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SPECIES DIVERSITY AND PHYTO-CLIMATIC GRADIENT OF A MONTANE ECOSYSTEM IN THE KARAKORUM RANGE

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Abstract

Analyzing species diversity and understanding phyto-climatic gradient is crucial for proper management of montane ecosystem. The study site is located in the Karakoram Mountains, Baltistan (Northern Pakistan), covering an area of 2750 Km². It is situated on the right bank of the River Indus in the Central Karakorum Mountains at an elevation range of 2000 to 6000 m at sea level. On the basis of change in topography, elevation and climate study area was classified into four Vegetation Zones viz. dry zone, agro-forestry zone, Sub-alpine zone and Alpine zone. A total of 180 species of vascular plants representing 139 genera and 53 families were collected with generic index of 1.2. Twenty four families were represented by single species. and family Asteraceae was dominant family including 36 species followed by families Papilionaceae, Polygonaceae, Rosaceaeand Chenopodiaceae representative of 11, 10, 10 and 8 species respectively. *Artemisia* (7 species), *Chenopodium* (4), *Astragalus* (4) and *Geranium* (3) were identified as leading genera. Habit wise perennial herbs prevailed with 113 species followed by annuals (41 species), shrubs (18), biennials (3) and trees (3).In biological spectrum, the area is dominated by 46% of Hemicryptophytes (84 species) followed by 21% therophytes (39), 11% Chamaephytes (21), 10% Nanophanerophytes (18),10% Geophytes (14) and 2% Mega-phanerophytes (3). The altitudinal gradient of species showed that the species richness declines with increase in elevation from sea level. Most of the species found in the middle elevations (2700-3300m) and a sharp decrease were observed at high elevation (above 3900m). Agricultural encroachment, grazing, blasts for gemstones; rock drifting and land sliding were common and severe natural and anthropogenic threats. These and many other threats to the available vegetation urge for more precise botanical explorations and prompt conservatory management in the scenario of national and global interest in these fragile ecosystems.

Key words: Vegetation, Diversity, Phytoclimatic gradient, Conservation, Baltistan, Karakorum Mountains

Introduction

Vegetation zonation on the basis of elevation is one of the most remarkable patterns of vegetation and much of the data is available on it at local scales all around the globe (Grytnes, 2003; Webster, 1961). Vertical zonation into altitudinal belts with distinct climate is a characteristic feature of high mountains (Becker *et al*., 2007). This topic always remained the focus of interest among the researchers and various studies could be found in different mountain system of the world for instance (Beals, 1969; Grytnes, 2003; Khan *et al*., 2011; Mahdavi *et al*., 2013; Ohsawa, 1984). Environmental conditions and vegetation change rapidly at mountainous ecosystems over short distances and consequently these ecosystems attained a sharply demarcated ecological gradient and vegetation zones (Friend *et al*., 1989; Lomolino, 2001; Odland, 2009). The knowledge of the floristic composition of an area is a prerequisite for any ecological and phyto-geographical studies and conservation management activities (Jafari & Akhani, 2008). Species richness is the simple and easily interpretable indicator of biological diversity (Chesson, 2000; Peet, 1974).

The Karakorum Range of mountains(71° - 79° E, 35°-36° N) is one of the diverse habitats in the world and floristically situated at the junction of the Western and Central Asiatic sub-regions of Tethyan Floristic Region (Takhtajan, 1986). It is one the majestic mountain systems on the earth surface stretching at about 500 Km in the North of greater Himalayas. A part of the Karakorum mountains is situated in the region of Gilgit-Baltistan of Northern Pakistan and is known as central Karakorum range where it follows the right bank of the River Indus and River Shyokin Baltistan, a botanically under explored region of Pakistan (Ali, 2008). Karakoram possesses dry summer climate. This mountain belt frame inner mountain basins, plateau and valley bottoms as desert-like responsible for the typical landscape of the Northern Areas of Pakistan (Kreutzmann, 2006). It encompasses dozens of deeply incised valleys which exhibit subtropical steppe among these high mountain ranges. Dry and semi-dry eco-region of the Karakorum is not so rich in floristic composition but give a unique species assemblage with respect to elevation and topography (Dickoré, 1995). According to (Seong *et al*., 2007) in the Central Karakoram, elevation effects on precipitation results in an altitudinal zonation of vegetation (Khan *et al.,* 2017; Khan *et al.,* 2012). Mountain ecosystems are the remarkable landforms on the earth surface distinguished with prominent vegetation zone mainly based on altitudinal and climatic variation (Khan *et al*., 2013b; Khan *et al.,* 2016).

The concept of life-forms of vascular plants dates back to Von Humboldt (1806) that was originally developed for a non-taxonomical comparison of vegetation types in different regions of the globe. Various literature ca be found in this aspect for instance (Qadir & Shetvy, 1986;

Tareen & Qadir, 1993; Pavón *et al*., 2000; Klimes, 2003; Mahdavi *et al*., 2013). Life forms in an ecosystem indicate the adaptations of plant species to the surrounding climate (Bano *et al*., 2017; Khan *et al*., 2013a). Life-form spectrum gives basic climatic information (Campbell & Werger, 1988; Danin & Orshan, 1990). It has been repeatedly shown that life-form spectra (proportion of species belonging to individual life- forms) can be predicted for particular climatic properties, for any continent, biogeographic region and an ecosystem (Sarmiento & Monasterio, 1983). The present study was aimed to investigate phyto-climatic gradient and develop vegetation zones in the studied region for better management and conservation of floristic diversity.

Materials and Methods

Study area: The study area Shighar Valley covers an area of approximately 2750 Km^2 in the District Skardu in Baltistan region (Northern Areas, Pakistan) (Fig.1) (Abbas *et al.,* 2016). It is situated on the right bank of the River Indus in the central Karakorum Mountains with elevation limits between 2000-6000m asl. It borders with a small valley Homarah in the East, Thowar in the west and the River Indus in the South. Kathio, Matumbur, Chongchan and Niarmo are well-known glaciers. Tributaries from these glaciers shape the valley main water course is an Indus tributary having numbers of settlements on its banks. Chabrunmo (Chutron) lake a hot spring while Baa-rzing (seasonal), Khla-rzing and Naqpo-rzingbu are permanent high altitude lakes in the valley.

Physiographically, two parallel sub mountain systems give zigzag shape to the valleys and it arise abruptly by stony belt in lower most area giving a diverse topography along the elevation. Lower terrain has boulders and screes. Middle elevations encompass enormous arable fields and terraces covered with dry northern and southern mountain slopes. Sub alpine has considerable plains on river banks where mono-cropic agriculture is in practice (Abbas *et al.,* 2016).

Winter is prolonged, harsh and cold with plenty of snowfall (Abbas *et al.,* 2016) . The lower areas exhibit hot and dry desert sort of environment but at higher elevations frequent precipitation give rise to richer vegetation. Exact metrological data is not available due to absence of weather station in the area. However, data from Skardu town, situated at a distance of 55 km from the study area showed mean monthly temperature (11.5℃), winter maxima (-23.2˚ C), and mean winter temperature (0℃) from November to March (Klimeš & Dickoré, 2005). Floristically, it falls in Eastern Irano-Turanian sub region (Ali & Qaiser, 1986).

Data Collection: Field trips were arranged to the study area in the summer of 2011 for a period of seven months. Plant specimens were collected at different elevations and various seasons. Qualitative attributes like species composition, diversity and phenology were assessed. The quantitative ecological techniques were found out using quadrat method. Sizes of the quadrats used for tree, shrub and herb species were 10 × 10 m^2, 5 × 5 m^2 and 1 × 1 m^2 respectively (Ahmad *et al*., 2016; Khan *et al*., 2016a; Khan *et al*., 2016b). All plant species were classified into life form categories using Raunkiaer classification (Khan *et al*., 2016c; Raunkiaer, 1934). The plant specimens were collected and identified through nomenclature mainly based on Flora of Pakistan and other literature (Nasir & Ali, 1968-1988; Ali & Nasir, 1989-1992; Ali & Qaiser 1993-Todate).

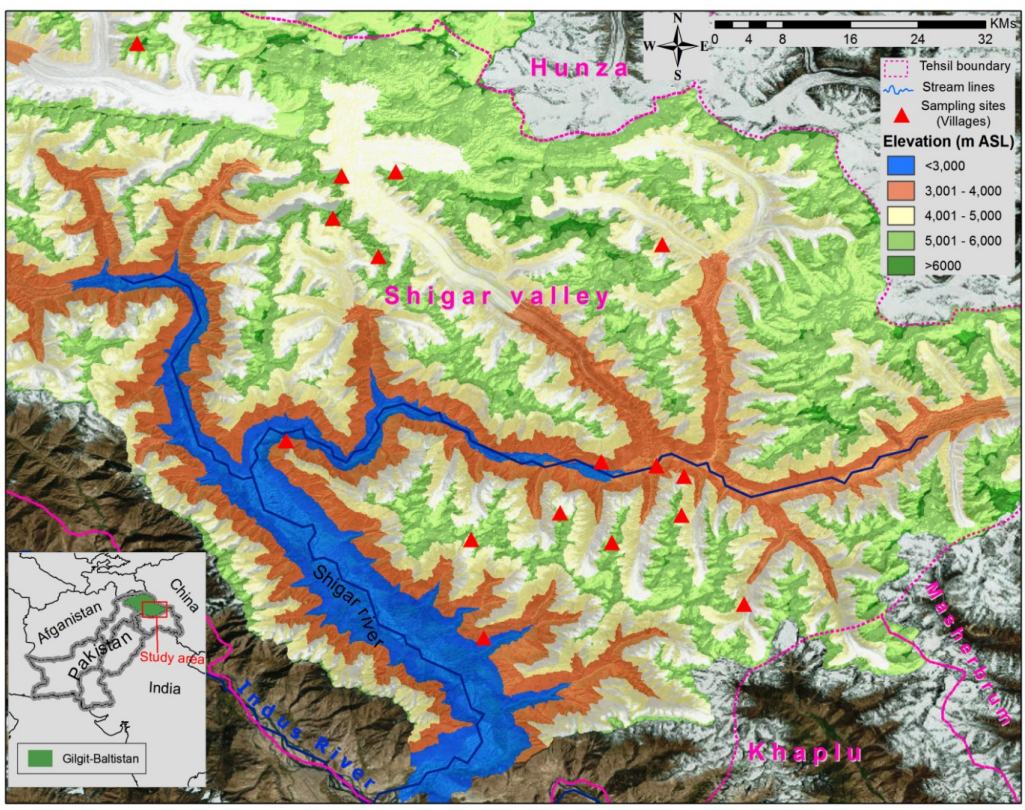

Fig 1 Map of the study area

Results

Vegetation Zonation: As the study area exhibits varied physical geography, climatic conditions and hence diverse species composition along the altitudinal gradient (Fig. 2).

On the basis of these factors and vegetation zones the area can be divided into four elevation zones i.e.

- Dry zone 2024 – 2700 m asl
- Agro-forestry zone 2700 – 2900 m asl
- Subalpine zone 2900 – 3500 m asl
- Alpine zone 3500 m asl and above

Dry zone: The lower elevation parts of the valley (2024 to 2700m) exhibit dry sort of habitat condition. This zone is rich in boulders, gravels, stable and unstable screes with varied slope, aspects and pedology. Monsoon rainfall is very rare in the area and the main source of soil water is melting snow. Due to its sand and boulder rich soil, this zone cannot retain more moisture as compared to upper elevations of the region. Due to dry nature this belt characterized by very few species with sparse distribution and low vegetation cover. Shrub species of this zone were *Pistacia khinjuk, Daphne mucronata Capparis spinosa*, sub shrubs were *Ephedra intermedia*, *Rumax hastatus*, *Kraschenin nikouiaceratoides* and herbaceous plants *Chenopodium badacshanicum, Heliotropium dassycarpum, Tribulus terrestris, Artemisia scoparia, Cynanchum acutum* are found. Agricultural activities rapidly increasing for instance the construction of water canals, terrace making for crops e.g. *Fagopyrum esculentum, Trifolium pratense* and plantation of *Populus, Salix* and *Elaeagnus*. Besides, rock drifting, land sliding, seasonal flood, uprooting of shrubs and semi shrubs for domestic fuel, land tilling, stone explosion were the common natural and anthropogenic threats causing habitat fragmentation.

Agro-forestry zone: Inner valley floor exhibits a bit moist climate due to water bodies and irrigation system for agriculture. Most of the area is covered by agricultural fields and small terraces. Northern and southern slopes provide temporary grazing area and domestic wood for the settlers. A number of species found in crop fields, waste lands and along water channels. Mountain bottom of the area possesses mono-cropic fields on gentle slopes of river banks. *Cerastium fontanum, Dactylorhiza hatagira, Descurainia sophia, Elymus dentatus, Eqiusetum arvense, Geranium wallichiana, Hyoscymus niger, Poa pratense, Silene valgare, Silene cashmeriana, Stellaria media, Trifolium repens, Urtica dioca* were some representative species. Seasonal floods, constructions and continuous agricultural encroachments are the main pressures on the plant diversity of this regio.

Sub alpine zone: The zone is covered by semi-arid mountain slopes with different species composition and distribution pattern. It has cool and moist environment and distinct vegetation strata can be observed. *Chenopodium foliosum,Cicer microphyllum*, *Fragaria nubicola, Gentianodes eumarginata. Gentianopsis paludosa, potentilla anserine, Rumax spp, Silene vulgaris, Trifolium spp and Taraxacum spp* are commonly distributed. *Hippophe rhamnoides Myricaria germanica ssp. pakistanica* and *Tamaricaria elegans* beautifully shape the riverine forest. Clumps of *Betula utilis, Cotaneaster spp, Juniperus communis, Juniperus excelsa, Salix spp*., *Rosa brunonii* are found on north facing slopes. Scarce vegetation found on south facing slopes with sparse distribution of *Artemisia brevifolia, Ephedra intermedia, Potentill asalesviana and Juniperus excelsa.* High rate and random deforestation and grazing are major hurdles for the vegetation.

Alpine zone: The alpine communities consist of alpine meadows, slopes, stable and unstable screes. Few and common herbaceous species of high elevation communities are *Pedicularis pectinatus, Rhodiola heterodonta, Anaphalis nepelensis, Gentianodes tianschanica, Leontopodium leontopodinum, Inula rhizocephala, Myosotis alpestre, Tanacetum falconeri,* and *Delphinium brunonianum*. *Rhododendron hypenanthum* is a rare species in the area. The alpine plant biota experiences the human imposed threats of excavation and explosion for gem stones and grazing cattles.

Floral diversity: Altogether a total of 180 species were collected belonging to 53 families and 139 genera. In these, Angiosperms were represented by 49 families, followed by two of gymnosperm and two families of pteridophytes. Among the Angiosperms the forty four (44) families represented dicots and rests of the 5 families were monocots. Family Asteraceae, Papilionacaeae, Polygonaceae, Rosaceae, Chenopodiaceae, Lamiaceae, Boraginaceae and Scrophulariaceae with thirty six (36), (11), (10), (10), (8), (7), (6) and (6) species respectively. On the basis of distribution of species in families monotypic families lead by 26 (49%) and 10 (19%) were represented by two species. *Artemisia* (7 species), *Chenopodium* (4 species), *Pedicularis* (4 species), *Astragalus* (3 species), *Geranium* (3 species) and *Potentilla* (3 species) were the distinct genera (Table 1).

Life form classification: In the total collected plants perennial herbaceous habit prevailed (113 species) followed by annuals (41), shrubs (18), biennials (3), and trees (3). Six life forms classes were distinguished in which Hemi-cryptophytes were dominant (84) species, followed by Therophytes (39), Chamaephytes (21), Nanophanerophytes (18), Geophytes (14) and Megaphanerophytes (3) (Table 1).

Altitudinal distribution: The total of 180 vascular plant species could be divided into three altitudinal classes of different altitudinal distribution pattern. Class A comprises of 50 species being the lower belt in the study area indicating intermediate distribution (27%) of overall species. Class B includes 99 species being the middle elevation belt presents more species occurrence i.e. 55%. Class C consists of 31 (17%) species and this less number is due to harshness of climate at upper altitudes (Fig. 3).

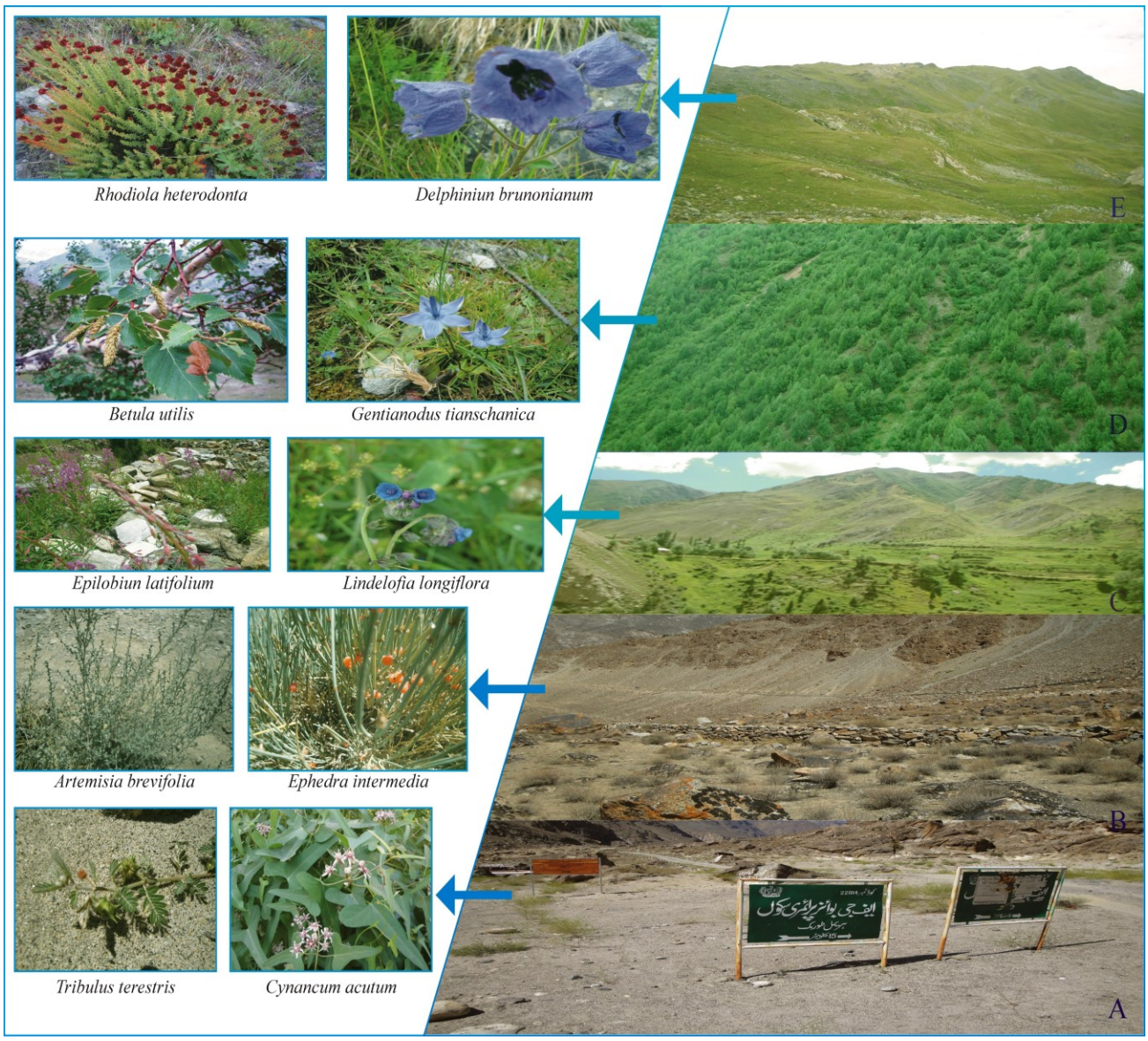

Fig. 2 Illustration of the vegetation zonation (A & B = Dry, C = Agro-forestry, D = Subalpine, E = Alpine Zone) with characteristic species of each zone

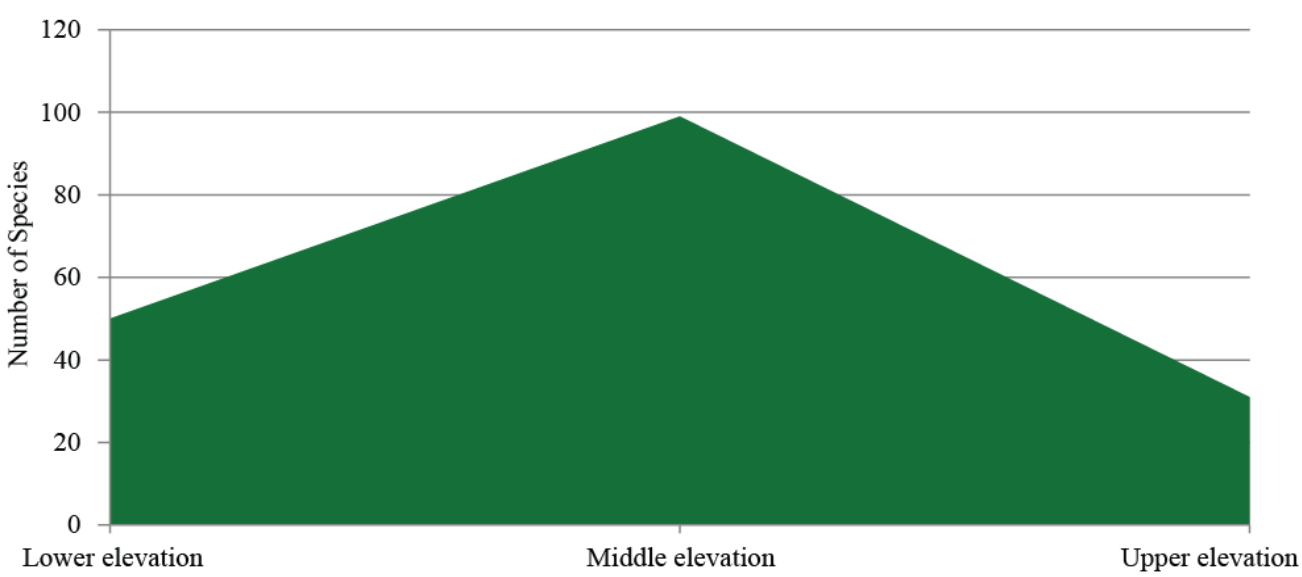

Fig. 3 Distribution of species along three elevation classes

Table 1 Plant species of the study region, habit, life form and elevation class.

Family	Species	Habit	Life form	Altitudinal Classes
Pteridaceae	*Adiantum capillus-veneris* L	Per	Geo	A
Equisetaceae	*Eqiusetum arvense* L.	Per	Geo	B
Cupressaceae	*Juniperus excels* M. Bieb.	Tre	Mph	B
	Juniperus communis L.	Shr	Nph	C
Ephedraceae	*Ephedra intermedia* Schrenk& Meyer	Shr	Nph	A
Alliaceae	*Allium carolinianum* DC.	Per	Geo	D
Cyperaceae	*Carexa trofusca* Schkuhr, Besschr. Riedgras.	Per	Geo	B
	*Kobresia laxa*Nees	Per	Geo	B
Juncaceae	*Juncus benghalensis* Kunth	Per	Geo	D
	Juncusm embranaceus Royle Ex. Don.	Per	Geo	B
Orchidaceae	*Dactylorhiza hatagirea* (D.Don.) Soo	Per	Geo	B
	Epipactis gigantean Dougl. ex Hook.	Per	Geo	B
Poaceae	*Bromus pectinatus* Thunb.	Anu	The	B
	Elymus caninus L.	Per	Hem	B
	Elymus dentatus (Hook.f.) T. A. Cope	Per	Hem	B
	Poa nemoralis L.	Per	Hem	C
	Poa pratensissubsp. angustifolia Gaud.	Per	Geo	B
	Setaria viridis (L.) P. Beauv.	Anu	The	B
Apiaceae	*Bupleurum tenue* Buch. Ham. ex Don.	Anu	The	B
	Pimpinella diversifolia DC.	Per	Hem	B
	Pleurospermum candollei (DC.) C. B. Clark.F.	Per	Hem	D
	Selinum sp.	Per	Hem	B
Amaranthaceae	*Amaranthus viridis* L.	Anu	The	A
Anacardiaceae	*Pistacia khinjuk* Stocks	Tree	Mph	A
Asclepiadaceae	*Cynanhum acutum* L.	Per	Hem	A
Asteraceae	*Allardia tomentosa* Decne.	Per	Hem	B
	Anaphalis nepalensis var. *nepalensis* (C. B. Clarke) Ridley	Per	Hem	D
	Anaphalis virgata Thomson ex C. B. Clarke	Per	Hem	D
	Anthemis cotula L.	Anu	The	B
	Artemisia absinthium L.	Per	Cha	B
	Artemisia annua L.	Anu	The	A
	Artemisia brevifolia Wall. ex DC.	Per	Cha	A
	Artemisia gmelinii Web. ex Stechm.	Per	Cha	A
	Artemisia japonica Thunb.	Per	Cha	A
	Artemisia santolinifolia Turcz ex Krasch.	Per	Cha	A
	Artemisia scoparia Waldst.	Bie/Per	Cha	A
	Aster hamlaicus C.B. Clarke	Anu	The	D
	Cichorium intybus L.	Per	Cha	A
	Circium vulgare (Savi) Ten.	Per	Cha	B
	Conyza bonariensis L.	Per	Hem	B
	Cousinia thomsonii Clarke	Per	Hem	B
	Erigeron sp.	Per	Hem	B
	Filago hurdwarica (Wall. ex DC.) Wagenitz	Anu	The	B
	Heteroppappus altaicus (Willd.) Novopokr	Per	Hem	B
	Hieracium prenanthoides Vill.	Anu	The	B

Table 1 (Cont'd)

Family	Species	Habit	Life form	Altitudinal Classes
	Inula rhizocephala Shrenk	Anu	The	D
	Inula royleana Clarke	Per	Cha	C
	Lactuca lassertiana (Wall. ex. DC.) Clarke	Per	Hem	B
	Leontopodium leontopodinum (DC.) Hand. Mazz.	Per	Hem	D
	Mulgedium decipiens H. & T.	Per	Hem	C
	Sassurea candolleana (Wall. ex DC.) Clarke	Per	Hem	C
	Sassurea falconerii Hook.f.	Per	Hem	D
	Sassurea obvallata (DC.) Sch. Bip	Per	Hem	D
	Scorzonera hondae Kitam.	Anu	The	B
	Scorzonera sp.	Anu	The	B
	Senecio krashinumkovii Schis.	Anu	The	C
	Tanacetum falconeri Hook.f.	Per	Cha	D
	Taraxacum officinale Weber	Per	Hem	B
	Taraxacum sp.	Anu	The	D
	Tusilago fafara L.	Per	Cha	B
	Tricholepis tibetica L.	Per	Hem	A
Balsaminaceae	*Impatience edgeworthii* Hook.f.	Anu	The	B
Berberidaceae	*Berberis pseudoumbellata subsp. gilgitica* Jafri	Shr	Nph	B
Betulaceae	*Betula utilis* D.Don.	Tre	Mph	B
Boraginaceae	*Cynoglossum lanceolatum* Forssk.	Bie	Hem	B
	Heliotropium dasycarpium Ledeb.	Per	Hem	A
	Lindelofia longiflora (Benth.) Baill.	Per	Hem	B
	Myosotis alpestris Vestergren ex Hulten	Per	Hem	B
	Onosma hispida Wall. ExG.Don.	Per	Hem	C
Brassicaceae	*Capsella bursa-pestoris* (L.) Desv.	Anu	The	B
	Descurainia sophia (L.) Web. &Benth.	Per	Cha	A
	Malcolmia cabulica (Boiss.) Hook. f. &Thoms.	Anu	The	B
	Draba stenocarpa Hook.f. & Thomson.	Anu	The	B
	Paryaes capa Ledeb.	Per	Hem	B
	Sisymbrium irio L.	Anu	The	B
Campanulaceae	*Campanula cashmeriana* Royle	Per	Hem	B
	Codonopsis calematidae (Shrenk) C.B.Clarke	Per	Hem	B
Capparidaceae	*Capparis spinosa* L.	Shr	Nph	A
Caprifoliacea	*Lonicera heterophylla* Decne.	Shr	Nph	B
Caryophyllaceae	*Cerastium fontanum* Baung.	Per	Hem	A
	Dianthus anatolicus Boiss.	Per	Hem	A
	Silene vulgaris (Moench) Garcke.	Per	Hem	B
	Silene kunawarensis Benth.	Per	Hem	B
	Stelleria media (L.) Vill.	Anu	The	A
Chenopodiaceae	*Chenopodium album* L.	Anu	The	A
	Chenopodium badachsanicum Tzvelev.	Anu	The	A
	Chenopodium botrys L.	Anu	The	A
	Chenopodium foliosum Asch.	Anu	The	B
	Kochia scoparia (L.) Schard.	Anu	The	A
	Kocthia stellaris Moq.	Bie	Hem	A
	Krascheninnikovia ceratoides (L.) Guldenst.	Shr	Nph	A

Table 1 (Cont'd)

Family	Species	Habit	Life form	Altitudinal Classes
	Salsola kali L.	Per	Hem	A
Convolvulaceae	*Convolvulus arvensis* L.	Anu	Hem	A
Crassulaceae	*Haloteliphium ewarsii* (Ledeb.) H.Ohba	Anu	Hem	C
	Rhodiola heterodonta (Hook. f., & Thomson) Boris.	Per	Hem	D
Cuscutaceae	*Cuscuta europea* L.	Anu	Twn	A
Elaeagnaceae	*Hippophe rhamnoides* subsp. *Turkestanica* Rous.	Shr	Nph	B
Ericaceae	*Rhododendron hypenanthum* Balf. f.	Shr	Nph	D
Fumariaceae	*Corydalis adiantifolia* Hook. f. & Thoms.	Per	Hem	B
Gentianaceae	*Comastoma borealis* (Bunge) T.N.Ho	Anu	The	C
	Gentianodes eumarginata Omer	Anu	The	C
	Gentianodes tianschanica (Rupr.exKusn) Omer Ali & Qaiser	Per	Hem	C
	Gentianopsis paludosa (Munro ex Hook. f.) Ma.	Per	Hem	C
	Swertia cordata (G. Don) Clarke	Anu	The	A
Geraniaceae	*Geranium wallichianum* D.Don ex Sweet.	Per	Hem	B
	Geranium pretense L.	Per	Hem	C
	Geranium nepalensis Sweet.	Anu	Hem	A
Grossulariaceae	*Ribes alpestre* Decne.	Shr	Nph	B
Lamiaceae	*Isodon rugosus* (Wall. ex Benth.)	Shr	Nph	A
	Leonurus cardiaca L.	Per	Geo	A
	Mentha royleana Benth.	Per	Hem	A
	Nepeta nervosa Royle ex Benth.	Per	Hem	B
	Scutellaria prostrata Jacq. ex Benth.	Per	Hem	B
	Scuttelaria scandens Buch. Ham.ex.D.Don	Per	Geo	B
	Thymus linearis Benth.	Per	Hem	B
Morinaceae	*Morina longifolia* Wall. ex DC.	Per	Cha	B
Onagaraceae	*Epilobium angustifolium* L.	Per	Hem	A
	Epilobium latifolium Royle	Per	Cha	B
Orobanchaceae	*Orobanchus cernua* Loeffl.	Bie/Per	Hem	A
Papaveraceae	*Papave rnodicaule* L.	Per	Hem	C
Papilionaceae	*Astragalus frigidus* L.	Per	Hem	B
	Astragalus himalyananus Klotzsch.	Anu	The	B
	Astragalus polemius Boiss.	Per	Hem	B
	Astragalus scorpiurus Bunge	Per	Hem	B
	Cicer microphyllum Benth.	Per	Hem	B
	Colutea paulsonii Freyn	Shr	Nph	A
	Lotus corniculatus L.	Per	Hem	B
	Mellilotus alba Desr	Anu	The	A
	Mellilotu sindica (L.) All.	Anu	The	A
	Trifolium pretense L.	Per	Hem	A
	Trifolium repens L.	Per	Hem	A
Parnassaceae	*Parnassia nubicola* Planch. ex. Clarke	Anu	The	B
Plantaginaceae	*Plantago major* L.	Per	Hem	A
	Plantago ovate Forssk.	Anu	The	B
Polygonaceae	*Aconogon onalpinum* (All.) Schur	Per	Hem	C
	Bistorta affinis (D.Don.) Green.	Per	Geo	C
	Bistorta vivipara (L.) S.F.Gray.	Per	Geo	C

Table 1 (Cont'd)

Family	Species	Habit	Life form	Altitudinal Classes
	Oxyria digyna (L.) Hill	Per	The	C
	Persicaria amphibia (L.) S. F. Gray.	Per	Hem	C
	Persicaria hydropiper (L.) Spach	Per	Hem	B
	Polygonum plebejum R.Br.	Anu	The	B
	Rheum webbianum Royle	Bie	Cha	C
	Rumex hastatus D.Don.	Shr	Nph	A
	Rumex nepalensis Spreng.	Per	Cha	B
Ranunculaceae	*Aconitum heterophyllum* Wall ex Royle	Bie	Cha	C
	Aconitum violceum Jacq. Ex Stapf.	Bie	Cha	D
	Aquilegia pubiflora Riedl & Yasin J. Nasir	Per	Cha	C
	Delphinium brunonianum Royle	Per	Hem	D
	Pulsatilla wallichiana (Royle) Ulbr.	Per	Hem	C
	Ranunculus palmatifidus H. Riedl	Per	Hem	B
Rosaceae	*Alchemilla trollii* Rothm.	Per	Hem	C
	Cotoneaster sp.	Shr	Nph	B
	Fragaria nubicola (Hook.f.) Lindl. ex Lacaita	Per	Hem	B
	Potentilla anserine L.	Per	Hem	D
	Potentilla salesoviana Steph.	Per	Hem	B
	Potentilla sp.	Per	Hem	B
	Rosa brunonii Lindl.	Shr	Nph	B
	Rosa webbiana Wall.ex Royle	Shr	Nph	B
	Sibbaldia pocumbens L.	Per	Hem	C
	Spiraea canescens D. Don	Per	Hem	C
	Asperulaoppositifolia subsp. Baltistanica Nazim.	Per	Hem	C
Rubiaceae	*Rubia cordifolia* L.	Per	Hem	B
	Galium boreale L.	Anu	The	A
Saxifragaceae	*Bergenia stracheyi (*Hook. f. & Thorns.) Engl.	Per	Hem	C
	*Saxifraga flagellaris s*ubsp. *Komarovii* (A.Los.) Hult.	Per	Hem	C
Solanaceae	*Datura fastuosa* L.	Per	Cha	B
	Hysocymus niger L.	Per	The	A
	Solanum nigrum L.	Anu	The	A
Scrophulariaceae	*Scrophulari anudata* Penn.	Per	Hem	A
	Veronica anagallis aquatic L.	Anu	The	A
	Pedicularis bicornuta Kl.	Per	Hem	C
	Pedicularis pectinata Wall. ex Benth.	Per	Hem	C
	Verbascum thapsus L.	Per	Cha	C
	Pedicularis sp.	Per	Hem	D
Tamaricaceae	*Myricaria germanica ssp. Pakistanica* Qaiser	Shr	Nph	B
	Myrtama elegans (Royle) Qaiser & Ali	Shr	Nph	B
Thymelaeaceae	*Daphne mucronata* Royle	Shr	Nph	A
Urticaceae	*Urtica dioca* L.	Per	Hem	A
Valerianaceae	*Valeriana himalyana* Grub.	Per	Hem	C
Zygophyllaceae	*Tribulu sterrestris* L.	Bie	Hem	A

Habit: *Anu* = Annual, *Per* = Perennial, *Bie* = Biennial, *Shr* = Shrub, Life form: *Geo* = Geophyte, *Hem* = Hemicryptophyte, *The* = Therophyte, *Cha* = Chamaephyte, *Mph* = Megaphanerophytes, *Nph* = Nanophanerophytes

Discussion

The environment of northern Pakistan in Karakoram mountain region is harsh (Derbyshire *et al*., 2001) and the monsoon does not reach in Baltistan. In the study area climate responds greatly its topography and shows different ranges from bottom up to alpine region. Generally, it confronts with short, dry, hot and sunny summer with intensive radiation. It may be due to Himalayan range as rain shadow in the south of entire Baltistan but considerable precipitation is received in early spring and late summer giving very short growing season.

Phyto-climatic gradient and species diversity

The study area presents a distinct zonation in terms of climatic and geo-physical factors. It was observed that altitude, topography and exposure have more influence in determining the vegetation zonation in the area. Each zone can be recognized by characteristic species that show specific habitat preferences. It can be correlated with the studies of (Eberhardt *et al.*, 2007) in Batura valley, Hunza Karakorum and (Webster & Nasir, 1965) in Hushe valley. Among climatic factors moisture has role in mapping the vegetation and species distribution validated by (Seong *et al*., 2007). *Capparis himalayansis, Kochia stellaris, Tribulus terrestris, Krascheninnikouia ceratoides,* are mostly found in lower areas, also exist in lower Ladakh (India) almost possesses similar geo-climatic conditions (Dickoré, 1995; Dvorský *et al*., 2011).

Plant diversity of the study area was not so rich but presents all plant divisions pteridophytes, gymnosperms and angiosperms. Angiosperms were well distributed and showed great variation in species composition prevailing dicots as compare to monocots. A sum of 180 species was collected representing 53 families and 139 genera with species average of 3 per family. Among fifty three families 24 (49%) families were represented by a single species, 10 families by 2 species in terms of number of species and only eight families possessed species more than five. It could be concluded that very few families are rich in Karakoram. Family Compositae is dominant in Karakoram Mountains and keeps considerable species richness and evenness and signified by the literatures (Abbas *et al*., 2013; Khan, 2007).

High number herbaceous species strongly pointed out about the short growing season and harsh environment (Tasser and Tappeiner, 2002). Similarly the Hemi-cryptophytic dominance of life forms show the higher elevation habitat of the cold and dry climate. Chamaephytes were found only in lower rocky terrain that indicate the dry environment supported by the study of (Jürgens *et al.*, 2010).

Conservation management

Biodiversity is gradually diminishing due to various factors and recent estimates suggest that more than half the habitable surface of the earth has already been significantly altered by human activities (Heywood, 1995). The mountain people rely on forest resources and they fulfill their daily needs on any cost. Therefore being fragile and complex ecosystem mountain phyto and zoo diversity more vulnerable to natural and anthropogenic threats. The international goals in order to persist the indigenous biodiversity can be achieved by protecting both biodiversity pattern (the full diversity of genes, species, communities, habitats and ecosystems, and landscapes) and ecological and evolutionary processes that sustain this pattern (Margules and Pressey, 2000). The plant biota of the study area experience numerous natural and human imposed threats viz. land sliding, seasonal floods, rock drifting, weathering, deforestation, grazing, trampling, plant uprooting and rock blast etc (Abbassi *et al.,* 2013). Most of these threats are related to direct habitat fragmentation and it is the most destructive cause for biodiversity (Fahrig, 2003).

The region of Baltistan is one of them and its deep mountainous valleys support rich floral diversity with unique physiography and climatology. In the context of floristic research these valleys are under explored. Isolated geography, inaccessibility and lack of research projects may be the basic handicaps to study vegetation of these regions. The comprehensive botanical expeditions and explorations of these regions could add new species to our national flora. This study pointed out various threats for indigenous flora which strongly suggest for prompt conservatory strategies for its protection.

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