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DIVERSITY, ECOLOGICAL FEATURE AND CONSERVATION OF A HIGH MONTANE FLORA OF THE SHIGAR VALLEY (KARAKORUM RANGE) BALTISTAN REGION, NORTHERN PAKISTAN

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Abstract

This paper presents the results of exploratory investigation on the flora of the Shigar valley, Central Karakorum Mountains, conducted in 2013-2016. The studies completed with the documentation of 345 vascular plants distributed in 206 genera and 63 families with maximum species of flowering plants. Asteraceae and *Saussurea* were leading taxa in terms of family and genera respectively. Arid mountain slopes was main habitat type sharing maximum species (84) in the native flora. Generally, the sum of species exposed herbaceous habit (301 species) with prevalence of perennial herbs (220 species). Life form grouping revealed the excessive occurrence of Hemicryptophytes (139 species). Distribution wise, the Irano-Turanian elements (35.36%) were the most frequent species co-dominating with Western Himalayan elements (28.69%). Some endemic and critically endangered species for instance *Festuca hartmannii, Aconitum violaceum* var. *weilerei, Anaphalis chitralensis, Asperula oppositifolia* subsp. *baltistanica, Pedicularis staintonii, Pyrola rotundifolia* subsp. *karakoramica,* and *Hedysarum falconeri* are also recognized. The flora is under extreme natural and human hazards and emphasizes the involvement of international and national organizations dedicated to biological conservation for effective protection of flora particularly the rare and endemic taxa.

Key words: Diversity, Ecology, Conservation, Karakorum, Shigar valley, Baltistan.

Introduction

Plants are the keystones to drive the ecological processes, productivity and shape many terrestrial ecosystems. Further, plants make fundamental and main component of biological diversity. Biodiversity is crucial for the functioning and stability of ecosystem apart from the economic, ethical and aesthetic benefits (Marston, 2008; Schulze & Mooney, 2012). Mountains are major land ecosystems and possess unique physiography encompassing remarkable species diversity (Kreft & Jetz, 2007; Khan, 2012). They accommodate one quarter terrestrial biological diversity, world half hotspots and considerable ethnic groups with varied cultures (Körner *et al.*, 2011; Spehn *et al.*, 2012). The documentation and assessment of floristic diversity is crucial to understand vegetation dynamics, services and conservation priorities of ecosystem. Therefore, species level diversity has been given great importance to understand the status, variability and ecological pattern to evaluate the biodiversity (Sorrie *et al.*, 2006). According to Ali (2008) Pakistan's flora still is in exploratory phase and various areas like Khyber Pass, Koh-i-Suleman Range, Kirther Mountain range, Deosai Plain, Hunza and Baltistan are yet to be fully explored. Botanical institutes and herbaria lack inventory of various parts of the country despite continuous effort for floristic investigation and publication of National Flora (Flora of Pakistan). However, the so far known flora indicates the country's varied climate, soil and multiple ecological and phytpgeographical regions (Ali & Qaiser, 1986; Alam, 2010). Botanically the region of Baltistan is poorly explored territory despite encompassing several biologically rich valleys. But in these elevated and isolated areas numerous degradation processes have been increasing with the passage of time and make the documentation of plants urgent. Remoteness, logistic strain, accessibility and funds may be the potential hindrances to halt the botanical surveys in the region. In the current study an attempt has been made to thoroughly explore the plant biodiversity of the Shigar valley Baltistan based on field investigation carried out from 2013-2016. Many representative spots were visited frequently and various species were collected with detail field information.

Materials and Methods

Study area: The valley of Shigar is located in the central Karakorum range with geographical coordinates (25°25'32" N and 75°42'59"E) at the right bank of the river Indus. Its total covered area is 4,373 sq. km with the elevation limits of 2,260 m to 8,611 m above sea level (Ehlers and Kreutzmann, 2000; Agheem *et al.*, 2014). It borders with China (Xinxiang Province) with a wall of majestic peak of K2 between the regions (Seong *et al.*, 2009). It is the valley of enormous ridges, rocks, and peaks Baltaro and Biafo glaciers, K2, Broad Peak (8047m), Angel Peak screes, and gorges. The highly elevated zone above 6000m encompasses the highest glaciers (6858m) and Skil Brum (7360m). The population estimated 75 thousand in the project area according to recent census of 2017. The settlements are found in villages on alluvial fans, terraces and gentle slopes above the Rivers, at altitude between 2300m (Marapi), 2790m (Arando) and 3050m (Askole) (Schmidt, 2008). Floristically, it is included in the Eastern Irano-Turanian sub region (Ali & Qaiser, 1986). Climate is generally cold experiences with short, dry, hot and sunny summer with intensive radiation providing very short growing season for native flora. Winter is very prolong with periodical and heavy snowfall (Abbas *et al.*, 2017) (Fig. 1).

Data collection: During the period of 2013 – 2016 consecutive field trips were conducted in the study area in order to document species diversity. The collected plants were identified based on Flora of Pakistan Nasir, E. & Ali, S.I. (Eds.) (1970-1989), Ali, S.I. & Nasir, Y.J. (Eds.) (1989-1991), Ali, S.I. & Qaiser, M. (Eds.) (1993-2017) and Flora of China (http://www.efloras.org/flora_page.aspx?flora_id=2). Taxonomists from Hazara University and National herbarium (PMNAH), Islamabad were also consulted. The botanical names, authorities and families were assigned by Angiosperm Phylogeny Group (Group, 2009). The recognized plant species were further evaluated for their habitat types, habit, life form, leaf classes and phytogeographical distribution. Based on microclimate and topography project area was classified into eleven habitat types (Table 1) by visual observation and according to the study of Kala (2011). For growth habit categorization of species Hussain *et al*., (2015) was consulted. The specimens were examined critically and classified for their life forms in accordance of (Raunkiaer, 1934). Leaf area calculation method proposed by Cain & Castro (1959) was adapted to investigate leaf classes. Data for geographical distribution of each species was drawn from extensive survey of literature, monograph and floras and classified into twelve groups (Table 2) followed the method used by Dickoré & Nüsser (2000) and Ullah *et al*., (2015). Information was also gathered from Stewart *et al*., (1972), Takhtajan (1986), Noroozi *et al*., (2008) and TROPICOS (Missouri Botanical Garden) online data. The level of natural and human impacts were observed visually and assessed using a three points scale: 1- low impact; 2- medium impact; 3- strong impact against each habitat type as used by Nowak *et al*., (2011). Finally, the collected specimens were given the voucher numbers after going through herbarium techniques and deposited in the Hazara University Herbarium, Mansehra, Pakistan.

Result

Floristic composition: In the floristic sampling a sum of 345 vascular plant species, distributed in 206 genera and 63 families representing three major plant groups (Pteridophytes, Gymnosperms and angiosperms) were documented (Table 3). Pteridophytes were least in number and Equisetaceae was the only family with two species of *Equisetum (E. arvense, E. ramossissimum*). Family Ephedraceae and Cupressaceae represented Gymnosperms comprising 2 genera (i.e. *Ephedra, Juniperus*) with three and two species respectively. The most prevailed plant group was angiosperm showing maximum diversity and magnitude of plant biota with 60 families, 203 genera and 338 species. Among angiosperms monocotyledons were presented with 7 families, 26 genera and 32 species and dicotyledons with 53 families, 177 genera and 306 species. Twenty four families were monotypic. In the remaining families, the species were distributed as 26 families shown species between 2-5, 3 families between 6-10 and 12 families between 11-15. Asteraceae was the largest family having 35 genera and 69 species, followed by Fabaceae (15 gen; 25 spp.), Poaceae (20 gen; 24spp.), Lamiaceae (8 gen; 18 spp.), Rosaceae (10 gen; 18 spp.), Polygonaceae (6 gen; 16spp.), Chenopodiaceae (7 gen; 15 spp.), Ranunculaceae (6 gen; 14 spp.), Apiaceae (12 gen; 13spp.), Scrophulariaceae (6 gen; 13 spp.), Caryophyllaceae(4 gen; 12 spp.) and Brassicaceae (10 gen; 11 spp.). The remaining families were with less than 11 species each (Table 4). *Saussurea* was prevailed genus with 8 species. Other noteworthy genera were *Pedicularis, Potentilla* and *Nepeta* represented with 7 species each while *Artemisia, Silene, Anaphalis, Chenopodium* and *Astragalus* with 6 species each. The generic index was 1.67.

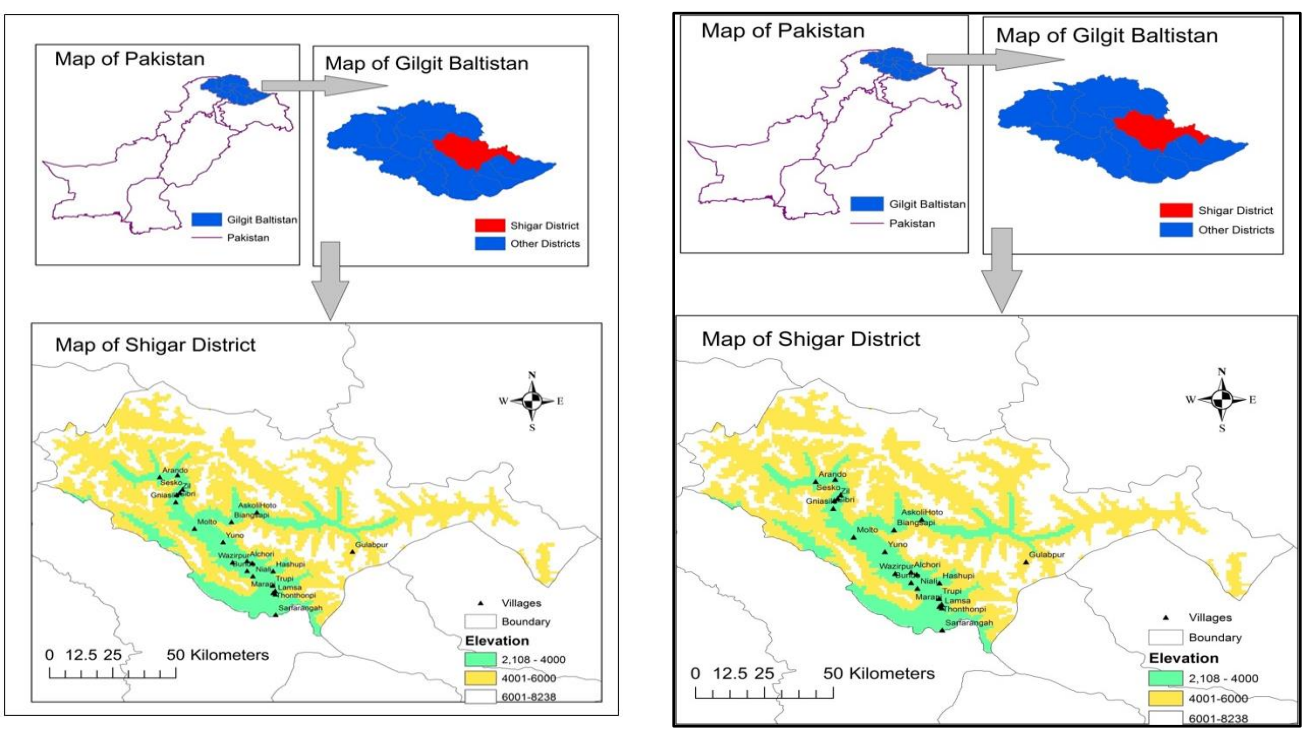

Fig. 1. Map of the valley of Shigar (the study area).

Table 1. Description of habitat types.

Habitat types	Code	Description
Alpine Boulders	ALB	High altitude boulders are mostly at banks of avalanches and tributaries. Few species are found in the boulders and moraines in alpine areas
Alpine Meadows	ALM	Alpine meadows are another common high elevation landform
Alpine Screes	ASC	Alpine scree comprised large stones but unstable. Vast alpine scree can be observed in Naltaro alpine of the valley
Alpine Slope	ALS	Alpine slopes occur above 3500 m being montane ecosystem this type of habitat is most common in the habitat classification
Dry Mountain Slope	DMS	The dry slope is the main habitat type in the study area and its demarcation is very difficult and can be observed at the altitude limit of 2215-3000. The valley bottom is bounded by northern and southern dry acclivities and also observed from Baha to Askole
Dry Sandy Plain	DSP	This specific habitat can be observed at lower elevation particularly in Sarfaranga, Thang, Baha and on the way of Blind lake (Jarba xo)
Mesic Mountain Slope	MMN	Mesic mountain steep and slopes are found on left bank of river above the villages of Sibri, Gniasilo, Sesko and Hamaisil
Moist Mountain Slope	MMS	Moist slopes mainly recognized in the sub alpine and alpine areas giving greenery to the higher elevation
River Bank	RBK	Riverine habitat is the long and major landscape type in the study area. Therefore. It is discussed separately from wetlands
Valley Waste Land	VWL	Valley dwellers always in agricultural activities and form terraces for cultivation. Waste land can be noted nearby main cultivable fields and small terraces
Wetlands	WTL	Wetland covers small tributaries, ephemeral rivulets and lake

Table 2. Account of phytogeographical elements.

Floristic element	Codes	Distribution range
Circum Polar	Cir-Pol	Occurring in the polar regions of both the hemisphere
Cosmopolitan	Cosmo	These are species with worldwide distribution on all or almost all continents
Endemic	End	Species which are restricted to the region of Gilgit-Baltistan and other parts of Pakistan
Eurasian	Eur-Asi	Widely distributed across the temperate zone of Europe and Asia. Some of them may extend into the northernmost part of Africa
Irano-Turanian	Ira-Tur	Taxa with centre of diversity in western Asia: Turkey, Mesopotamia, Anatolia, Irano-Armenia and extends up to Tien-Shan
Himalayan	Himal	Taxa occurring in all Himalayan regions (Western, Eastern and Pan-Himalaya)
Holarctic	Holar	Taxa distributed primarily in the cold temperate regions of Europe, Asia and North America (Northern Hemisphere)
Mediterranean	Med	Taxa distributed across the Mediterranean region in southern Europe, western Asia, and North Africa
Palaeotropical	Pal-Tro	Distributed in the tropics of Asia, Australia and Africa, also called old-world's tropics.
Pantropical	Pantr	Occurring in and around the tropical and subtropical regions of the world, some taxa may extend to temperate region e.g. middle east, japan, North Korea and South Korea
Tibetan	Tibet	Species occurring in the state of Tibet, China
Western Himalayan	Wes-Him	Species with centre of diversity in NW Himalayas, however occasionally may extend eastward to eastern Himalayas or northwards to central Asia and Afghanistan

Habitat and habit diversity: In the context of habitat types dry mountain slopes were recorded as the main habitat type supporting 84 (24%) plant species followed by moist mountain slopes 70 (20%), mesic mountain slope 48 (14%), valley waste land 31 (9%), alpine meadows 28 (8.11%), wetlands 27 (7.82 %), alpine slope 22 (6.37%), river bank (11 (3.18%), dry sandy plain 9 (3%), alpine screes 8 (2.31%) and alpine boulders 7 (2.02%). The plants were investigated for their growth habit and three main groups were recognized i.e. herbs, shrubs and trees. For clearer understanding of the habits, herbaceous plant species were further classified into three subcategories of annual herbs, biennial herbs and perennial herbs. Similarly the shrubs species are further categorized into shrubs and shrub let (undershrub) based on their size. Habit-wise perennial herbs were prevailed with 220 species (64.05%) followed by annual herbs 71 species (20.57 %), shrubs 26 species (7.82%), trees 4 species (1.15%), shrub lets 14 (4.05%) and biennial herbs 10 (2.89%) (Fig. 2).

Life form and leaf spectra: Following the Raunkierian classification of species based on their perennation buds six life form classes were determined. Hemicrpytophytes were the highest with 139 ssp. (40.57%) followed by chamaephytes 75 species (22.02%), therophytes 68 species (19.71%), geophytes 32 species (9.27%), nanopahanerophytes 27 species (7.82%) and megaphanerophytes 4 (1.15%). Leaf size spectra revealed that microphyll were foremost class (165 species with 47%), followed by nanophyll (119 species, 34.49%), leptophyll (35 species, 10.05%), mesophyll (14 species, 4.05%), megaphyll (3 species, 0.86%) and aphyllous (9 species, 2.60%)

Table 3. Floristic diversity of the Shigar valley: Nomenclature, habitat, habit, life form, leaf classes and floristic elements.

Family	Botanical names of species	Habitat	Habit	Life form	Leaf class	Floristic elements
Equisetaceae	*Equisetum arvense* L.	RBK	Ah	Ge	Ap	Cosmo
	Equisetum ramosissimum Desf.	WTL	Ah	Ge	Ap	Cosmo
Cupressaceae	*Juniperus excelsa* M.Bieb.	DMS	Tr	Mp	Na	Ira-Tur
	Juniperus communis L.	MMN	Sh	Np	Le	Holar
Ephedraceae	*Ephedra geradiana* Wall. ex Stapf	DMS	Sl	Ch	Ap	Wes-Him
	Ephedra intermedia Schrenk & Meyer	DMS	Sl	Ch	Ap	Cen-Asi
	Ephedra regeliana Florins	MMN	Sl	Ch	Ap	Cen-Asi
Alliaceae	*Allium carolinianum* DC.	MMN	Ph	Ge	Me	Wes-Him
	Allium oreoprasum Schrenk	DSP	Ph	Ge	Na	Cen-Asi
Cyperaceae	*Carex melanantha* C.A.Mey.	ALM	Ph	He	Mi	Cen-Asi
	Carex nubigena D. Don ex Tilloch & Taylor	MMS	Ph	He	Mi	Wes-Him
	Kobresia laxa Nees	ALM	Ph	He	Mi	Cen-Asi
Iridaceae	*Iris lactea* Pall.	VWL	Ph	Ge	Mi	Cen-Asi
Juncaceae	*Juncus articulates* L.	WTL	Ph	Ge	Mi	Cosmo
	Juncus himalensis Klotzsch	WTL	Ph	Ge	Mi	Wes-Him
Orchidaceae	*Dactylorhiza hatagirea* (D. Don) Soo	MMS	Ph	Ge	Mi	Tibet
	Epipactis gigantea Douglus ex Hook.	WTL	Ph	Ge	Mi	Holar
Poaceae	*Agrostis gigantean* Roth	MMS	Ph	He	Mi	Cosmo
	Agrostis hissarica Roshev.	MMN	Ph	He	Mi	Cen-Asi
	Alopecurus arundinaceus Poir.	MMN	Ph	He	Mi	Eur-Asi
	Avena sativa L.	CUF	Ah	Th	Mi	Cen-Asi
	Bromus hordeaceus L.	MMN	Ah	Th	Mi	Eur-Asi
	Bromus pectinatus Thunb.	MMN	Ah	Th	Mi	Cosmo
	Calamagrostis pseudophragmites (Hall.f.) Koel.	MMS	Ph	Ch	Na	Eur-Asi
	Chrysopogon gryllus (L.) Trin.	MMN	Ph	He	Mi	Ira-Tur
	Echinochloa crus-galli (L.) P.Beauv.	WTL	Ah	Th	Mi	Holar
	Elymus repens (L.) Gould	WTL	Ph	He	Mi	Eur-Asi
	Elymus nutans Griseb.	MMS	Ph	He	Mi	Cen-Asi
	Festuca hartmannii (Markgr.-Dann.) E.B. Alexeev	ALB	Ph	He	Na	End
	Pennisetum lanatum Klotzsch	DMS	Ph	He	Mi	Wes-Him
	Phragmites karka (Retz.) Trin. ex Steud.	WTL	Ph	Ch	Mi	Paltr
	Poa alpine L.	ALM	Ph	He	Mi	Holar
	Cymbopogon jwarancusa (Jones) Schult.	DMS	Ph	He	Mi	Himal
	Koeleria macrantha (Ledeb.) Schult.	DMS	Ph	He	Na	Cen-Asi
	Leymus secalinus (Georgi) Tzvelev	DMS	Ph	He	Mi	Cen-Asi
	Piptatherum gracile Mez	MMN	Ph	He	Na	Cen-Asi
	Piptatherum laterale (Regel) Nevski	DMS	Ph	He	Mi	Ira-Tur
	Schoenoplectus litoralis subsp. *Thermalis* (Trab.) S.S.Hooper	WTL	Ph	Ge	Mi	Paltr
Typhaceae	*Typha minima* Funck ex Hoppe	RBK	Ph	Ge	Na	Cen-Asi

Table 3. (Cont'd.).

Family	Botanical names of species	Habitat	Habit	Life form	Leaf class	Floristic elements
Amaranthaceae	*Amaranthus retroflexus* L.	VWL	Ah	Th	Mi	Cosmo
	Amaranthus spinosus L.	VWL	Ah	Th	Mi	Cosmo
Anacardiaceae	*Pistacia khinjuk* Stocks	DMS	Sh	Np	Mi	Ira-Tur
Apiaceae	*Aegopodium alpestre* Ledeb.	MMS	Ah	Ch	Mi	Cen-Asi
	Bupleurum hoffmeisteri Klotzsch	MMN	Ph	He	Mi	Wes-Him
	Carum carvi L.	MMS	Ph	He	Le	Eur-Asi
	Ferula jaeschkeana Votke	DMS	Ph	Ch	Me	Cen-Asi
	Heracleum pinnatum C.B. Clarke	DMS	Ph	Ch	Mi	Wes-Him
	Pimpinella diversifolia DC.	MMN	Ph	He	Na	Wes-Him
	Platytaenia lasiocarpa ssp. thomsonii (Clarke) Rech. f. & Riedl	DMS	Ph	He	Na	Wes-Him
	Pleurospermum candollei (DC.) C. B. Clark. F.	MMN	Ph	He	Mi	Wes-Him
	*Pleurospermum hookeri*C.B. Clarke	ALM	Ph	He	Mi	Wes-Him
	Selinum candollii DC.	MMS	Ph	He	Mi	Wes-Him
Apocyanaceae	*Apocynum venetum* L.	RBK	Ph	He	Mi	Eur-Asi
Asclepediaceae	*Cynanchum acutum* L.	DMS	Ph	Ch	Mi	Medit
Asteraceae	*Ajania fruticulosa* (Ledeb) Poljak	DMS	Sl	Ch	Na	Cen-Asi
	Allardia glabra Decne.	WTL	Ph	He	Na	Wes-Him
	Allardia tomentosa Decne.	ASC	Ph	He	Na	Cen-Asi
	Anaphalis boisierri Georgiadou	DMS	Ph	Ch	Na	Wes-Him
	Anaphalis chitralensis Qaiser & Abid	DMS	Ph	Ch	Na	End
	Anaphalis nepelensis var. monocephala(DC.) Hand.-Mazz.	ALM	Ph	He	Na	Wes-Him
	Anaphalis nepalensis var. nepalensis (C. B. Clarke) Ridley	ASC	Ph	He	Mi	Wes-Him
	Anaphalis staintonii Georgiadou	MMS	Ph	Ch	Na	Wes-Him
	Anaphalis virgata Thomson ex C.B. Clarke	DMS	Ph	Ch	Na	Wes-Him
	Anthemis cotula L.	VWL	Ah	Th	Mi	Cen-Asi
	Artemisia absinthium L.	VWL	Ph	Ch	Mi	Eur-Asi
	Seriphidium brevifolium (Wall. ex DC.) Ling & Y. R. Ling.	DMS	Ph	Ch	Mi	Wes-Him
	Artemisia macrocephala Jacquem. ex Besser	MMN	Ah	Th	Mi	Cen-Asi
	Artemisia rutifolia Stephan ex Spreng.	DMS	Ph	Ch	Na	Cen-Asi
	Artemisia santolinifolia Turcz.ex Krasch.	DSP	Ph	Ch	Mi	Cen-Asi
	Artemisia scoparia Waldst.	DSP	Ph	Ch	Mi	Ira-Tur
	Carduus acanthoides L.	MMN	Ph	Ch	Mi	Eur-Asi
	Carpesium abrotanoides L.	VWL	Ah	Th	Na	Eur-Asi
	Chondrilla graminea M. Bieb.	DMS	Ph	Ch	Mi	Ira-Tur
	Cichorium intybus L.	VWL	Ph	Ch	Mi	Cen-Asi
	Circium valgare (Savi) Ten.	VWL	Ph	Ch	Mi	Cen-Asi
	Conyza canadensis (L.) Cronquist	VWL	Ah	Th	Mi	CIR-Pol
	Cousinia thomsonii Clarke	MMN	Bh	He	Mi	Wes-Him

Table 3. (Cont'd.).

Family	Botanical names of species	Habitat	Habit	Life form	Leaf class	Floristic elements
	Crepis flexuosa Kit.	DMS	Ph	He	Le	Wes-Him
	Crepis sancta (L.) Bornm.	DMS	Ph	He	Na	Medit
	Erigeron acer L.	MMN	Ph	He	Mi	Holar
	Erigeron multiradiatus (Lindley ex Candolle) Bentham ex C. B. Clarke	MMN	Ph	He	Na	Wes-Him
	Echinops cornigerus DC.	DMS	Ph	Ch	Mi	Cen-Asi
	Erigeron flaccidus (Bunge) Botsch.	MMN	Ph	He	Mi	Cen-Asi
	Filago hurdwarica (Wall. ex DC.) Wagenitz	MMN	Ah	Th	Na	Cen-Asi
	Filago paradoxa Wagenitz	MMN	Ah	Th	Le	Ira-Tur
	Jurinea dolomiaea Boiss.	ALM	Ph	Ch	Mi	Ira-Tur
	Heteroppappus altaicus (Willd.) Novopokr	MMN	Ph	He	Mi	Cen-Asi
	Hieracium robustum Fries	RBK	Ph	Ge	Na	Cen-Asi
	Hieracium umbellatum L.	MMN	Ph	Ge	Mi	Holar
	Inula acuminata Royle ex DC.	WTL	Ph	He	Mi	Wes-Him
	Inula rhizocephala Schrenk	ALS	Ph	He	Na	Cen-Asi
	Inula royleana Clarke	ALM	Ph	He	Mi	Wes-Him
	Koelpinia linaeris pall.	DMS	Ah	Th	Na	Cen-Asi
	Melanoseris decipiens N. Kilian & Z. H. Wang	MMS	Ah	Th	Na	Wes-Him
	Lactuca orientalis (Boiss.) Boiss.	DMS	Sl	Ch	Mi	Cen-Asi
	Lactuca tatarica (L.) C.A. Mey.	RBK	Ph	He	Mi	Cen-Asi
	Leontopodium leontopodinum (DC.) Hand. Mazz.	ALM	Ph	He	Le	Cen-Asi
	Leontopodium linearifolium (Wedd.) Benth. & Hook. f.	MMN	Ph	Ge	Le	Tibet
	Psychrogeton poncinsii (Franchet) Y. Ling & Y.L. Chen	MMN	Ph	Ge	Na	Cen-Asi
	Pulicaria dysentrica (L.) Gaertn.	DMS	Ph	Ch	Na	Medit
	Saussurea candolleana (Wall.ex DC.) Clarke	MMS	Ph	He	Mi	Wes-Him
	Saussurea ceratopcarpa (Dcne.) Benth. & Hook.f.	ALM	Ah	Th	Mi	Wes-Him
	Saussurea chenopodifolia Klatt	VWL	Ah	Th	Mi	Wes-Him
	Saussurea costus (Falc.) Lipsch.	MMS	Ph	He	Me	Wes-Him
	Saussurea falconerii Hk. f.	MMS	Ph	He	MI	Tibet
	Saussurea jacea (Klotzsch) C.B. Clarke	MMS	Ph	Ch	Me	Wes-Him
	Saussurea simpsoniana (Fielding &Gardner) Lipsch.	ALB	Ph	He	Mi	Tibet
	Sassurea obvallata (DC.) Sch. Bip.	ALB	Ph	He	Me	Wes-Him
	Saussurea taraxicifolia (Lindle.) Wall. ex DC.	ALM	Ph	He	Mi	Wes-Him
	Scorzonera virgata DC.	ALS	Ph	He	Me	Wes-Him
	Senecio analogus DC.	ALS	Ph	Ge	Mi	Wes-Him
	Senecio flexuosus E.D. Clarke	DMS	Ah	Th	Na	Wes-Him
	Senecio krashinumkovii Schischk.	DMS	Ah	Th	Me	Cen-Asi
	Senecio tibeticus Hook.f.	ALM	Ph	He	Mi	Tibet
	Solidago dahurica Kitag.	MMS	Ph	Ge	Mi	Cen-Asi
	Sonchus asper (L.) Hill	WTL	Ah	Th	Mi	Medit

Table 3. (Cont'd.).

Family	Botanical names of species	Habitat	Habit	Life form	Leaf class	Floristic elements
	Sonchus oleraceus (L.) L.	WTL	Ah	Th	Mi	Medit
	Tanacetum falconeri Hook.R.	MMS	Ph	Ch	Mi	Wes-Him
	Taraxacum officinale (L.) Weber ex F.H.Wigg.	WTL	Ah	Th	Mi	Medit
	Taraxacum spp.	ALM	Ah	Th	Na	Tibet
	Tricholepis tibetica Hook. f. & Thomson ex C.B. Clarke	DMS	Ph	Ch	Mi	Tibet
	Tusilago farfara L.	RBK	Ph	Ge	Me	Cosmo
	Xanthium strumarium L.	VWL	Ah	Th	Me	Pantr
Balsaminaceae	*Impatiens edgeworthii* Hook. F.	MMS	Ah	Th	Mi	Wes-Him
Berberidaceae	*Berberis brandisiana* Ahrendt	MMS	Sh	Np	Mi	Wes-Him
	Berberis orthrobotrys Bien. ex Aitch.	MMN	Sh	Np	Mi	Wes-Him
	Berberis pseudoumbellata subsp. *gilgitica* Jafri	RBK	Sh	Np	Mi	End
Betulaceae	*Betula utilis* D. Don.	MMS	Tr	Mp	Mi	Wes-Him
Biebersteiniaceae	*Biebersteinia odora* Steph. ex Fisch.	ASC	Ph	He	Na	Cen-Asi
Boraginaceae	*Arnebia guttata* Bunge	DMS	Ph	He	Na	Cen-Asi
	Cynoglossum glochidiatum Wall. ex Benth.	DMS	Bh	He	Mi	Wes-Him
	Cynoglossum microglochin Benth.	DMS	Bh	He	Mi	Wes-Him
	Cynoglossum lanceolatum Forssk.	DMS	Bh	He	Na	Wes-Him
	Heliotropium dasycarpum var. gymnostomum Kazmi	DMS	Ph	Ch	Na	Ira-Tur
	Lindelofia longiflora (Benth.) Baill.	MMS	Ph	He	Mi	Wes-Him
	Myosotis alpestris F.W. Schmidt	MMS	Ph	He	Na	Cen-Asi
	Onosma hispida Wall. ex G. Don	MMS	Ph	He	Mi	Wes-Him
	Rochelia disperma (L.f.) K.Koch	DMS	Ah	Th	Na	Ira-Tur
Brassicaceae	*Capsella bursa-pestoris* (L.) Desv.	VWL	Ah	Th	Mi	Cosmo
	Chorispora sabulosa Camb. in Jacquem.	ASC	Ah	Th	Na	Cen-Asi
	Chorispora sibirica (L.) DC.	DMS	Ah	Th	Na	Cen-Asi
	Conringia planisiliqua Fischer & C. A. Meyer	VWL	Ah	Th	Mi	Cen-Asi
	Descurainia sophia (L.) Webb & Berth.	VWL	Ah	Th	Mi	Cen-Asi
	Draba winterbottomii (Hook. f. & Thoms.) Pohle	ALB	Ph	Ch	Le	Tibet
	Malcolmia cabulica (Boiss.) Hook.f. & Thoms.	VWL	Ah	Th	Mi	Ira-Tur
	Malcolmia africana (L.) R.Br.	VWL	Ah	Th	Mi	Eur-Asi
	Matthiola chorassanica Bunge ex Boiss.	DMS	Ph	He	Mi	Ira-Tur
	Sisymbrium irio L.	VWL	Ah	Th	Mi	Eur-Asi
Campanulaceae	*Campanula cashmeriana* Royle	DMS	Ph	He	Na	Wes-Him
	Codonopsis clematidea (Shrenk) C.B.Clarke	MMS	Ph	Ge	Na	Cen-Asi
Cannabaceae	*Cannabis sativa* L.	VWL	Ah	Th	Na	Cen-Asi
Capparidaceae	*Capparis himalayensis* Jafri	DMS	Sl	Ch	Mi	End
Caprifoliacea	*Lonicera microphylla* Willd. ex Schult.	MMN	Sh	Np	Na	Cen-Asi
Caryophyllaceae	*Cerastium dichotomum* L.	MMS	Ph	He	Na	Medit

Table 3. (Cont'd.).

Family	Botanical names of species	Habitat	Habit	Life form	Leaf class	Floristic elements
	Cerastium fontanum Baung.	VWL	Ph	He	Na	Wes-Him
	Cerastium cerastoides (L.) Britton	ALS	Ph	He	Le	CIR-Pol
	Dianthus anatolicus Boiss.	DMS	Ph	He	Na	Ira-Tur
	Silene arenosa C. Koch	ALS	Ah	Th	Na	Cen-Asi
	Silene conoidea L.	VWL	Ah	Th	Na	Ira-Tur
	Silene gonosperma (Rupr.) Bocquet	ALM	Ph	He	Na	Cen-Asi
	Silene gonosperma subsp. himalayensis (Rohrb.) Bocquet	ALS	Ph	He	Na	Tibet
	Silene moorcroftiana Wall. ex Benth.	ALS	Ph	He	Na	Wes-Him
	Silene vulgaris (Moench) Garcke	MMS	Ph	He	Mi	Eur-Asi
	Stellaria media (L.) Vill.	WTL	Ah	Th	Na	Cosmo
	Stellaria persica Boiss.	MMS	Ah	Th	Na	Ira-Tur
Chenopodiaceae	*Chenopodium album* L.	VWL	Ah	Th	Na	Cosmo
	Chenopodium badachsanicum Tzvelev.	DSP	Ah	Th	Mi	Cen-Asi
	Chenopodium botrys L.	MMN	Ah	Th	Mi	Medit
	Chenopodium foliosum Asch.	MMN	Ah	Th	Na	Ira-Tur
	Chenopodium murale L.	MMS	Ah	Th	Mi	Eur-Asi
	Chenopodium pamiricum Iljin	MMN	Ah	Th	Na	Ira-Tur
	Corispermum tibeticum Iljin	DSP	Ah	Th	Na	Cen-Asi
	Halogeton tibeticus Bunge	DMS	Ah	Th	Le	Cen-Asi
	Haloxylon griffithii (Moq.) Boiss.	DMS	Sl	Ch	Le	Cen-Asi
	Haloxylon thomsonii Bunge ex Boiss.	DMS	Sl	Ch	Na	Tibet
	Kochia prostrata (L.) Schrad.	DMS	Sh	Np	Le	Cen-Asi
	Kochia indica Wight	DMS	Sh	Np	Na	Medit
	Krascheninnikovia ceratoides (L.) Guldenst.	DMS	Sh	Np	Na	Medit
	Krascheninnikovia pungens Podlech	DMS	Sh	Np	Le	Cen-Asi
	Salsola tragus L.	DMS	Ph	He	Na	Cen-Asi
Convolvulaceae	*Convolvulus arvensis* L.	VWL	Ph	He	Mi	Cosmo
Crassulaceae	*Haloteliphium ewarsii* (Ledeb.) H.Ohba	MMS	Ph	Ch	Na	Cen-Asi
	Rhodiola coccinea subsp. Scabrida (Franch.) H. Ohba	MMN	Ph	Ch	Na	Tibet
	Rhodiola fastigiata (Hook. f. & Thomson) S.H. Fu	ALS	Ph	Ch	Mi	Wes-Him
	Rhodiola heterodonta (Hook. f., & Thomson) Boriss.	ALM	Ph	Ch	Na	Medit
	Rhodiola tibetica (Hook.f. &Thomson) S.H.Fu	ALM	Ph	Ch	Na	Wes-Him
	Rhodiola wallichiana (Hook.) S.H. Fu	MMS	Ph	Ge	Na	Wes-Him
Cuscutaceae	*Cuscuta capitata* Roxb.	DMS	Ph	He	Ap	Cen-Asi
	Cuscuta epithymum (L.) L.	DMS	Ah	Th	Ap	Holar
	Cuscuta hyalina Roth	DMS	Ah	Th	Ap	Ira-Tur
	Cuscuta lupiliformis Krock.	DMS	Ah	Th	Ap	Eur-Asi
Elaeagnaceae	*Hippophae rhamnoides* ssp. *turkestanica* Rousisss	CUF	Sh	Np	Na	Cen-Asi

Table 3. (Cont'd.).

Family	Botanical names of species	Habitat	Habit	Life form	Leaf class	Floristic elements
Fabaceae	*Astragalus falconeri* Bunge	MMS	Ph	He	Mi	Tibet
	Astragalus frigidus L.	MMS	Ph	He	Mi	Eur-Asi
	Astragalus himalyananus Klotzsch.	MMS	Ph	He	Na	Wes-Him
	Astragalus peduncularis Royle	MMS	Ph	He	Mi	Cen-Asi
	Astragalus polemius Boiss.	DMS	Ph	He	Le	End
	Astragalus rhizanthus Benth.	MMN	Ph	He	Me	Tibet
	Colutea paulsonii ssp. *paulsonii* (Shap. ex Ali) Ali	DMS	Sh	Np	Mi	Cen-Asi
	Desmodium gangeticum L.	DMS	Ph	Ch	Mi	Paltr
	Hedysarum falconeri Baker	MMS	Ph	He	Na	End
	Lotus corniculatus L.	MMS	Ph	He	Na	Ira-Tur
	Medicago minima (L.) L.	MMS	Ph	He	Na	Ira-Tur
	Melilotus alba Ledeb.	MMN	Ah	Th	Na	Eur-Asi
	Melilotus indica (L.) All.	MMN	Ah	Th	Na	Eur-Asi
	Onobrychis dasycephala Baker	DMS	Ph	He	Mi	Ira-Tur
	Oxytropis microphylla (Pall.) DC.	DMS	Ph	He	Le	Tibet
	Oxytropis lapponica (Wahlenb.) Gay	MMS	Ph	He	Mi	CIR-Pol
	Oxytropis cachemiriana Cambess.	ALM	Ph	He	Le	Wes-Him
	Oxytropis mollis Benth.	MMS	Ph	He	Na	Wes-Him
	Sophora alopecuroides L.	DMS	Ph	He	Na	Cen-Asi
	Trifolium pratense L.	VWL	Ph	He	Na	Eur-Asi
	Trifolium repens L.	WTL	Ph	He	Na	Cen-Asi
	Cicer microphyllum Benth.	MMS	Ah	Th	Mi	Cen-Asi
Fumariaceae	*Corydalis adiantifolia* Hook.f. & Thomson	MMS	Ph	He	Mi	Tibet
	Corydalis tibetica Hook.f. & Thoms.	MMS	Ph	He	Mi	Tibet
	Corydalis flabellata Edgew.	DMS	Ph	He	Mi	Wes-Him
Geraniceae	*Erodium cicutarium* (L.) L'Hér.	DMS	Ah	Th	Na	Medit
	Geranium sibiricum L	VWL	Ph	He	Mi	Eur-Asi
	Geranium wallichianum D. Don ex Sweet.	ALM	Ph	He	Mi	Wes-Him
Gentianaceae	*Comastoma borealis* (Bunge) T.N.Ho	MMS	Ah	Th	Mi	Holar
	Jaeschkea canaliculata (Royle ex G. Don) Knobl.	ALM	Bh	Ge	Na	Wes-Him
	Gentianodes eumarginata Omer	MMS	Ah	Th	Le	Wes-Him
	Gentianodes tianschanica (Rupr.ex Kusn.) Omer.Ali & Qaiser	MMS	Ph	He	Mi	Cen-Asi
	Gentianopsis paludosa (Munro ex Hook.f.) Ma.	MMS	Ah	Th	Mi	Tibet
	Lomatogonium carinthiacum (Wulfen) A.Braun	MMS	Ah	Th	Mi	Cen-Asi
	Lomatogonium spathulatum (A. Kern.) Fernald	MMS	Ah	Th	Mi	Tibet
	Swertia cordata (G.Don) Clark	WTL	Ah	Th	Na	Wes-Him
	Swertia petiolata D. Don	ALS	Ph	He	Mi	Cen-Asi
Grossulariaceae	*Ribes alpestre* Decne.	MMN	Sh	Np	Mi	Ira-Tur
	Ribes himalense Royle ex Decne.	MMS	Sh	Np	Mi	Wes-Him
	Ribes orientale Desf.	MMN	Sh	Np	Mi	Cen-Asi

Table 3. (Cont'd.).

Family	Botanical names of species	Habitat	Habit	Life form	Leaf class	Floristic elements
Lamiaceae	*Dracocephalum nutans* L.	MMS	Ph	He	Na	Cen-Asi
	Isodon rugosus (Wall.ex Benth.) Codd	DSP	Ph	Ch	Na	Ira-Tur
	Leonurus cardiaca L.	MMN	Ph	Ch	Mi	Cen-Asi
	Mentha royleana Benth.	WTL	Ph	He	Mi	Wes-Him
	Nepeta discolor Boyle ex Benth.	DMS	Ph	Ch	Mi	Wes-Him
	Nepeta clarkei Hook.f.	ALB	Ph	Ch	Na	Wes-Him
	Nepeta floccosa Benth.	DMS	Ph	Ch	Mi	Cen-Asi
	Nepeta adenophyta Hedge	DMS	Ph	He	Na	End
	Nepeta leucolaena Benth. ex Hook.f.	DMS	Ph	He	Le	Tibet
	Nepeta linearis Royle ex Benth.	DMS	Ph	He	Mi	Wes-Him
	Nepeta erecta (Royle ex Benth.) Benth.	ASC	Ph	Ch	Na	Wes-Him
	Perovskia abrotanoides Kar.	DMS	Ph	Ch	Na	Cen-Asi
	Prunella vulgaris L.	VWL	Ph	He	Mi	Holar
	Scutellaria prostrate Jacquem. ex Benth.	DMS	Ph	He	Mi	Wes-Him
	Scutellaria scandens D. Don	DMS	Ph	He	Me	Tibet
	Stachys tibetica Vatke	DMS	Ph	Ch	Mi	Wes-Him
	Thymus linearis Benth.	MMN	Ph	He	Na	Wes-Him
Malavaceae	*Malva neglecta* Wallr.	VWL	Ph	Ch	Mi	Cosmo
Morinaceae	*Morina coulteriana* Royle	MMN	Ph	Ch	Mi	Wes-Him
Oleaceae	*Fraxinus xanthoxyloides* (G.Don) DC.	DMS	Sh	Np	Mi	Wes-Him
Onagaraceae	*Epilobium angustifolium* L.	MMN	Ph	Ch	Mi	Cosmo
	Epilobium latifolium subsp. *latifolium* P.C. Hoch & P.H.Raven	MMN	Ph	Ch	Mi	Wes-Him
Orobanchaceae	*Orobanche cernua* Loeffl.	DMS	Ph	Ch	Le	Eur-Asi
Papaveraceae	*Papaver nodicaule* L.	ALS	Ph	He	Mi	Cen-Asi
Parnassaceae	*Parnassia nubicola* Planch.ex Clark	WTL	Ah	Th	Na	Wes-Him
Plantaginaceae	*Plantago major* L.	MMS	Ph	He	Me	Eur-Asi
	Plantago ovata Forssk.	VWL	Ph	He	Mi	Medit
Plumbaginaceae	*Acantholimon lycopoidioides* (Girard) Boiss.	DMS	Ph	Ch	Le	Cen-Asi
	Acantholimon tianschaniucum Czerniak.	DMS	Sl	Ch	Na	End
	Dictyolimon macrorrhabdos (Boiss.) Rech. f.	DMS	Sl	Ch	Mi	Wes-Him
Polygonaceae	*Bistorta affinis* (D. Don.) Green.	ALS	Ph	Ge	Na	Wes-Him
	Bistorta vivipara (L.) S.F. Gray.	ALS	Ph	Ge	Na	CIR-Pol
	Oxyria digyna (L.) Hill	ALS	Ph	He	Na	CIR-Pol
	Persicaria amphibia (L.) Delarbre	WTL	Ph	Ch	Mi	CIR-Pol
	Persicaria hydropiper (L.) Spach	WTL	Ph	Ch	Na	Holar
	Persicaria nepalensis (Meisn.) Miyabe	WTL	Ph	Ch	Na	Paltr
	Polygonum paronychioides C.A. Mey.	DMS	Ph	Ch	Na	Cen-Asi
	Polygonum plebejum R.Br.	DSP	Ah	Th	Na	Paltr
	Rheum tibeticum Maxim. ex Hook. f.	DMS	Ph	Ch	Mi	Tibet

Table 3. (Cont'd.).

Family	Botanical names of species	Habitat	Habit	Life form	Leaf class	Floristic elements
	Rumex conglumeratus Murray	MMS	Bh	Ch	Mi	Eur-Asi
	Rumex hastatus D. Don.	DMS	Sl	Ch	Na	Cen-Asi
	Rumex nepalensis Spreng.	MMS	Ph	Ch	Me	Ira-Tur
	Rumex patientia L.	MMS	Ph	Ch	Mi	Cen-Asi
	Rheum webbianum Royle	MMN	Ph	He	Me	Wes-Him
Primulaceae	*Primula denticulata* Smith	WTL	Ph	He	Mi	Wes-Him
	Primula warshenewskiana B. Fedtsch	ASC	Ph	He	Mi	Cen-Asi
Pyrolaceae	*Pyrola rotundifolia* subsp. *karakoramica* (Krisa) Y.Nasir	MMS	Ph	He	Mi	End
Ranunculaceae	*Aconitum heterophyllum* all ex Royle	ALM	Bh	Ge	Mi	Wes-Him
	Aconitum violaceum var. weileri (Gilli) Riedl	ALS	Bh	Ge	Mi	End
	Aconitum rotundifolium Kar. & Kir.	ALM	Bh	Ge	Na	Cen-Asi
	Aquilegia fragrans Benth.	ALS	Ph	Ge	Mi	End
	Aquilegia fragrans var. *kanawareensis* (Jacqu. ex Camb.) H. Riedl	MMS	Ph	Ge	Mi	Wes-Him
	Clematis alpine var. sibirica (L.) Kuntze	MMS	Sh	Np	Le	Cen-Asi
	Clematis grata Wall.	DMS	Ph	Ch	Mi	Wes-Him
	Clematis orientalis L.	DMS	Ph	He	Na	Cen-Asi
	Delphinium brunonianum Royle	ALB	Ph	Ge	Mi	Tibet
	Delphinium cashmerianum Royle	ALS	Ph	He	Na	Tibet
	Pulsatilla wallichiana (Royle) Ulbr.	ALS	Ph	He	Na	Wes-Him
	Ranunculus palmatifidus H.Riedl	WTL	Ph	He	Na	End
	Ranunculus repens L.	VWL	Ph	Ge	Mi	Eur-Asi
	Thalictrum foliolosum DC.	MMS	Ph	Ge	Le	Wes-Him
Rhamnaceae	*Rhamnus prostrata* Jacq. ex Parker	DMS	Sh	Np	Na	Ira-Tur
	Rhamnus triquetra (Wall.) Brandis	DMS	Tr	Mp	Mi	Wes-Him
Rosaceae	*Alchemilla trollii* Rothm.	ALM	Ph	He	Mi	Wes-Him
	Cotoneaster intergerrimus Medik.	DMS	Sh	Np	Na	Eur-Asi
	Fragaria nubicola (Hook.f.) Lindl.ex Lacaita	MMS	Ph	He	Na	Wes-Him
	Potentilla dryadanthoides (Juz.) Vorosch.	ALB	Sl	Ch	Le	Cen-Asi
	Potentilla anserina L.	VWL	Ph	He	Mi	CIR-Pol
	Potentilla atrosanguinea Lodd.	ALM	Ph	He	Mi	Wes-Him
	Potentilla ornithopoda Tausch	ALS	Ph	He	Le	Cen-Asi
	Potentilla salesoviana Steph.	MMS	Ph	He	Mi	Cen-Asi
	Potentilla spp.	ASC	Ph	He	Na	Cen-Asi
	Rosa webbiana Wall.ex Royle	MMN	Sh	Np	Na	Cen-Asi
	Spiraea hypericifolia L.	MMS	Sh	Np	Na	Ira-Tur
	Sibbaldia cunneata O. Kunz	ALM	Ph	Ch	Na	Eur-Asi
	Sibbaldia tetrandra Bunge	ASC	Ph	Ch	Na	Cen-Asi
	Sorbus tianschanica Rupr.	MMS	Tr	Mp	Mi	Cen-Asi
Rubiaceae	*Asperula oppositifolia* Regel & Schmalh.	MMN	Ph	He	Le	End

Table 3. (Cont'd.).

Family	Botanical names of species	Habitat	Habit	Life form	Leaf class	Floristic elements
	Galium asperifolium subsp. a*sperifolium* (Wall.) Kitam	MMS	Ph	He	Na	Wes-Him
	Galium verum L.	ALS	Ah	Th	Na	Holar
Salicaceae	*Salix karelinii* Turcz.	MMS	Sh	Np	Mi	Ira-Tur
Saxifragaceae	*Bergenia stracheyi* (Hook.f. & Thorns.) Engl.	MMS	Ph	Ch	Me	Cen-Asi
	Saxifraga flagellaris Willd.	ALM	Ph	He	Le	Wes-Him
	Saxifraga sibirica Gaud.	ALM	Ph	He	Le	Eur-Asi
Scrophulariaceae	*Scrophularia nudata* Penn.	DMS	Ph	He	Mi	End
	Lagotis kunawurensis (Royle) Rupr.	WTL	Ph	He	Mi	Wes-Him
	Leptorhabdos parviflora (Benth.) Benth.	DMS	Ph	He	Na	Ira-Tur
	Pedicularis bicornuta Kl.	MMS	Ph	He	Mi	Wes-Him
	Pedicularis longiflora Rudolph ssp. *tubiformis* (Klotzch) Rennell	WTL	Ph	He	Mi	Himal
	Pedicularis pectinata Wall. ex Bth.	MMS	Ph	He	Mi	Wes-Him
	Pedicularis staintonii R.R.Mill	MMS	Ph	He	Mi	End
	Pedicularis rhinanthoides Schrenk	ALM	Ph	He	Mi	Wes-Him
	Pedicularis punctate	MMS	Ph	He	Mi	Wes-Him
	Pedicularis albida Pennell	ALM	Ah	Th	Na	Wes-Him
	Veronica alpina L.	ALS	Ah	Th	Le	Wes-Him
	Euphrasia multiflora Pennell	MMS	Ah	Th	Le	Wes-Him
	Verbascum thapsus L.	MMN	Bh	He	Ma	Eur-Asi
Solanaceae	*Hysocymus niger* L.	MMN	Ah	Th	Mi	CIR-Pol
	Hyoscymus pusillus L.	MMN	Ph	Ch	Mi	Cen-Asi
	Solanum nigrum L.	VWL	Ah	Th	Le	Cosmo
	Datura stramonium L.	VWL	Ph	Ch	Mi	Cosmo
	Lycium ruthenicum Murray	MMN	Sl	Ch	Le	Eur-Asi
Tamaricaceae	*Myricaria germanica ssp. pakistanica* Qaiser	RBK	Sh	Np	Le	Cen-Asi
	Tamaricaria elegans (Royle) Qaiser & Ali	RBK	Sh	Np	Le	Cen-Asi
	Tamarix ramosissima Ledeb.	RBK	Sh	Np	Le	Cen-Asi
	Tamarix leptostachya Bunge	RBK	Sh	Np	Le	Cen-Asi
Thymelaeaceae	*Daphne mucronata* Royle	DMS	Sl	Np	Na	Wes-Him
Urticaceae	*Urtica dioca* L.	WTL	Ph	He	Mi	Holar
	Parietaria judaica L.	MMN	Ph	He	Na	Medit
Valerianaceae	*Valeriana himalayana* Grub.	ALS	Ph	Ge	Na	Wes-Him
	Valeriana jaeschkei C.B. Clarke	ALM	Ph	Ch	Na	Wes-Him
Zygophyllaceae	*Tribulus terrestris* L	DSP	Ah	Th	Na	Medit
	Peganum harmala L.	DSP	Ph	He	Na	Medit

Key: **Habitat**: DMS; dry mountain slope, RBK; river bank, MMS; Moist mountain slope, MMN; mesic mountain slope , VWL; valley waste land, CUF; cultivated fields ALM; alpine meadows, WTL; wetlands ALS; alpine slope, DSP; dry sandy plain, ASC; alpine screes, ALB; alpine boulders **Habit:** Ah; Annual herb, Bh; Biennial herb, Ph; Perennial herb Sl; Shrublet, Sh; Shrub, Tr: Tree **Life form**: Th; Therophyte Ge; Geophyte, He; Hemicryptophyte, Ch; Chamaephyte, Np; Nanophanerpphyte, Mp; Megaphanerophyte, **Leaf classes**: Le; Leptophyll, Ma; Megaphyll, Me; Mesophyll, Mi; Microphyll, Na; Nanophyll, Ap; Aphyllous **Floristic elements**: Cosmo; Cosmopolitan, Ira-Tur; Irano-Turanian, Wes-Him; Western Himalayan, Cen-Asi; Central Asian, Holar; Holarctic, Tibet; Tibetan, Medit; Mediterranean, Eur-Asi; Eurasian, Cir-Pol; Circum polar, Paltr; Paleotropical and Pantr; Pantropical

Table 4. Family-wise distribution of genera and species.

Family	Genera	%	Species	%	Family	Genera	%	Species	%
Alliaceae	1	0.48	2	0.57	Iridaceae	1	0.48	1	0.28
Amaranthaceae	2	0.97	2	0.57	Juncaceae	1	0.48	2	0.57
Anacardiaceae	1	0.48	1	0.28	Lamiaceae	8	3.88	17	4.92
Apiaceae	9	4.36	10	2.89	Malavaceae	1	0.48	1	0.28
Apocyanaceae	1	0.48	1	0.28	Morinaceae	1	0.48	1	0.28
Asclepiadaceae	1	0.48	1	0.28	Oleaceae	1	0.48	1	0.28
Asteraceae	35	16.99	69	20	Onagaraceae	1	0.48	2	0.57
Balsaminaceae	1	0.48	1	0.28	Orchidaceae	2	0.97	2	0.57
Berberidaceae	1	0.48	3	0.86	Orobanchaceae	1	0.48	1	0.28
Betulaceae	1	0.48	1	0.28	Papaveraceae	1	0.48	1	0.28
Biebersteiniaceae	1	0.48	1	0.28	Parnassiaceae	1	0.48	1	0.28
Boraginaceae	7	3.39	9	2.6	Plantaginaceae	1	0.48	2	0.57
Brassicaceae	9	4.36	10	2.89	Plumbaginaceae	2	0.97	3	0.86
Campanulaceae	2	0.97	2	0.57	Poaceae	19	9.22	21	6.08
Cannabaceae	1	0.48	1	0.28	Polygonaceae	5	2.4	14	4.05
Capparidaceae	1	0.48	1	0.28	Primulaceae	1	0.48	2	0.57
Caprifoliacea	1	0.48	1	0.28	Pyrolaceae	1	0.48	1	0.28
Caryophyllaceae	4	1.94	12	3.4	Ranunculaceae	6	2.91	14	4.05
Chenopodiaceae	7	3.39	15	4.34	Rhamnaceae	1	0.48	2	0.57
Convolvulaceae	1	0.48	1	0.28	Rosaceae	8	3.88	14	4.05
Crassulaceae	2	0.97	6	1.73	Rubiaceae	2	0.97	3	0.86
Cupressaceae	1	0.48	2	0.57	Salicaceae	1	0.48	1	0.28
Cuscutaceae	1	0.48	4	1.15	Saxifragaceae	2	0.97	3	0.86
Cyperaceae	2	0.97	3	0.86	Scrophulariaceae	6	2.91	13	3.7
Elaeagnaceae	1	0.48	1	0.28	Solanaceae	4	1.94	5	1.44
Ephedraceae	1	0.48	3	0.86	Tamaricaceae	3	1.45	4	1.15
Equisetaceae	1	0.48	2	0.57	Thymelaeaceae	1	0.48	1	0.28
Fabaceae	12	5.82	22	6.37	Typhaceae	1	0.48	1	0.28
Fumariaceae	1	0.48	3	0.86	Urticaceae	2	0.97	2	0.57
Gentianaceae	6	2.91	9	2.6	Valerianaceae	1	0.48	2	0.57
Geraniaceae	2	0.97	3	0.86	Zygophyllaceae	2	0.97	2	0.57
Grossulariaceae	1	0.48	3	0.86					

Fig. 2. Some characteristic species of the study area; a. *Allardia tomentosa* a high alpine species b. *Chorispora sabulosa* a rare species of alpine boulders c. *Rhodiola bupleuroides* a common species of alpine scree d. *Stellaria persica* a rare sub alpine species e. *Delphinium brunonianum* a rare and famous medicinal plant f. *Clematis alpina* var. *sibirica* a regionally endemic medicinal species.

Phytogeography

The assessment on global geographical range distribution of the species was documented in order to understand the migratory path and floristic distribution of the collected species. It revealed the huge existence of Irano-turanian elements in the study area with 122 species (35.36%). The rest comparative sharing of other floristic elements were shown as Western Himalayan elements (97 species, 28.69%) Eurasian (28 species, 8.40%), Cosmopolitan (16 species, 4.63%), Tibetan (6.66 species, 6.66%), Mediterranean (16 species, 4.63%), Endemic (15 species, 4.34%), Holarctic (12 species, 3.47%), Circum polar (8 species, 2.31%), Paleotropical (5 species, 1.4 %), Himalayan 2 species, 0.57%) and Pantropical (1 species, 0.28%).

Threats to flora

Twelve types of both human impacts and natural hazards were pointed out at habitat level. The most common and destructive threats was intensive grazing as no single habitat type is free of it. Land and ice sliding, erosion, mining and blasting were noted as other potential pressures to local plant species (Table 5).

Table 5. Natural and human impacts at habitat level.

Types of impacts / Habitat types	Land sliding	Ice sliding	Flood	Drought	Trampling	Agriculture	Erosion	Cutting	Uprooting	Mining	Blasting	Grazing	Σ
Alpine boulders	3	3	0	0	2	0	1	0	0	3	0	2	14
Alpine meadows	0	0	0	0	3	0	0	0	0	2	0	3	8
Alpine screes	3	3	0	0	2	0	2	0	0	3	0	2	15
Alpine slope	1	1	0	0	3	0	0	0		0	0	3	8
Dry mountain slope	1	1	1	3	2	2	1	2	3	1	2	2	21
Dry sandy plain	0	0	0	1	1	0	0	0	1	0	0	1	4
Mesic mountain slope	0	0	0	0	2	2	0	0	0	0	0	2	6
Moist mountain slope	1	2	2	0	1	1	2	3	2	2	0	3	19
River Bank	1	1	3	0	1	1	3	3	2	0	0	1	16
Valley waste land	0	0	1	1	1	3	1	3	3	0	2	1	16
Wetlands	0	0	1	0	2	1	1	1	1	0	0	0	7
Σ	10	11	8	5	20	10	11	12	12	11	4	20	

Key: 1- low impact; 2- medium impact; 3- strong impact

Discussion

The Shigar valley resides substantial plant diversity and presents ferns and seed plants. Angiosperms are the successful group of the project area due to their adaptations with varied habitat types. These findings show harmony with the Abbas (2012) in Tormik valley and (Khan, 2007) in the valleys of Haramosh and Bugrote. Asteraceae was dominant family in terms of genera (35) and species (69). It is considered as highly advanced and specialized in morphology. Moreover, it possesses broad ecological niche and makes their assortment in all world biomes from tropics to polar regions (Xiaoping & Bremer, 1993; Barreda *et al.*, 2012). The outcome agreed with the study of Chawla *et al.*, (2008) and Noroozi *et al.*, (2008). The present total is the first data base of the area and further skillful taxonomic work may raise the species number. Habitat is the basic prerequisite for the survival and maintenance of biological diversity. The floral variability is directly associated with the ecosystem and habitat (Tews *et al.*, 2004). Habitat diversity enhances the species diversity making easy assessment and conservation of biological diversity of any region (Amoros, 2001; Pärtel, 2002). The main habitat type was arid mountain slope favoring maximum assortment of the species and agreed with the work of Nowak *et al.*, (2014) conducted in the colline and rocky mountains of Pamir-Alai and Tien Shan Mountains in Tajikistan. The flora with dominant herbaceous plants strongly indicates the harsh environment, short growing season and thick snow layer (Lekhak & Yadav, 2012). Shrubs and sub shrubs were uncommon and decline with respect to elevation increase. Frequent drought and extreme radiation could be the possible reasons behind poor assemblage of trees and shrubs. Only four tree species were observed and only Birch tree presented its considerable clump in the sub alpine areas. The short vegetation season and low precipitation could also be co-related with less tree number in the study area these outcomes agreed with the outcomes of Mahdavi *et al.*, (2013) carried out in the Alborz Mountains, Iran where they reported very few phanerophytes (0.7%). These results were also supported by the conclusions of Qiong *et al.*, (2010) in Gyama valley reporting single tree species in Tibetan Plateau. Life form classification is one of the common ecological index used in literature and provides basic climatic information and comparison of regional flora (Danin & Orshan, 1990; Klimes, 2003). Hemicryptophytes (142, 41%) were very common and showed rise with altitude and this prevalence points toward the cold and dry climate. Mostly Chamaephytes were found in lower rocky terrain indicating the desert environment supported by the study of Qadir & Shetvy (1986). The knowledge of leaf spectra may be useful in order to understand the physiological process of plants and their communities (Oosting, 1956). The present work revealed that the leaf classes microphyll (184 species, 53%) and nanophylls (121 species, 35%) were common in the valley. These findings contradict with the results of (Hussain *et al.*, 2015) from Chitral since their study was based on different vegetation types. However, our results agreed with the findings of Tareen & Qadir (1993) who

conducted in the dry lands of Baluchistan. The agreement could be related with the water scarcity and favor the growth of xeric adapted plants with small leaves size. The analysis of species for their geographical distribution proved the prevalence of Irano-Turanian elements (122 species, 35.36%) followed by Western Himalayan elements (97 species, 28%). In phytogeographical analysis Irano-Turanian species dominates and indicated that the flora still can be included in Irano-turanian type. This may be attributed with more or less similar rocky mountainous geography and physiographical settings with the territories of Irano-Turanian region particularly the Central Asiatic states. Furthermore, the project area shares more species with Central Asiatic subregion territories and may be linked with the generally similar climatic conditions with arid and semi-arid montane and sub montane belts of the region. Although autonomous state of Tibet (China) is located nearer to the region but due to giant Glaciers of Baltaro and Siachan as barriers share only 23 species. According to Dickoré & Nüsser (2000) the colline belt (valley floor) of the valleys is the potential path foe the migration of central Asiatic elements. However, our findings contradict with the phytogeographical analysis of Nanga Parbat carried out by aforecited authors. They separately reported the small proportions of floristic elements of Irano-Turanian region and Central Asiatic subregion by 8.8% and 8.6% respectively and with Western Himalayan pervasiveness (26%). Fifteen endemic species were recorded i.e. *Asperula oppositifolia* susp. *baltistanica* is exclusively endemic to the area and declared as critically endangered species and in the study area it is found with limited individuals (Alam & Ali, 2010). *Aconitum violoceum* var. *weihlerei* is vulnerable for Pakistan. *Pyrola rotundifolia* subs. *Karamkoramica is* another endemic taxon with very few records of collection. Other endemic, rare and regionally unique species were *Accantholimon tianschanicum*, *Ranunculus palmatifidus* H.Riedl, *Scrophularia nudata* Penn. *Pedicularis staintonii* R.R.Mill, *Festuca hartmannii* (Markgr.-Dann.) E. B. Alexeev, *Anaphalis chitralensis* Qaiser & Abid, *Berberis pseudoumbellata* subsp. *gilgitica* Jafri *Capparis himalayensis* Jafri and *Apocynum venetum* L. The transition climatic condition of mountain landforms believed to be the ideal condition for speciation and revison of some genera for instance, *Saussurea*, *Chenopodium*, *Astragalus* could possibly enhance the endemic total. The flora experiences various anthropogenic pressure and natural hazards causing direct habitat fragmentation. The endemic species are considered to be more susceptible of environmental fluctuations and threatened due to their narrow niche and restricted distribution (Ali, 2008; Abbas *et al.*, 2013). Therefore, the study advocates the vulnerability and risk to these species inviting special attention to ensure the protection for their survival.

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