrequent species percentage was also the highest in Alpine zone. In the life-form categories, Hemicryptophytes were more numerous in all ecological zones. Their percentage in floras of different zones gradually increased from Desert to Alpine zone. Although their number was the highest in the Subalpine zone (198), but their percentage was the highest in Alpine zone, where they formed 76.8% of the Alpine flora. The percentage of Geophytes also was the highest in the Alpine zone. The percentage of Phanerophytes and Chamaephytes gradually decreased from Desert to Alpine zone. 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.The meteorological data have shown a rise in mean daily temperatures, particularly in the months of February and March. A mean rise of more than 3°C in the daily minimum temperature of these months in a short period of six years can be termed as a phenomenal rise. Due to rising temperature, the migration of species from Temperate zone to Subalpine, and 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 distribution range. It was observed that the species of lower reaches such as *Corydalis* spp. *Carex* spp. *Veronica alpina, Cremanthodium decaisnei* etc. were migrating upwards and dislodging *Saussurea simpsoniana* from its habitat continuously. On the other hand *Salix karelinii* was abundantly found in the Eastern and Western facing slopes and along stream and spring banks of Alpine and Subalpine zones from 3000-3600 m. During the last one decade it has continually declined and is now restricted to Western facing slopes and streams and spring banks of Alpine zone only; and completely disappeared from Subalpine zone and Eastern facing slopes of Alpine zone in the study area. According to fourteen years observation *Primula elliptica, Allium oreoprasum, Pulsatilla wallichiana, Saussurea simpsoniana* and *Salix karelinii* were under threat from climate change in the study area. As any baseline study on the area pertaining to the time before the present global warming era is not available, one cannot say with certainty whether 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. Certain studies from the other parts of the world have either documented or predicted the migration of species in response to global warming. Lenior *et al*. (2008) reported an average 29 meter per decade upwards altitudinal shift in 171 forest plant species of W. Europe between 1986 to 2005. According to them, the shift is larger for species restricted to mountain habitats and for grassy species that have a faster population turnover. Lenior *et al*. (2008) suggest that with the anticipated climate change, up to 66% of California's 2387 endemic plant taxa will experience > 80% reduction in range size within a century. Climate change has strongly influenced distribution and abundance of plants at range margins both in latitude and elevation (Hickling *et al.,* 2006; Tryjanowski, 2005). Colwell *et al.* (2008) suggest that in tropical areas, range-shifts will be from lower towards higher altitudes rather than from south to north. The migration of plant species however depends upon their ability to disperse, their specialization to restricted soil types, their degree of adaptive evolutionary responses, etc. (Loarie *et al.,* 2008). That is, every species would not be able to migrate with equal success in response to rising temperatures. 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. The flora of the high mountainous areas of northern Pakistan including the study area is at a greater risk than other parts of the world, because the rate of rise in temperature is very high, such as mean rise of more than 3°C in February and March minimum temperatures in the study area just within a span of 10 years. This high rate of temperature rise is due to the presence of the so-called "Brown cloud" of South Asia that hangs over from Iran to Bangladesh in the months October to March each year (Srinivasan, 2002). This cloud consists of particulate matter generated from the burning of organic matter like wood, straw, dung etc. (Gustafsson, Orjan *et al*., 2009). The particulate matter absorbs solar radiation, therefore it has a cooling effect on the lands of low altitudes; but at higher altitudes it actually has a warming effect due to the warming of the atmosphere that is in contact with the high altitude areas (Ramanathan, 2007). Besides this, the dirt of particulate matter comes down with precipitation, due to which the albedo of snowy peaks decreases and they absorb more solar radiation, resulting in temperature rise and melting of ice (Ramanathan, 2007). This is why the rate of temperature rise in the high mountainous areas of northern Pakistan is disproportionately high as compared to other areas, resulting in a greater frequency of avalanches which pose an additional threat to biodiversity. With this high rate of climate change, many species would not be able to migrate at a matching pace; and while the species from lower altitudes have a chance to migrate towards higher altitudes, the species already in the Alpine zone have nowhere else to go. Loarie *et al.* (2008) found that species losses were disproportionately clustered in mountain areas as opposed to lowlands in the South African Cape. 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. These taxa are at the greater risk in view of the steadily rising temperature. Similarly, the distribution of larger genera (those with 5 or more species each) also showed greater concentration towards higher altitudes. In the Alpine zone, 104 species belonged to 25 larger genera, which constituted 44.6% of the Alpine flora. Although the total number of species was the highest (332) in the Subalpine zone, but in the species specific to any one zone, the Alpine zone had the highest number, that is, 96 of the total 232 species of Alpine zone were exclusively found in this zone only. Out of these 96 species specific to the Alpine zone, 53 belonged to such 22 genera that too were exclusively found in the Alpine only. The altitudinal gradient provides an array of microclimates with differences in temperature, precipitation and solar radiation. The diversity of topography thus has a direct bearing on the biodiversity of an area, giving rise to a broad array of ecosystems (Foster, 1993; Hua *et al*., 1998). 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. A mountainous area has its expanse not only in the horizontal square kilometers, but also additional square kilometers vertically; therefore actually a larger surface area is available for plants to grow, as compared to an area of equal size in the plains. And since in the vertical kilometers the microclimate rapidly changes, the rate of species turnover is also high with the ecological zonation. This is why the mountainous areas almost always have greater species richness than the plain areas. The current study revealed five habitat types on the basis of vegetation types such were Permanent snow line, Late lying snow patches, rocky moist slopes and cliffs, Open meadows / grassy slopes and Stream banks /springs. Furthermore, it was concluded that on the basis of five habitat types there are different life forms such are Dwarf perennial herbs- with relatively large flowers, with prostrate rosette leaves, with well branched herbaceous rhizomes, with well branched woody rootstock forming compact tufts mats or cushions, perennials with thick hollow stems, perennial with winter buds or bulbils boon deep underground, plants covered with straight hairs, with drooping flowers and Dwarf shrub with stunted or prostrate woody branches. The two valleys, Haramosh and Bagrote had quite similar flora with a high value of Similarity Index (0.92). However, the former was floristically richer than the latter. 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 (Klopper *et al.,* 2007). The present study is the first detailed work on the floristic, vegetation, and conservation of any part of the Northern Areas of Pakistan, involving thorough inventorying of plant biodiversity.

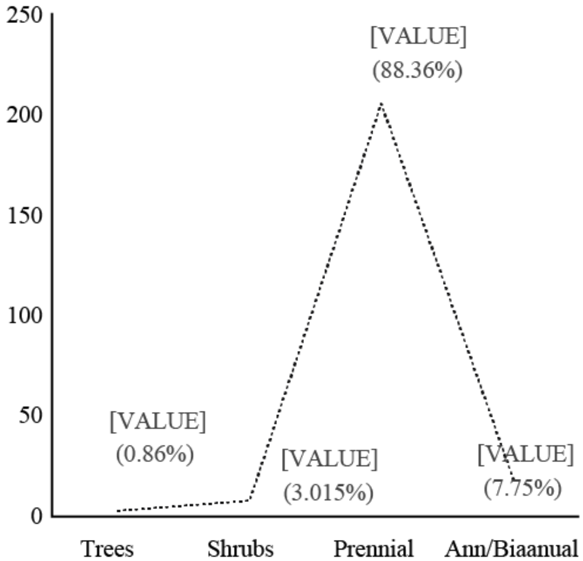


Fig. 2. Habit wise distribution of species in Alpine zone.

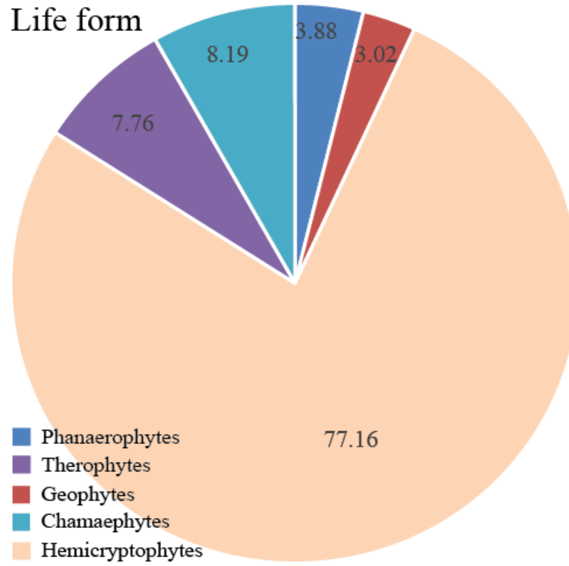


Fig. 3. Life form categories % age wise distribution.

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