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CONSERVATION STATUS OF *ANDROSACE RUSSELLII* Y. NASIR: A CRITICALLY ENDANGERED SPECIES IN GILGIT DISTRICT, PAKISTAN

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Abstract

Androsace russellii Y. Nasir, a narrow endemic species, belongs to the family Primulaceae. It is exclusively endemic in Gilgit district, Pakistan. It was originally reported from Gharesa glacier, Gilgit district. A current six-year re-assessment (i.e., 2003-2008) reveals that this species has now restricted in two localities of Hunza (Gilgit) i.e., Ultar Nullah and Shatu Bar despite of previously mentioned locality. Eleven field surveys were made from 2003 to 2008 in connection with the study of its distribution, nature of habitat, population size and mode of reproduction in the natural habitat. Based on population size (i.e. maximum 69 individual plants) and geographic range (i.e., 0.4 km^2 area of occupancy and 21.85 km^2 extent of occurrence), the conservation status of this species according to IUCN Red list Categories and Criteria should be regarded as critically endangered (CR). Remedial measures are also suggested.

Introduction

The precise evaluation of the conservation status of concerned taxon is considered to be the most important step in order to successfully prevent its extinction (Vischi *et al*., 2004). Such evaluation of the degree of risk of extinction of a taxon further leads us to assign it a standardized threatened category in this connection. In highly threatened taxa, if immediate site-specific actions were not taken they will likely be extinct (Ricketts *et al*., 2005). So preservation of species from extinction is considered to be the prime priority in order to minimize rates of global biodiversity loss (Ricketts *et al*., 2005). IUCN Red List Categories and Criteria (Anon., 1994 & 2001) have been developed for this purpose.

In order to evaluate the conservation status of a taxon, it is necessary to determine the population size, fluctuation in its population size, number of localities, quality of habitat, area that is occupied by the taxon concerned (i.e., extent of occurrence and the area of occupancy) and is kept under observation in nature over a number of years (Anon., 2001). Pakistan is also under tremendous pressure due to population explosion, unplanned urbanization, deforestation, over-exploitation of natural resources, soil erosion, salinity and water logging (Ali, 2000; Anon., 2000; Sheikh *et al*., 2002; Ahmad *et al*., 2005; Eberhart *et al*., 2006; Schickhooff, 2006), but unfortunately very little critical field work has been done on threatened plants of Pakistan as proposed in the IUCN Red List Categories and Criteria 2001 (Alam & Ali, 2009).

From the point of view of vulnerability, the endemic taxa of an area are most important because these plants are restricted to a particular region and are not found anywhere else in the world (Ali, 2008). Moreover, these plants have small populations, which occupy small geographic ranges and specific habitats (Rabinowitz, 1981; Kruckeberg & Rabinowitz, 1985; Mills & Schwartz, 2005; Ricketts *et al*., 2005). Their low population size and a single distribution on a small scale might trigger extinction. Hence, endemic species, particularly narrow endemics of Pakistan deserve our immediate attention.

Androsace russellii, member of the family Primulaceae is a compact perennial herb (Fig. 1A-C) and exclusively endemic to Gilgit district. Historically this species was

reported from one locality of Gilgit district i.e., Gharesa glacier (Nasir, 1984). In the present study, an attempt has been made to determine the conservation status of the species by using IUCN Red List Categories and Criteria (Anon., 2001). Quality of habitat, population size, geographic distribution, mode of reproduction, phenology, habit and life form were studied in the natural habitat of the species from 2003 to 2008.

Materials and Methods

a. Study area: Gilgit district is located in the Northern Areas of Pakistan between 35.6°-37° N and 74°-75.2° E with total area of 18292 sq. km. bordering China on the eastern side connected through Khunjerab Pass, having Central Asian states on its northern frontiers, Afghanistan on northwestern border, while western and southern sides are delimited by means of Ghizer, Astore and the valleys of occupied Kashmir (M. Ali, 2000). This area is part of the well-known mountain range, the Karakorum and many famous peaks of the world, above 7000 m are found here, like Godwin Austin (K-2, 8611m), the second highest peak in the world and also host many large glaciers out side the polar region. As a result, the most part of the area is inhabitable. Only 2% of the area is under cultivation. From the phytogeographic point of view it is regarded as an Eastern Irano-Turanian sub-region (Ali & Qaiser, 1986).

b. Experimental design: Eleven field trips were arranged from 2003-2008 (c. two trips per year) in order to study and collect the concerned species.

i. For population size, mature individual plants of *Androsace russellii* were counted in the habitat in Shatu Bar and Ultar Nullah. 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 are counted separately.
ii. The known distribution area was measured by encircling three known localities of the species on the map of the project area (Ali, 2000).
iii. The area of occupancy i.e., the actual occupied area by a taxon within the extent of occurrence (Anon., 2001), was roughly estimated through extensive walks by encompassing marginal individual plants of the species in their habitat.
iv. Nature of habitat i.e., quality of habitat was determined by considering association, accessibility to the locality, soil erosion and other anthropogenic impacts.
v. Altitudinal range was recorded by Global Positioning System.
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 30 individual plants were counted. These Individual plants were randomly selected in the population.
viii. Herbarium material of *Androsace russellii* 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 material properly were identified with the help of the Flora of Pakistan (Nasir & Ali, 1970-1989, (Nos. 1-190); Ali & Y. Nasir 1989-1991, (Nos. 191-193); Ali & Qaiser 1993-2008, (Nos. 194-214) and already existed authentic specimens, deposited at Karachi University Herbarium (KUH). *Saxifraga unguipetala* Engler & Irmscher was identified with the help of the Flora of China (Wu Zheng-yi & Peter Raven, 2001) as this is a new record for the Flora of Pakistan. Finally the data was analyzed in the light of IUCN Red List Categories & Criteria (Anon., 2001).

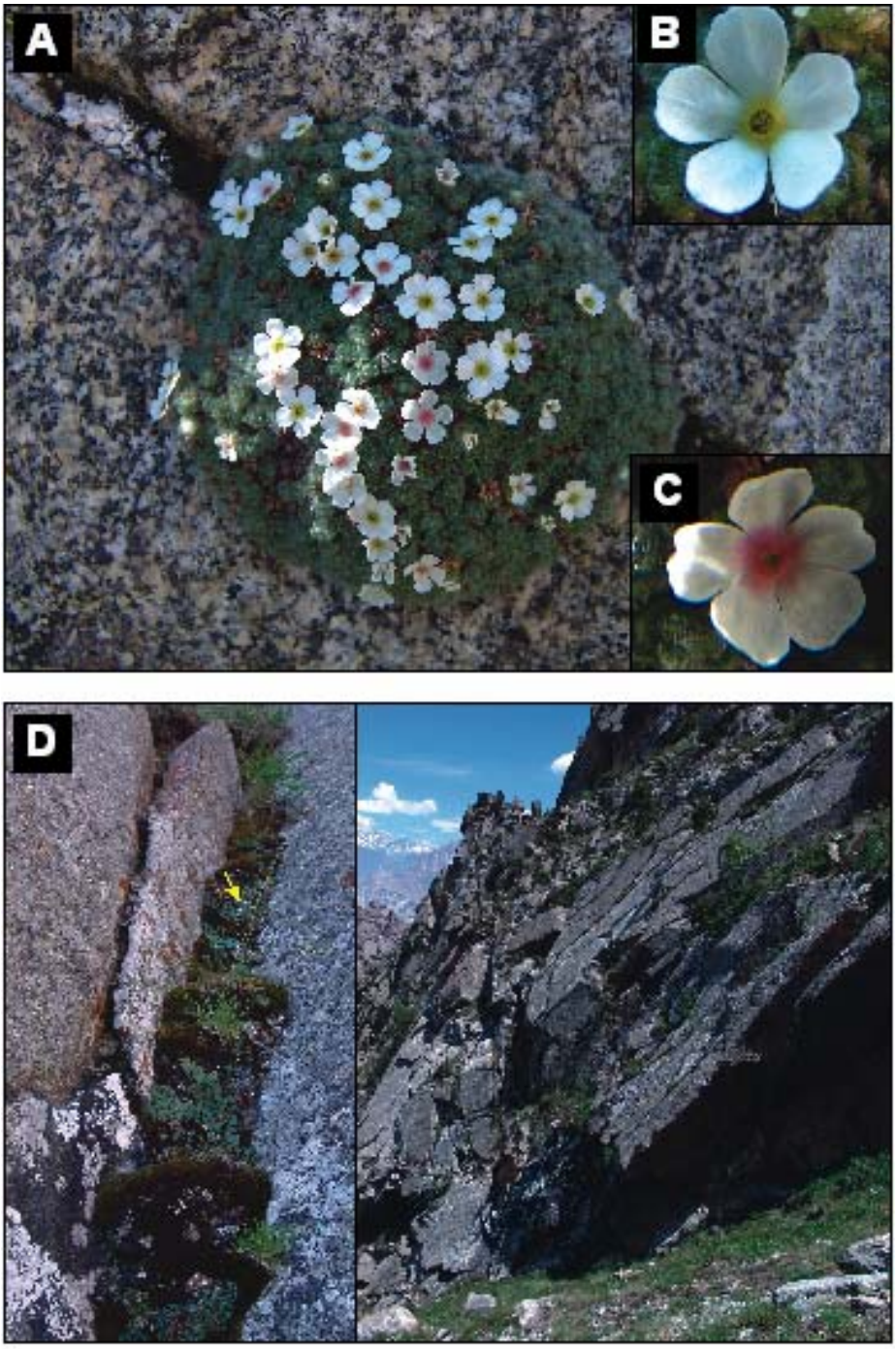

Fig. 1. A, *Androsace russellii*; B, flower with pink throat; C, flower with yellow throat; D, showing moist rocky habitat (Shatu Bar).

Results

a. Habitat and their altitudinal range: *Androsace russellii* was found to occur in shady and moist mountain crevices in Ultar Nullah, Karimabad and Shatu Bar, Gulmit from 2700 m to 3800 m. It was also observed that *Androsace russellii* was exclusively restricted on North-facing slopes in these localities (Fig. 1D). *Bistorta affinis, Saxifraga unguipetala* and *Saxifraga pulvinaria* were dominant species in the habitat. Eighty three species were observed as associates in the habitat, distributed in 27 families and 58 genera (Table 1). Of these, 69 (83.14%) were perennial herbs, followed by 11 (13.26%) shrubs, while the remaining habits were found in 1-2 species each (Table 2). From the point of view of life forms, hemicryptophytes were observed to be dominant having 68 species (81.93%), followed by chemaephytes having 6 species (7.24%), while the remaining life forms had less than 5 species each (Table 3).

Population size: Population size of the species observed during 2003-2008 is given in Table 4. Highest number of known individual plants i.e., 69 was observed in 2007 and 2008. Of these, 65 individual plants (i.e., 94.2%) were observed in Shatu Bar, Gulmit and rest of the 4 individual plants were seen in Ultar Nullah, Karimabad. Similarly, 67 and 7 individual plants were found to occur in 2006 and 2005, respectively. Out of 65 individual plants in Shatu Bar, 56 individual plants (i.e., 87.5%) were seen between 3600 m and 3800 m. During 2006 to 2008, 2-5 immature individual plants (seedlings) were also observed, which could not produce flowers even at the end of the season (i.e., September).

During field surveys, spread over six years, even a single individual of the species could not be found in a previously known locality i.e., Gharesa glacier (Table 4).

Distribution: Previously, *Androsace russellii* was reported from Gharesa glacier, Nagar (Gilgit District) (Nasir, 1984). In the present investigation this species could not be found in the said locality, but it was found to occur in other two localities of Gilgit District (Hunza) i.e., Ultar Nullah-Karimabad and Shatu Bar-Gulmit. As formerly mentioned that even within the observed localities, individual plants were confined to North-facing moist and shady slopes. In Ultar Nullah, only four individual plants were observed, distributed within an area of about 100 m^2 (Fig. 2).

In view of the extent of occurrence, these known localities collectively encompassed an area of only about 14. 79 km^2 (Table 5; Fig. 2), while actually occupied area by individual plants of the species in the habitat (i.e., area of occupancy) is c. 0.5 km^2 (Table 5). This figure hardly meets 3.38% of extent of occurrence of the species. It was also estimated that these localities are located at a distance of about 20 km away from each other.

Life form: *Androsace russellii* is a hemicryptophyte. During unfavourable season, upper part of the plant dries up. In the next suitable season, new branches arise from the remaining rootstock.

Mode of reproduction: Both reproductive methods were observed i.e., sexual and asexual reproduction.

a. Sexual reproduction: The flowering season extends usually from second week of June to 20^{th} June. The population has a peak of flower production from 10^{th} June to 15^{th} June. Young individual plants and the seedlings were observed (Fig. 3a). It was observed that whenever the young individual plant attained, a diameter of c. 5 cm, it usually flowered. Average numbers of fruits per plant were estimated to be 200, while an average number of seeds per fruit were 2. Thus, the estimated mean seed production per plant was 400 seeds (Table 6).

Table 1. Observed associates of *Androsace russellii* along their habit and life form.

S. No.	Family name	Name	Habit	Life form
1.	Alliaceae	*Allium carolinianum* DC.	Perennial herb	Geophyte
2.	Alliaceae	*Allium consanguineum* Kunth	Biennial herb	Geophyte
3.	Asteraceae	*Anaphalis nepalensis* (Spreng.) Hand. -Mazz. var. *monocephala* (DC.) Hand. -Mazz.	Perennial herb	Hemicryptophyte
4.	Asteraceae	*Artemisia rutifolia* Spreng.	Shrub	Chamaephyte
5.	Asteraceae	*Artemisia santolinifolia* Turcz. ex Krasch.	Shrub	Chamaephyte
6.	Asteraceae	*Cicerbita decipiens* (C.B. Clarke) Beauv.	Perennial herb	Hemicryptophyte
7.	Asteraceae	*Leontopodium brachyactis* Gand.	Perennial herb	Hemicryptophyte
8.	Asteraceae	*Leontopodium leontopodinum* (DC.) Hand.-Mazz.	Perennial herb	Hemicryptophyte
9.	Asteraceae	*Seriphidium brevifolium* (Wall. ex DC.) Ling & Y.R. Ling	Shrub	Chamaephyte
10.	Asteraceae	*Tanacetum artemisioides* Schultz-Bip. ex Hook. f.	Perennial herb	Hemicryptophyte
11.	Asteraceae	*Tanacetum baltistanicum* Podlech	Shrub	Phenerophyte
12.	Boraginaceae	*Arnebia euchroma* (Royle ex Benth.) I.M. Johnston	Perennial herb	Hemicryptophyte
13.	Boraginaceae	*Eritrichium canum* (Benth. in Royle) Kitamura var. *fruticulosum* (Kl.) Y. Nasir	Perennial herb	Hemicryptophyte
14.	Boraginaceae	*Eritrichium canum* (Benth. in Royle) Kitamura var. *patens* (Decne.) Y. Nasir	Perennial herb	Hemicryptophyte
15.	Boraginaceae	*Myosotis alpestris* F.W. Schmidt subsp. *asiatica* Vestergren ex Hulten var. *asiatica*	Perennial herb	Hemicryptophyte
16.	Boraginaceae	*Pseudomertensia echioides* (Benth.) Riedl	Perennial herb	Hemicryptophyte
17.	Brassicaceae	*Arabis saxicola* Edgew. var. *saxicola*	Perennial herb	Hemicryptophyte
18.	Brassicaceae	*Draba stenocarpa* Hook. f. & Thoms.	Perennial herb	Hemicryptophyte
19.	Caprifoliaceae	*Lonicera heterophylla* Decne.	Perennial herb	Phanerophyte
20.	Caryophyllaceae	*Minuartia kashmirica* (Edgew.) Mattf.	Perennial herb	Hemicryptophyte
21.	Caryophyllaceae	*Silene gonosperma* (Rupr.) Bocquet subsp. *himalayensis* (Rohrb.) Bocquet	Perennial herb	Hemicryptophyte
22.	Caryophyllaceae	*Silene kunawarensis* Benth.	Perennial herb	Hemicryptophyte
23.	Caryophyllaceae	*Silene moorcroftiana* Wall. ex Benth.	Perennial herb	Hemicryptophyte
24.	Crassulaceae	*Hylotelephium ewersii* (Ledeb.) H. Ohba	Perennial herb	Hemicryptophyte
25.	Crassulaceae	*Pseudosedum lievenii* (Ledeb.) A. Berger	Perennial herb	Hemicryptophyte
26.	Crassulaceae	*Rhodiola saxifragoides* (Fröd.) H. Ohba	Perennial herb	Hemicryptophyte
27.	Crassulaceae	*Rhodiola tibetica* (Hook.f. & Thomson) S.H.Fu	Perennial herb	Hemicryptophyte
28.	Crassulaceae	*Rhodiola wallichiana* (Hook. Clarke) S.H.Fu	Perennial herb	Hemicryptophyte

Table 1. (Cont'd.).

S. No.	Family name	Name	Habit	Life form
29.	Cupressaceae	*Juniperus excelsa* M. Bieb.	Shrub	Phanerophyte
30.	Cupressaceae	*Juniperus turkestanica* Komarov	Shrub	Phanerophyte
31.	Fumariaceae	*Corydalis pseudocrithmifoia* Jafri	Perennial herb	Hemicryptophyte
32.	Fumariaceae	*Corydalis tibetica* Hook.f. & Thoms.	Perennial herb	Hemicryptophyte
33.	Gentianaceae	*Gentianodes barkillii* (H.Smith)Omer, Ali & Qaiser	Annual herb	Therophyte
34.	Gentianaceae	*Gentianodes tianschanica* (Rupr. ex Kusn.) Omer,Ali & Qaiser	Perennial herb	Hemicryptophyte
35.	Gentianaceae	*Gentianopsis vvedenskyi* (Grossh.) V.V. Pis,Yaukova	Perennial herb	Hemicryptophyte
36.	Gentianaceae	*Swertia cordata* (G.Don) Clarke	Perennial herb	Hemicryptophyte
37.	Geraniaceae	*Gerenium himalayense* Kl.	Perennial herb	Hemicryptophyte
38.	Labiatae	*Nepeta discolor* Royle ex Benth.	Perennial herb	Hemicryptophyte
39.	Labiatae	*Nepeta leuocolaena* Benth. ex Hook.f.	Perennial herb	Hemicryptophyte
40.	Labiatae	*Thymus linearis* Benth. subsp. *linearis*	Perennial herb	Hemicryptophyte
41.	Liliaceae	*Lloydia serotina* (L.) Reichenb.	Perennial herb	Hemicryptophyte
42.	Onagraceae	*Epilobium angustifolium* L.	Perennial herb	Hemicryptophyte
43.	Papaveraceae	*Papaver nodicaule* L.	Perennial herb	Hemicryptophyte
44.	Papilionaceae	*Astragalus falconeri* Bunge	Perennial herb	Hemicryptophyte
45.	Papilionaceae	*Astragalus frigidus* (L.) A. Gray	Perennial herb	Hemicryptophyte
46.	Papilionaceae	*Astragalus peduncularis* Royle ex Benth.	Perennial herb	Hemicryptophyte
47.	Papilionaceae	*Hedysarum falconeri* Baker	Perennial herb	Hemicryptophyte
48.	Papilionaceae	*Oxytropis immersa* (Baker ex Aitchison) Bunge. ex Feddtschenko var. *immersa*	Perennial herb	Hemicryptophyte
49.	Papilionaceae	*Oxytropis lapponica* (Wahl.) Gay	Perennial herb	Hemicryptophyte
50.	Papilionaceae	*Oxytropis mollis* Royle ex Benth.	Perennial herb	Hemicryptophyte
51.	Parnassiaceae	*Parnassia nubicola* Wall. ex Royle subsp. *occidentalis* E.S-Temesy	Perennial herb	Hemicryptophyte
52.	Plantaginaceae	*Plantago gentianoides* Sibth. & Smith subsp. *griffithii* (Decne.) Rech.f.	Perennial herb	Hemicryptophyte
53.	Plumbaginaceae	*Acantholimon lycopodioides* (Girard) Boiss.	Shrub	Chamaephyte
54.	Poaceae	*Elymus repens* (L.) Gould	Perennial herb	Hemicryptophyte
55.	Poaceae	*Poa alpina* L.	Perennial herb	Hemicryptophyte

Table 1. (Cont'd.).

S. No.	Family name	Name	Habit	Life form
56.	Poaceae	*Poa annua* L.	Annual herb	Therophyte
57.	Polygonaceae	*Aconogonon tortuosum* (D. Don) Hara var. *tibetanum* (Meisn.) S.P. Hong.	Perennial herb	Hemicryptophyte
58.	Polygonaceae	*Bistorta affinis* (D. Don) Green	Perennial herb	Hemicryptophyte
59.	Polygonaceae	*Oxyria digyna* D. Don	Perennial herb	Hemicryptophyte
60.	Polygonaceae	*Rheum webbianum* Royle	Perennial herb	Hemicryptophyte
61.	Primulaceae	*Androsace thomsonii* (Watt) Y. Nasir	Perennial herb	Hemicryptophyte
62.	Primulaceae	*Primula warschenewskiana* B. Fed.	Perennial herb	Hemicryptophyte
63.	Ranunculaceae	*Anemone obtusiloba* D.Don var. *obtusiloba*	Perennial herb	Hemicryptophyte
64.	Ranunculaceae	*Aquilegia fragrans* Benth. var. *fragrans*	Perennial herb	Hemicryptophyte
65.	Ranunculaceae	*Delphinium cashmerianum* Royle	Perennial herb	Hemicryptophyte
66.	Ranunculaceae	*Paraquilegia anemonoides* (Willd.) Ulbr.	Perennial herb	Hemicryptophyte
67.	Ranunculaceae	*Thalictrum foetidum* L.	Perennial herb	Hemicryptophyte
68.	Rosaceae	*Potantilla dryadanthoides* (Juz.) Viroshilov	Shrub	Chamaephyte
69.	Rosaceae	*Rosa webbiana* Wall. ex Royle	Shrub	Phanerophyte
70.	Rosaceae	*Sorbus tianshanica* Rupr.	Shrub	Phanerophyte
71.	Rosaceae	*Spiraea canescens* D.Don	Shrub	Chamaephyte
72.	Saxifragaceae	*Bergenia stracheyi* (Hook.f. & Thoms.)Engl.	Perennial herb	Hemicryptophyte
73.	Saxifragaceae	*Saxifraga flagellaris* Willd. ex Sternb. subsp. *flagellaris* (Royle) Hulten	Perennial herb	Hemicryptophyte
74.	Saxifragaceae	*Saxifraga pulvinaria* H.Sm.	Perennial herb	Chamaephyte
75.	Saxifragaceae	*Saxifraga sibirica* L.	Perennial herb	Hemicryptophyte
76.	Saxifragaceae	*Saxifraga unguipetala* Engler & Irmscher	Perennial herb	Hemicryptophyte
77.	Scrophulariaceae	*Pedicularis pyramidata* Royle in Benth.	Perennial herb	Hemicryptophyte
78.	Umbelliferae	*Heracleum pinnatum* C. B. Clarke	Perennial herb	Hemicryptophyte
79.	Umbelliferae	*Pleurospermum candollei* (DC.) Clarke	Perennial herb	Hemicryptophyte
80.	Umbelliferae	*Pleurospermum stylosum* C.B. Clarke	Perennial herb	Hemicryptophyte
81.	Umbelliferae	*Seseli libanotis* (L.) Koch	Perennial herb	Hemicryptophyte
82.	Urticaceae	*Parietaria judaica* L.	Perennial herb	Hemicryptophyte
83.	Urticaceae	*Urtica hyperborea* Jacq. ex Wedd.	Perennial herb	Hemicryptophyte

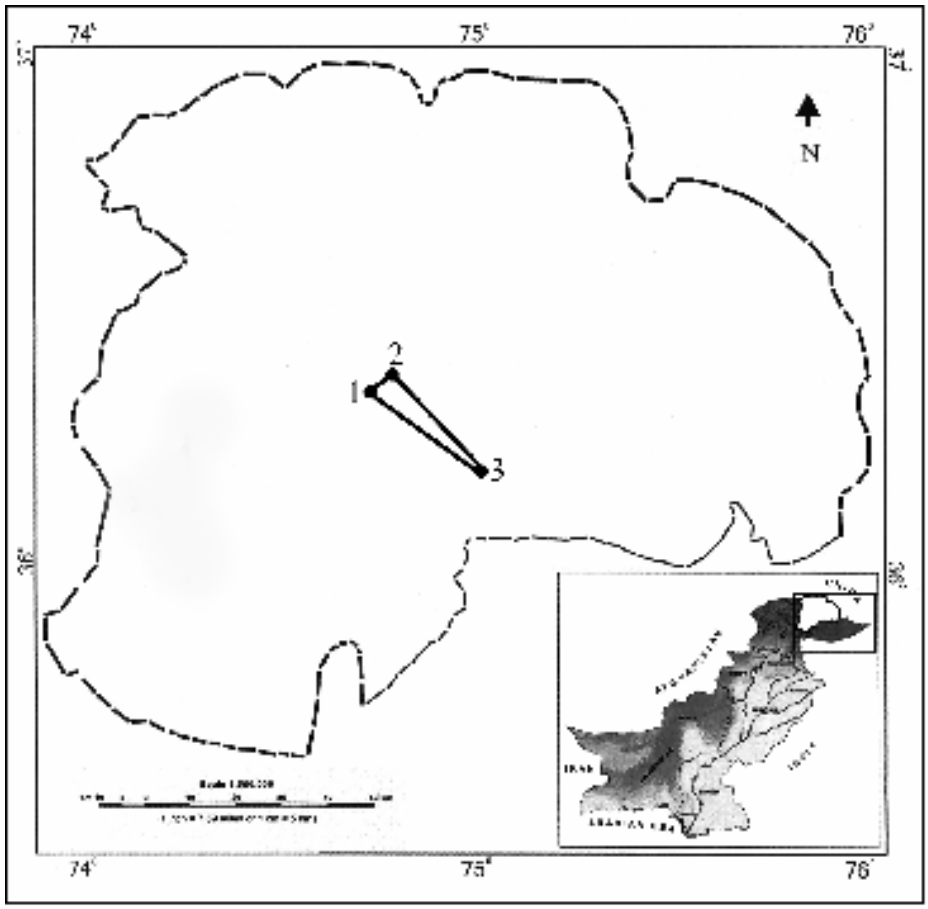

Fig. 2. Distribution of *Androsace russellii* 1, Shatu Bar, Culmit; 2, Ultar Nullah, Karimabad; 3, Gharesa glacier, Nagar.

Table 2. ***Androsace russellii*: numerical analysis of the habits in the plants associated with the habitat.**

S. No.	Habit	Observed species	% in the total
1.	Shrubs	11	13.26
2.	Perennial herbs	69	83.14
3.	Biennial herbs	1	1.21
4.	Annual herbs	2	2.41

Table 3. *Androsace russellii*: numerical analysis of life forms of the plants associated with the habitat.

S. No.	Life form	Number of species	% in the total species
1.	Phanerophytes	5	6.03
2.	Chamaephytes	6	7.24
3.	Hemicryptophytes	68	81.93
4.	Cryptophytes	2	2.41
5	Therophytes	2	2.41

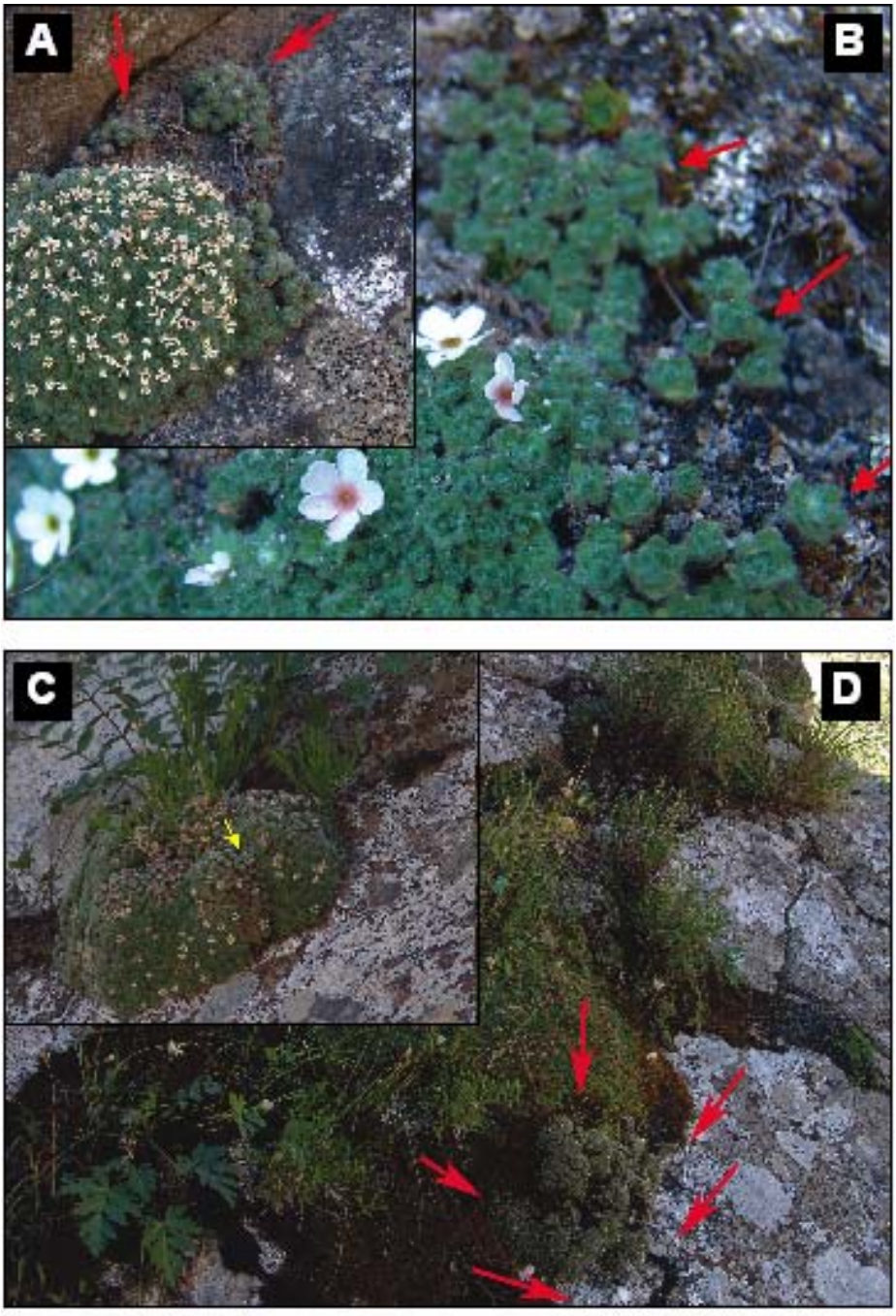

Fig. 3. *Androsace russellii*; A, sexual reproduction; B, vegetative reproduction; C, an individual plant with few associates; D, an individual plant growing in micro site thick soil deposition with many associates.

Table 4. *Androsace russellii*: locality-wise population size in known localities.

Locality	2003		2004		2005		2006		2007		2008	
	a	b	a	b	a	b	a	b	a	b	a	b
1. Gharesa glacier, Nagar*	*	*	*	*	*	*	*	*	*	*	*	*
2. Shatu Bar, Gulmit	-		-	-	3	-	63	2	65	5	65	4
3. Ultar Nullah, Karimabad	-	-	-	-	4	-	4	-	4	-	4	-
Total	**-**	**-**	**-**	**-**	**7**	**-**	**67**	**2**	**69**	**5**	**69**	**4**

Note: * The taxon was previously known from one locality only. The area was searched for the taxon throughout the field surveys but no plant could be found. (i.e., Gharesa glacier, Nagar), but by investigating the other potential habitats it was collected in two other localities in the subsequent years. The nill value (-) indicates the area is not visited in that particular year.
a: Mature individual plants
b: immature individual plants

Table 5. *Androsace russellii*: summary of observed geographic range.

Area of occupancy in km^2	Extent of occurrence in km^2
c. 0.5	21.85

Table 6. *Androsace russellii*: variation in the number of fruits per individual plant and the number of seeds per fruit.

	Minimum	Average	Maximum
Fruits	34	200	366
Seeds	2	2	5

b. Vegetative reproduction: In *Androsace russellii*, new individual plants were produced through extensive columnar branching from their rootstock. Those micro-sites in the habitats, where comparatively more moisture is available and less exposed to direct sunlight, maximum vegetative reproduction is observed. Moreover, in crevice, where there is less soil deposition and with few associates, each individual plant occupied more area and was healthy as compared to individual plants which were present on thick soil deposited micro-sites with many associates. Those individual plants which were growing in thick soil deposited micro site gradually marginalized towards the rocky area. It was also observed that vegetative reproduction in the species takes place usually in the marginal portion of the habitat (Fig. 3B-D).

Anthropogenic impacts: Ultar Nullah and Shatu Bar are far from respective villages in the study area. In addition to remoteness, harsh topography (steep) is also important. Hence, the habitat is naturally protected from any human induced threat. The habitat of the taxon is comparatively more stable.

Discussion

The locality of Gharesa glacier is a highly rugged mountainous terrain with steep inaccessible slopes. The taxon was searched thoroughly for consecutively five years in the previously known locality but even a single individual plant was not found. As a result it is concluded that the species is either very rare and is specified to micro-sites in the habitats which are almost inaccessible to any collector. On the other hand it is also possible that the taxon might have extirpated in that locality.

The north-facing slopes in the area are more moisturized and have less availability of direct sun light as compared to south-facing slopes. Hence, presence of the species exclusively on north-facing slopes suggests that this is shade and moisture- loving species.

As defined by Rabinowitz (1981), rarity of the organisms may be due to small population size, narrow distribution area, habitat specificity or a combination of these components. In the case of *Androsace russellii*, maximum 69 individual plants are known to exist, exclusively on north-facing moist and shady slopes in Shatu Bar and in Ultar Nullah from 3000 m to 3800 m. Moreover, population of the species is restricted to a very limited area (i.e., 1.84%) within the whole distribution (i.e., 21.85 km^2). Hence, these results strongly suggest that this species has a highly specific micro- habitat and should be considered as a typical rare species. Only 84 species were observed as associates in the habitat of *Androsace russellii* within its whole range of distribution. This figure is rather low as compared to the whole flora in the area (i.e., c. 1100 species). This might be due to highly specific habitat requirement in order to sustain above ground competition and fewer competitive interactions (Lavergne *et al*., 2004).

Vegetative reproduction is said to be another outstanding strategy in order to increase survival potential of a taxon, especially in mountainous habitats, where ecological niche availability is limited and probably a large proportion of seeds do not find a suitable habitat after dispersal in the area. In the case of *Androsace russellii*, each individual plant produces an average of 800 seeds. However, production of seedlings in the population from seeds is minimal (maximum six individual plants were observed). Hence, vegetative reproduction seems to be more suitable strategy for *Androsace russellii* where, the habitat is narrow and highly specialized while on the other hand, crevices are the only places only where it can grow.

According to the IUCN Red List Categories and Criteria (Anon., 2001), as mature individual plants of the species are less than 250 (i.e., 69), *Androsace russellii* falls under the criterion "C" of critically endangered category. Further as its area of occupancy is less than 10 km^2 (i.e., 0.4 km^2 only) and the extent of occurrence is less than 100 km^2 (i.e., 21.85 km^2). This species is placed under B1 and B2 of critically endangered categories. The population size and geographic range, therefore, strongly lead us to keep this species under Critically Endangered (CR) category at global level. By following the hierarchical alphanumeric numbering system of the criteria (Anon., 2001), evaluation of the conservation status of *Androsace russellii* can be summarized as follows:

CR B1ab (vi)+B2ab (vi); C2a (ii)

CR, Critically Endangered; B1, Extent of occurrence; a, Severely fragmented; b, Inferred continuing decline; B2, Area of occupancy; vi, Decline in number locations or subpopulations; C, Population size; a (last), Population structure; ii, At least 90% population of mature individuals in one subpopulation

Most threatened plant species are predisposed to threat due to their small population size, narrow geographic range or narrow habitat requirements (Rabinowitz, 1981; Kruckeberg & Rabinowitz, 1985). As the population size of *Androsace russellii* is very small i.e., 69 individual plants, with a very small geographic range of 21.85km^2 and fragmented into two localities. Moreover, its habitat is highly specific to the moist and shady north-facing slopes. Hence, this species is facing multiple natural threats and should be considered as a typical threatened species.

A rare species is not only important at the national level but also from the point of view of the global biodiversity. Hence, conservation measures as proposed below are extremely necessary in order to protect the taxon from extinction.

i. *Androsace russellii* Y.Nasir should be included in the Red Data List of threatened species.
ii. *Androsace russellii* should also be introduced in the botanical gardens.
iii. The complete biology of the species should be investigated.
iv. Permanent monitoring programme should be developed.

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