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ASTRAGALUS CLARKEANUS ALI: A THREATENED AND NARROW ENDEMIC SPECIES IN GILGIT-BALTISTAN, PAKISTAN

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Abstract

Astragalus clarkeanus Ali, a narrow endemic species, belongs to the family Fabaceae-Papilionoideae. It is exclusively endemic to two localities of Gilgit-Baltistan, Pakistan. Based on ten field surveys, made from 2004 to 2007, the population size (i.e. maximum 54 individual plants) and geographic range (i.e., 10 km^2) of this species should be regarded as Critically Endangered (CR) according to IUCN Red list Categories and Criteria. The main threat factors to the taxon are extremely small population size, limited geographic range, habitat degradation due to extensive grazing and soil erosion. Remedial measures are also suggested.

Key Words: Conservation Status; Gilgit-Baltistan; Endemic; Pakistan; Critically Endangered

introduction

The species extinction crisis is considered to be the most serious threat to mankind for their survival. Therefore, protection of biological diversity is the moral and evolutionary responsibility of mankind in order to smoothly running of various ecological systems on the earth.

Pakistan occupies an area of 804,152 sq. km. In the South it is bound by Arabian Sea and in the north the second highest peaks of the world i.e. Godwin Austin or K2 (8610m) is situated. Furthermore, larger glaciers out side of the Polar Regions are also located here, like Biafo glacier, is 62 km long and covers an area of 529 sq. km (Perkin, 2003). Climate of the country is also variable and may be classified from arid to subarid in the South to subhumid-humid in the north (Khan, 1995). Due to the diversity in terrain and climate, the Flora of Pakistan is quite rich in species diversity; the generic index is as low as 25.87 % (Ali & Qaiser, 1986). Due to Climatic and topographic diversity, Pakistan harbors with c. 400 endemic phanerogams (Ali, 2008) and of these, majority of the taxa are confined to the mountainous part of the country (Ali & Qaiser, 1986). Endemic species have special significance in conservation actions due to unique evolutionary history. It is imperative for us to protect them and ensure their survival. For any plant, once lost, is lost forever.

In real sense, few research workers have been involved and they evaluated the conservation status of some endemic and rare vascular plant species of Pakistan based on field studies. A cumulative figure suggest that only 53 flowering taxa, to date, have been evaluated according to IUCN red list and criteria 2001 (Abbas, 2010; Abbas *et al.*, 2010; Alam, 2010; Alam & Ali, 2009 & 2010; Ali, H. 2010; Ali, H. & Qaiser, 2011 & 2012). Of these taxa, one taxon has already been become extinct, two taxa are regionally extinct, 9 possibly extinct, 21 taxa are critically endangered (CR), 8 taxa endangered, 2 vulnerable, and 10 remaining taxa are Data Deficient. Moreover, these taxa hardly make 0.8% of the total known flowering plant species of Pakistan. The main reasons for their endangerment are small population size, fragmented populations, narrow distribution area, habitat loss, deforestation, grazing, fuel wood-collections, invasive species and collection for medicinal purposes as well.

In the earlier paper (Alam & Ali, 2010), a check list of 19 threatened species was published with precise information and it was decided that detailed account of the each species will be published separately. The present paper is continuation of the paper and detailed information regarding the conservation status of *Astragalus clarkeanus* is given by using IUCN red list and criteria 2001 (Anon,, 2001). *Astragalus clarkeanus* is a perennial herb and the member of the family Fabaceae-Papilionaceae (Ali, 1977). Quality of habitat, population size, geographic distribution, mode of reproduction, phenology, habit, life form were studied in the natural habitat of the species from 2003-2007.

Materials and Methods

Study area: The Gilgit-Baltistan province is located in the northern areas of Pakistan. This region is part of the well-known mountain range, the Karakorum and occupies major extreme north-east mountainous part the country between 35.6°-37° N and 74°-76° E with total area of 70,332 sq. km. Most parts of the area are inhabitable and only 2% of the area is under cultivation. Eastern side is bordered by China, having Central Asian states on its northernfrontiers, Afghanistan on northwestern border, while western and southern sides are delimited by means of Ghizer, Astore and the valleys of occupied Kashmir (Ali, 2000). Phytogeographically, Gilgit and Baltistan belong to Eastern Irano-Turanian sub-region (Ali & Qaiser, 1986).

Experimental design: Ten field trips were arranged from 2004-2007 (c. two trips per year) in order to study and collect information about the following attributes.

i. The known distribution area was measured by encircling known localities of the species on the map of the study area (Ali, 2000).
ii. Altitudinal range was recorded by Global Positioning System (I Finder).
iii. For population size, mature individual plants of *Astragalus clarkeanus* were counted in the respective localities. Those individual plants, which were found in flowering or fruiting, were considered as mature individual plants, those which could not attain flowering and fruiting stage even at the end of the season, were considered as immature individual plants and were counted separately.
iv. The area of occupancy was roughly estimated through extensive walks by encompassing marginal individual plants of the species in their habitat.
v. Nature of habitat i.e., quality of habitat was determined by considering association, accessibility to the locality, soil erosion and other anthropogenic impacts.
vi. Life form of the species and each associate was determined by following Raunkier's proposed classification (Raunkiaer, 1934).
vii. Number of fruits per individual plant and the number of seeds per fruit of 10 individual plants were counted. These Individual plants were randomly selected in the population.
viii. Herbarium material of *Astragalus clarkeanus* and their associates were collected, pressed, poisoned and mounted in each case. The photographs were also taken including habitat, habit and phenology.
ix. The herbarium specimens were properly identified with the help of the Flora of Pakistan (Nasir & Ali, 1970-1989; Ali & Y. Nasir 1989-1991; Ali & Qaiser 1993-2015) and specimens deposited at Centre for Plant Conservation, University of Karachi Herbarium. Finally the data was analyzed in the light of IUCN Red List Categories & Criteria (Anon., 2001).

Results

Habitat: This species grows on moist grassy steep mountain slopes and sometimes extended downward to the stream banks from 3500 m to 4100 m. Ninety seven species were observed as associates in the habitat. Of these, 88 were perennial herbs (90.73 %), followed by 7 shrubs (7.22 %), while the remaining habit was found in 2 species. From the point of view of life forms, hemicryptophytes were observed to be dominant having 88 species (i.e. 90.73 %), followed by phanerophytes having 4 species (4.13 %), while the remaining life forms had less than 3 species (Tables 1-3; Fig.1).

Fig. 1. Habit of *Astragalus clarkeanus* Ali

Table 1. Observed associates of *Astragalus clarkeanus* along with their habit and life form

No.	Family Name	Name	Habit	Life form
1.	Alliaceae	*Allium carolinianum* DC.	Perennial herb	Geophyte
2.	Apiaceae	*Ligusticum thomsonii* C.B. Clarke	Perennial herb	Hemicryptophyte
3.	Apiaceae	*Pleurospermum candollei* (DC.) C.B. Clarke	Perennial herb	Hemicryptophyte
4.	Apiaceae	*Pleurospermum hookeri* Clarke var. *thomsonii* Clarke	Perennial herb	Hemicryptophyte
5.	Apiaceae	*Pleurospermum stylosum* Clarke	Perennial herb	Hemicryptophyte
6.	Apiaceae	*Thalictrum alpinum* L.	Perennial herb	Hemicryptophyte
7.	Asteraceae	*Allardia nivea* Hook. f. & Thomson ex C. B. Clarke	Perennial herb	Hemicryptophyte
8.	Asteraceae	*Allardia tomentosa* Decne.	Perennial herb	Hemicryptophyte
9.	Asteraceae	*Anaphalis nepalensis* (Spreng.) Hand.-Mazz. var. *nepalensis*	Perennial herb	Hemicryptophyte
10.	Asteraceae	*Artemisia dracunculus* L.	Perennial herb	Hemicryptophyte
11.	Asteraceae	*Artemisia santolinifolia* Turcz. ex Krasch.	Shrub	Chamaephyte
12.	Asteraceae	*Aster flaccidus* Bunge	Perennial herb	Hemicryptophyte
13.	Asteraceae	*Erigeron acer* L. var. *multicaulis* (Wall. ex DC.) Clarke	Perennial herb	Hemicryptophyte
14.	Asteraceae	*Erigeron acris* L.	Perennial herb	Hemicryptophyte
15.	Asteraceae	*Erigeron alpinum* L.	Perennial herb	Hemicryptophyte
16.	Asteraceae	*Jurinea ceratocarpa* (Decne.) Benth.	Perennial herb	Hemicryptophyte
17.	Asteraceae	*Leontopodium brachyactis* Gand.	Perennial herb	Hemicryptophyte
18.	Asteraceae	*Leontopodium leontopodinum* (DC.) Hand. -Mazz.	Perennial herb	Hemicryptophyte
19.	Asteraceae	*Leontopodium nanum* (Hook. f. &Thomson ex C.B. Clarke) Hand.- Mazz.	Perennial herb	Hemicryptophyte
20.	Asteraceae	*Psychrogeton andryaloides* (DC.) Novopokr. ex Krasch.	Perennial herb	Hemicryptophyte
21.	Asteraceae	*Saussurea gnaphalodes* (Royle) Sch. Bip.	Perennial herb	Hemicryptophyte
22.	Asteraceae	*Saussurea jacea* (Klotzsch) Clarke	Perennial herb	Hemicryptophyte
23.	Asteraceae	*Senecio karschenninikovii* Schischkin	Annual herb	Therophyte
24.	Asteraceae	*Senecio tibeticus* Hook. f.	Perennial herb	Hemicryptophyte
25.	Asteraceae	*Seriphidium brevifolium* (Wall. ex DC.) Ling & Y.R. Ling	Shrub	Chamaephyte
26.	Asteraceae	*Tanacetum coccineum* (Willd.) Grierson	Perennial herb	Hemicryptophyte
27.	Asteraceae	*Tanacetum falconeri* Hook. f.	Perennial herb	Hemicryptophyte
28.	Boraginaceae	*Cynoglossum glochidiatum* Wall. ex Benth.	Perennial herb	Hemicryptophyte
29.	Boraginaceae	*Cynoglossum lanceolatum* Forrsk.	Perennial herb	Hemicryptophyte
30.	Boraginaceae	*Myosotis alpestris* F.W. Schmidt subsp. *asiatica* Vestergren ex Hulten var. *asiatica*	Perennial herb	Hemicryptophyte
31.	Boraginaceae	*Pseudomertensia echioides* (Benth.) Riedl	Perennial herb	Hemicryptophyte
32.	Brassicaceae	*Chorispora sibirica* (L.) DC.	Perennial herb	Hemicryptophyte
33.	Caprifoliaceae	*Lonicera microphylla* Willd. ex Roem. & Schultes	Shrub	Chamaephyte
34.	Caryophyllaceae	*Silene gonosperma* (Rupr.) Bocquet subsp. *himalayensis* (Rohrb.) Bocquet	Perennial herb	Hemicryptophyte
35.	Caryophyllaceae	*Silene moorcroftiana* Wall. ex Benth.	Perennial herb	Hemicryptophyte
36.	Caryophyllaceae	*Silene teunis* Willd.	Perennial herb	Hemicryptophyte
37.	Crassulaceae	*Hylotelephium ewersii* (Ledeb.) H. Ohba	Perennial herb	Hemicryptophyte
38.	Crassulaceae	*Rhodiola quadrifida* (Pallas) Schrenk	Perennial herb	Hemicryptophyte
39.	Cupressaceae	*Juniperus excelsa* M.Bieb.	Shrub	Phanerophyte
40.	Cupressaceae	*Juniperus turkestanica* Komarov	Shrub	Phanerophyte
41.	Gentianaceae	*Gentianodes tianschanica* (Rupr. ex Kusn.) Omer, Ali & Qaiser	Perennial herb	Hemicryptophyte
42.	Gentianaceae	*Gentianopsis vvedenskyi* (Grossh.) V.V. Pis,Yaukova	Perennial herb	Hemicryptophyte
43.	Gentianaceae	*Swertia petiolata* D. Don	Perennial herb	Hemicryptophyte
44.	Geraniaceae	*Geranium pratense* L. subsp. *stewartianum* Y.Nasir	Perennial herb	Hemicryptophyte
45.	Gereniaceae	*Gerenium himalayense* Kl.	Perennial herb	Hemicryptophyte
46.	Grossulariaceae	*Ribes himalense* Decne.	Shrub	Phanerophyte
47.	Juncaginaceae	*Triglochin palustris* L.	Perennial herb	Hemicryptophyte

Table 1. (Cont'd)

No.	Family Name	Name	Habit	Life form
48.	Fabaceae	*Astragalus frigidus* (L.) A. Gray	Perennial herb	Hemicryptophyte
49.	Fabaceae	*Astragalus peduncularis* Royle ex Benth.	Perennial herb	Hemicryptophyte
50.	Fabaceae	*Astragalus rhizanthus* Royle ex Benth.	Perennial herb	Hemicryptophyte
51.	Fabaceae	*Astragalus staintonianus* Ali	Perennial herb	Hemicryptophyte
52.	Fabaceae	*Astragalus tibetanus* Benth. ex Bunge	Perennial herb	Hemicryptophyte
53.	Fabaceae	*Cicer microphyllum* Benth.	Perennial herb	Hemicryptophyte
54.	Fabaceae	*Hedysarum falconeri* Baker	Perennial herb	Hemicryptophyte
55.	Fabaceae	*Lathyrus sativus* L.	Annual herb	Therophyte
56.	Fabaceae	*Oxytropis crassiuscula* A. Boriss.	Perennial herb	Hemicryptophyte
57.	Fabaceae	*Oxytropis densa* Benth.ex Bunge	Perennial herb	Hemicryptophyte
58.	Fabaceae	*Oxytropis glabra* DC.	Perennial herb	Hemicryptophyte
59.	Fabaceae	*Oxytropis immersa* (Baker ex Aitchison) Bunge ex Fedtshenko	Perennial herb	Hemicryptophyte
60.	Fabaceae	*Oxytropis lapponica* (Wahl.) Gay	Perennial herb	Hemicryptophyte
61.	Fabaceae	*Oxytropis microphylla* (Pallas) DC.	Perennial herb	Hemicryptophyte
62.	Fabaceae	*Oxytropis mollis* Royle ex Benth.	Perennial herb	Hemicryptophyte
63.	Fabaceae	*Oxytropis platonychia* Bunge	Perennial herb	Hemicryptophyte
64.	Parnassiaceae	*Parnassia nubicola* Wall. ex Royle subsp. *occidentalis* Schönbeck-Temesy.	Perennial herb	Hemicryptophyte
65.	Poaceae	*Agrostis viridis* Gouan	Perennial herb	Hemicryptophyte
66.	Poaceae	*Elymus longe-aristatus* (Boiss.) Tzvelev subsp. *canaliculatus* (Nevski) Tzvelev	Perennial herb	Hemicryptophyte
67.	Poaceae	*Elymus nutans* Griseb.	Perennial herb	Hemicryptophyte
68.	Poaceae	*Elymus repens* (L.) Gould	Perennial herb	Hemicryptophyte
69.	Poaceae	*Elymus semicostatus* (Nees ex Stued.) Meld.	Perennial herb	Hemicryptophyte
70.	Poaceae	*Elymus sp.*	Perennial herb	Hemicryptophyte
71.	Poaceae	*Pennisetum orientale* L.C. Rich.	Perennial herb	Hemicryptophyte
72.	Poaceae	*Phleum alpinum* L.	Perennial herb	Perennial herb
73.	Poaceae	*Poa alpina* L.	Perennial herb	Perennial herb
74.	Poaceae	*Poa annua* L.	Perennial herb	Perennial herb
75.	Poaceae	*Poa nemoralis* L.	Perennial herb	Perennial herb
76.	Poaceae	*Stipa sibirica* (L.) Lam.	Perennial herb	Hemicryptophyte
77.	Polygonaceae	*Aconogonon tortuosum* (D. Don) Hara var. *tibetanum* (Meisn.) S.P. Hong	Perennial herb	Hemicryptophyte
78.	Polygonaceae	*Bistorta affinis* (D. Don) Green	Perennial herb	Hemicryptophyte
79.	Polygonaceae	*Bistorta vivipara* (L.) S.F. Gray	Perennial herb	Hemicryptophyte
80.	Polygonaceae	*Rheum spiciforme* Royle	Perennial herb	Hemicryptophyte
81.	Polygonaceae	*Rheum webbianum* Royle	Perennial herb	Hemicryptophyte
82.	Primulaceae	*Primula macrophylla* D. Don var. *macrophylla*	Perennial herb	Hemicryptophyte
83.	Primulaceae	*Primula warshenewskiana* B. Fedtsch. subsp. *warshenewskiana*	Perennial herb	Hemicryptophyte
84.	Ranunculaceae	*Aconitum violaceum* Jacq. ex Stapf var. *weileri* (Gilli) H.Riedl	Perennial herb	Hemicryptophyte
85.	Ranunculaceae	*Aquilegia fragrans* Benth. var. *fragrans*	Perennial herb	Hemicryptophyte
86.	Ranunculaceae	*Delphinium cashmerianum* Royle	Perennial herb	Hemicryptophyte
87.	Ranunculaceae	*Thalictrum alpinum* L.	Perennial herb	Hemicryptophyte
88.	Ranunculaceae	*Thalictrum foetidum* L.	Perennial herb	Hemicryptophyte
89.	Rosaceae	*Potentilla dryadanthoides* (Juz.) Viroshillov.	Shrub	Chamaephyte
90.	Rosaceae	*Rosa webbiana* Wall.	Shrub	Phanerophyte
91.	Saxifragaceae	*Saxifraga flagellaris* Willd. ex Sternb. subsp. *stenophylla* (Royle) Hulten	Perennial herb	Hemicryptophyte
92.	Saxifragaceae	*Saxifraga hirculus* L. var. *alpina* Engl.	Perennial herb	Hemicryptophyte
93.	Saxifragaceae	*Saxifraga sibirica* L.	Perennial herb	Hemicryptophyte
94.	Scrophulariaceae	*Lagotis globosa* (Kurz)Hook. f.	Perennial herb	Hemicryptophyte
95.	Scrophulariaceae	*Pedicularis albida* Pennell	Perennial herb	Hemicryptophyte
96.	Scrophulariaceae	*Pedicularis oederi* Vahl subsp. *oederi*	Perennial herb	Hemicryptophyte
97.	Scrophulariaceae	*Pedicularis pyramidata* Royle in Benth.	Perennial herb	Hemicryptophyte

Table 2. *Astragalus clarkeanus*: numerical analysis of the habits of the plants associated with the habitat.

S. No.	Habit	Observed species	% of the in the total
1	Shrubs	7	7.22
2	Perennial herbs	88	90.73
3	Annual herbs	2	2.06

Table 3. *Astragalus clarkeanus*: numerical analysis of life forms of the plants associated with the habitat.

S. No.	Life form	Number of species	% of the total species
1	Phanerophytes	3	3.09
2	Chamaephytes	4	4.13
3	Hemicryptophytes	88	90.73
4	Therophytes	2	2.06

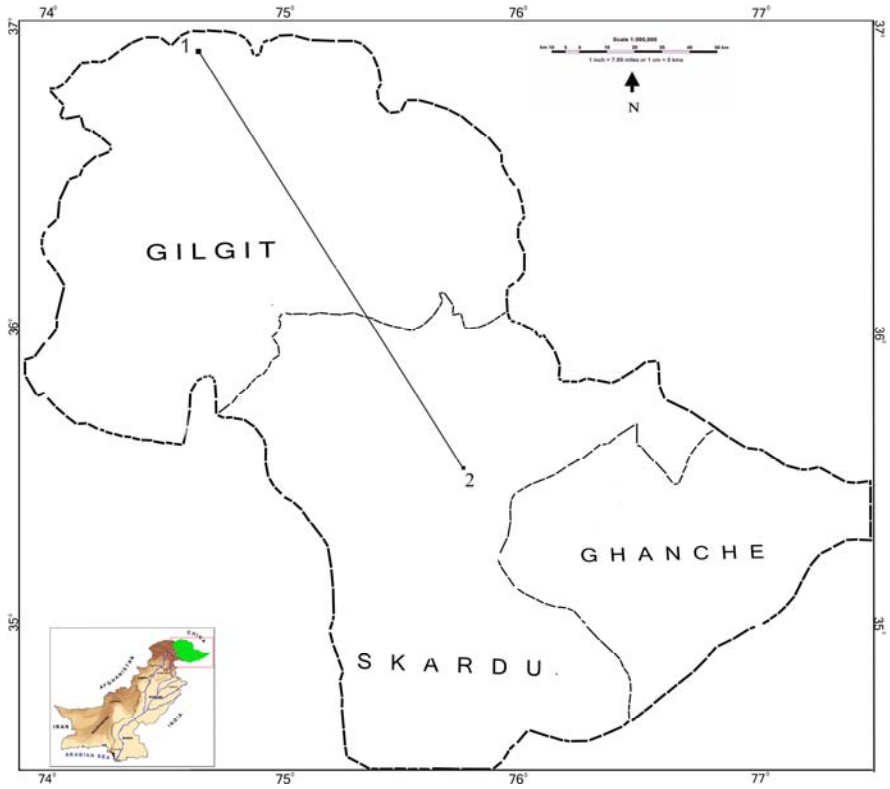

Fig. 2. *Astragalus clarkeanus*: 1, Kilik; 2, Skoro La

Population size: Population size of the species, observed during the study period is given in the Table 4. This species could be investigated from two localities in the study area.

Highest observed population size was observed in 2005 i.e. 54 individual plants, while in the remaining years, 12 to 51 individual plants were observed. In view of locality-wise population size, highest number of plants was observed in Kilik in the whole study period. An average about 91.67 % of the population was seen in this locality. In Skoro La, nine or less than nine individual plants per year were found to occur during the study period. Over all population size gradually decreased after 2005. An average, 5.73 % individuals were reduced in the last two years. At the end of fruiting season, two immature individual plants of *Astragalus clarkeanus* were also found in 2005. In the remaining years, no immature individual was seen (Table 4).

Table 4. *Astragalus clarkeanus*: locality-wise population size of *Astragalus clarkeanus* in known localities.

Locality	2004		2005		2006		2007	
	a	b	a	b	a	b	a	b
1) Kilik	10	*	46	2	43	*	44	*
2) Skoro La	2	*	8	*	9	2	4	*
Total	**12**	**0**	**54**	**2**	**52**	**2**	**48**	**0**

* indicates no immature plant could be found in that particular year

Distribution: Previously, *Astragalus clarkeanus* was reported from Karakorum without giving any precise locality (Ali, 1977: 162). In the present investigation, this species was reconfirmed from two localities i.e. Skoro La and Kilik (Fig. 2).

Astragalus clarkeanus is fragmented in their distribution. It was estimated that these known localities are about 180 km far from each other. From point of view

of extent of occurrence, both localities collectively encompassed an area of about 10 km^2. However, actual occupied area (i.e. area of occupancy), in each locality consists of small patch (habitat). Both patches collectively occupied about 2.5 km^2 as the area of occupancy. It is estimated that the area of occupancy meets 25 % of the total extent of occurrence (Table 5).

Table 5. *Astragalus clarkeanus*: summary of geographic range

Extent of Occurrence in km^2	Area of Occupancy in km^2
2.5	c.10

Mode of reproduction: Sexual reproduction was observed in the species. The flowering season extends usually from second week of July to mid of August. The population has a peak of flower production from 20th July to 10th August.

Number of fruits per plant and number of seeds per fruit is shown in the Table 6. An average number of fruits per plant were estimated to be 24 with a range of 11 to 41, while an average number of seeds per fruit were 5.10, having a range of 4 to 6. Thus, the estimated mean seeds production per plant was 122.4 seeds.

Table 6. *Astragalus clarkeanus*: variation in number of fruits per individual plant and number of seeds per fruit.

	Maximum	Average	Minimum
Fruit	41	24	11
Seed	6	5.10	4

Anthropogenic impacts: Grazing and deforestation were observed as the main threats in the habitat.

i) Grazing: Skoro La and Kilik are well known alpine pastures in the study area. It was observed that annually for approximately four months more than 2000 livestock grazed in Skoro La. Similarly the same situation was also met with in Kilik. In view of this, these core habitats were seriously affected due to over grazing. An average 66.41% individuals plants were found grazed per year. Highest individual plants were grazed in 2006 i.e. 37 out of 51 total individual plants (72.55 %). In every season, these individual plants were grazed before the formation of fruits (Table 7).

Table 7. *Astragalus clarkeanus*: summary of grazing impact analysis

	2003	2004	2005	2006	2007	A	B
Observed population size	-	12	54	51	48		
Observed grazed individuals per year	-	8	30	37	34		
						27.52	66.41

Key: A, Average grazed individual plants per year; B, Average % of grazed individual plants per year.

ii) Deforestation: Deforestation was observed in Skoro La. Inhabitants used *Juniperus excelsa* M.Bieb., *Juniperus turkistanica* Komarov, *Ribes himalense* Decne., and *Rosa webbiana* Wall. for fuel wood in their household activities. After mid August, villagers (at least one person per house) spent some days in order to collect fuel wood by cutting the above-mentioned species. Then cut fuel wood is dumped in a place. Collected material is gradually transported to the relevant village. It is estimated that an average, 1600 kg fuel wood is collected annually by about 30-35 houses each (local informant).

Natural impacts

i) Erosion: Water erosion is more serious in Skoro La. During summer, as a result of snow melting, heavy flowing of water in stream is observed, and the stream margins are gradually eroded. Those individuals, which extend downward to the stream bank, were affected due to extensive flow of water during summer.

Discussion and Conclusion

Previously, this taxon was reported from Karakorum without mentioning their precise locality (Ali, 1977). In the present investigation, however, this taxon was collected from two localities of the study area. In each locality, distribution of the taxon is restricted to mountain slopes from sub-alpine to alpine zone. Even within the observed altitudinal range (i.e. 3500-4000 m), it was sparse in the habitat. These results suggest that habitat of the species is narrow and specific.

As defined by Rabinowitz (1981), rarity may be due to small population sizes, narrow distribution area or habitat specificity or a combination of these components. In the case of *Astragalus clarkeanus*, an average, presence of 25 individual plants per locality, their restriction in specific habitat from 3500-4000 m and presence c. 3 km^2 the area of occupancy suggest that this is a very rare species.

According to IUCN Red list categories and criteria (Anon., 2001), as mature individual plants are less than 250 (i.e. 54) and habitat is under continuous degradation due to over-grazing and water erosion, *Astragalus clarkeanus* belongs to criterion "C" of critically endangered category. Further, 91% population of the taxon is restricted in Kilik, this figure falls under the sub-criterion 2(ii) of "C" of critically endangered category. Its extent of occurrence is about 10 km^2 (i.e. less than 100 km^2) and area of occupancy is 2.5 Km^2 (i.e. less than 10 km^2). Furthermore, the species is highly fragmented into two localities and the habitat is also degraded. Based on these results this species is placed under B1 and B2 of critically endangered

category. As the mature individual plants are less than 50 individual plants, therefore, this species is placed under the criterion "D" without taking into account any sub-criterion.

Narrow geographic range, extremely small population size, over-grazing and degraded habitat strongly suggest that *Astragalus clarkeanus* should be considered a critically endangered (CR) species. By following the hierarchical alphanumeric numbering system of the criteria (Anon., 2001), evaluation of the conservation status of *Astragalus clarkeanus* can be summarized as follows:

CRB1ab (iii) +2ab (iii); C2 (ii)

Where
CR, Critically Endangered; B, Geographic range; 1, Extent of Occurrence; 2 (with B), Area of occupancy; a, Severely fragmented or known to exist at only a single location; b, Continuing decline, observed, inferred or projected; iii, Quality of habitat; C, Estimated population size; 2 (with C), A continuing decline in the number of mature individuals; ii, At least 90% of the mature individual plants are in one subpopulation.

The following recommendations are suggested in order to protect them from extinction:
i) *Astragalus clarkeanus* should be included in the Red Data List of plants of Pakistan.
ii) Habitat of the species is under threat due to over-grazing. Therefore, it should be in order to minimize the habitat loss.
iii) Astragalus clakeanus should also be introduced in the botanical gardens.
iv) The complete biology of the species should be investigated.
v) Permanent monitoring programme should be also developed.
vi) Protocols for in vitro conservation as a backup support model be designed in order to ensure ex-situ conservation strategy.
vii) Seeds of *Astragalus clarkeanus* should be preserved in seed banks as part of the conservation strategy.

References

Abbas, H. 2010. *Ex-situ conservation of some threatened endemic and rare plants of Southern Pakistan through tissue culture*, (Ph.D Dissertation). University of Karachi. Available from HEC-Pakistan web site, http:// prr.hec.gov.pk.6547H.

Abbas, H., M. Qaiser, and J. Alam. 2010. Conservation status of *Cadaba heterotricha* stocks (Capparaceae): an endangered species in Pakistan. *Pak. J. Bot*, 42(1), 35-46

Alam, J. and S.I. Ali. 2009. Conservation status of *Astragalus gilgitensis* Ali (Fabaceae): a critically endangered species in Gilgit District, Pakistan. *Phyton (Horn, Austria)* 48: 211-223.

Alam, J. and S.I. Ali. 2010. Contribution to the red list of the plants of Pakistan-I. *Pak. J. Bot.*, 42(5): 2967-2971.

Alam, J. 2010. *Endemic flora of Gilgit and Baltistan and conservation strategies for threatened endemic taxa [Dissertation]*. University of Karachi, Available from HEC-Pakistan web site, http:// prr.hec.gov.pk.3250H.

Ali, H. 2010. *Floristic studies of Chitral: threatened plants and conservation strategies* [Ph.D dissertation]. University of Karachi, Available from HEC-Pakistan web site, http://prr.hec.gov.pk.3251H.

Ali, H. and M. Qaiser. 2011. Contribution to the Red List of Pakistan: a case study of the narrow endemic *Silene longisepala* (Caryophyllaceae). *Oryx*, 45(04): 522-527.

Ali, H., M. Qaiser and K.B. Marwat. 2012. Contribution to the red list of Pakistan: a case study of *Delphinium nordhagenii* (Ranunculaceae). *Pak. J. Bot*, 44(1): 27-31.

Ali, M. 2000. Atlas of northern areas, Map-1. Geography Department, Government Postgraduate College, Gilgit Lahore.

Ali, S.I. and M. Qaiser. 1986. A phytoeographical analysis of phanerogams of Pakistan and Kashmir. *Proceedings of Royle Society*, Edinburgh, 89 B: 89-101.

Ali, S.I. and M. Qaiser (Eds.). 1993-2015. Flora of Pakistan Nos. 194-220. Karachi.

Ali, S.I. and Y.J. Nasir (Eds.). 1989-1991. Flora of Pakistan Nos: 191-193. Karachi and Islamabad.

Ali, S.I. 1977. Papilionaceae. In: *Flora of Pakistan.* (Eds.): E. Nasir & S.I. Ali. No.100: 162. Karachi.

Ali, S.I. 2008. Significance of flora with special reference to Pakistan. *Pak. J. Bot.*, 40(3): 967-971.

Anonymous. 2001. IUCN Red List Categories and Criteria: Version 3.1 IUCN Species Survival Commission. IUCN, Gland, Switzerland and Cambridge, UK.

Khan, F.K. 1995. *A Geography of Pakistan: Environment, People and Economy*: Oxford University Press. Karachi, Lahore and Islamabad, 50.

Nasir, E. and S.I. Ali (Eds.). 1970-89. *Flora of Pakistan*. Nos. 1-190. Karachi and Islamabad.

Perkin, S. 2003. Northern Areas: State of environment and development. Government of Pakistan and IUCN Pakistan, Karachi; 55-176.

Rabinowitz, D. 1981. Seven forms of rarity In: Synge (Ed.). The Biological Aspects of Rare Plant Conservation. Wiley & Sons Ltd., 205-217.

Raunkiaer, C. 1934. *The life forms of plants and statistical geography*. Claredon, Oxford, 632.

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