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EVALUATION OF THE CONSERVATION STATUS OF *RHODODENDRON AFGHANICUM* AITCH. & HEMSL.: A NARROW ENDEMIC SPECIES FOR PAKISTAN

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Abstract

The conservation status of *Rhododendron afghanicum* Aitch. & Hemsl. (Ericaceae) has been evaluated according to IUCN Red List Categories and Criteria 2001. This species is exclusively endemic to Kurram Agency, Pakistan. Previously, this species was reported from Shend Toi, Kurram Agency. In the current assessment, 7 localities were traced out during field studies conducted from 2011 to 2013. Based on population size (979 individuals), Extent of occurrence (354.881 km^2), Area of occupancy (116.511 km^2) and severely anthropogenic impacts i.e., uprooting and deforestation, *Rhododendron afghanicum* has been classified as Endangered (EN) according to IUCN Red List Categories and Criteria 2001. Both in-situ and ex-situ conservation measures have been proposed for its effective protection.

Key words: Conservation status, *Rhododendron afghanicum*, Endemic, Endangered, Kurram Agency, Pakistan.

Introduction

Rhododendron is known as the largest genus of the family Ericaceae and comprises c. 1157 species throughout the world mostly concentrated within a short arc covering the highlands of Nepal, India and New Guinea, South West China, North America and certain parts of Europe (Nasir & Ali, 1971; Justice, 2000; Maiti & Chauhan, 2000; Singh *et al*., 2009). In the case of Pakistan, 6 species have been reported viz., *Rhododendron arboretum* Sm, *Rhododendron campanulatum* D. Don, *Rhododendron lepidotum* Wall. ex. D. Don, *Rhododendron hypenanthum* Balf, *Rhododendron afghanicum* Aitch. & Hemsl. and *Rhododendron collettianum* Aitch. & Hemsl.. Of these one species *Rhododendron afghanicum* is a narrow endemic to Kurram Agency and *Rhododendron collettianum* is partially endemic for this area and also found in Chitral. These species are distributed in northern mountainous parts of the country (Nasir & Ali, 1971).

As plants are a vital part of our ecosystem and key components of global biological diversity but, unfortunately they are facing major and multiple anthropogenic threats i.e. habitat alteration, habitat fragmentation, habitats destruction, extend of invasive, inappropriate agricultural practices, and unsustainable forestry practices, urbanization, pollution, diseases, over-exploitation and over-collecting as well., further more climatic change is another serious factor in this connection (Ali, 2000; Sala *et al*., 2000; Alonso *et al*., 2001; Barbosa & Marquet, 2002; Sudhersan *et al*., 2003; Thomas *et al*., 2004; Alam & Ali, 2009; Abbas *et al*., 2010; Habib *et al.*, 2016; Shaheen *et al.*, 2017).

Pakistan harbours a great diversity in the flora due to its peculiar geographic and topographic position. More than 6000 vascular plant species have been reported form this region and, of these, about 400 taxa are endemic to Pakistan (Ali, 2008). However, to date, only 52 taxa have been evaluated according to IUCN Red List Categories and Criteria 2001 (Anon., 2001). Of these, 21 are Critically Endangered, 10 Endangered, 2 Vulnerable, 8 possibly extinct, 2 regionally extinct,1 extinct and remaining are Data Difficient (Ali, 2000; Abbas, 2010; Abbas *et al*., 2010; Alam & Ali, 2009; Alam & Ali, 2010; Ali, H. & Qaiser, 2010a, 2010b, 2011, 2012; Khan *et al.*, 2011, 2014). This figure hardly meets about 0.8% of the flora of Pakistan. Therefore, evaluation of the conservation status of the flora of Pakistan should be focused on urgent basis; particularly endemic taxa of Pakistan are ranked at top priority.

In the current study an effort has been made to evaluate the conservation status of *Rhododendron afghanicum* according to IUCN Red List Categories and Criteria (Anon., 2001) based on field studies carried out from 2011-2013. Population size, habit, Quality of habitat, phenology, mode of reproduction, life form, traditional uses and geographic distribution, were studied in their natural habitat of the concerned species.

Materials and Methods

i. Location: Kurram Agency Federally administrated tribal zone (FATA) of Pakistan situated and found at the border of Afghanistan and Pakistan. The total area of the agency is about 3,380 km^2. It stretches approximately 115 kilometres in a north-westerly direction from Thall (in Hangu District) to Tari Mengal on the Afghan border. The major municipality of the area is Parachinar and is close to the spot where parallel of latitude 34th crosses the 70th parallel longitude (Stewart, 1972, 1982) and can easily be detected on the map (Figs. 2 and 3).

ii. Experimental design: Detailed and comprehensive field surveys were conducted, Information regarding distribution, presence localities, altitude, geographic coordinates, bio geophysical characteristics of the area, habit, type of habitat(s), life form, population size, way of reproduction, distribution range, traditional uses, anthropogenic threats like grazing, uprooting pressure, over-exploitation and habitat degradation were recorded and studied in their natural habitat. Plants samples were collected as voucher specimens were processed according

to standard herbarium technique. Based on the above survey, comprehensive field trips were arranged. Details for each studied parameters are given as below. For population size, mature individual plants were counted / estimated by counting no of individuals per unit area; only those individual plants found in flowering or fruiting were considered as mature individual. Nature of habitat i.e. quality of habitat were determined by considering grazing impact, accessibility to the locality, deforestation, soil erosion, and other anthropogenic impacts. For the ethno botanical studies, surveys were conducted to collect information about the traditional usage of plants by the local community. Proper identification of specimen were made with the help of Flora of Pakistan (Nasir & Ali, 1970-1989, (Nos. 1-190); Ali & Y. Nasir 1989-1991, (Nos. 191-193); Ali & Qaiser 1993-2010, (Nos. 194-219) and other related literature. Conservation status of taxon was evaluated with the help of (Anon., 2001). The herbarium specimens were deposited at Hazara University Herbarium.

Results

1. Habit, habitat and community structure: *Rhododendron afghanicum* is a shrub up to approximately 1 m tall (Fig. 1). Stem woody and branchlet, glabrous with leaves scar. This species grows in the subalpine zone between 2000-3000m. Especially most individuals of the taxon were found to occur in the sloppy area on limestone cliffs and on the rocks edges in dense forest. About 39 species were found as associated species with this taxon. Dominant species viz., *Pinus wallichiana*, *Euphorbia wallichiana*, *Sophora mollis* subsp. *griffithii* was observed. 39 species belong to 20 families and 35 genera. Their growth and life forms are mentioned in Table 1.

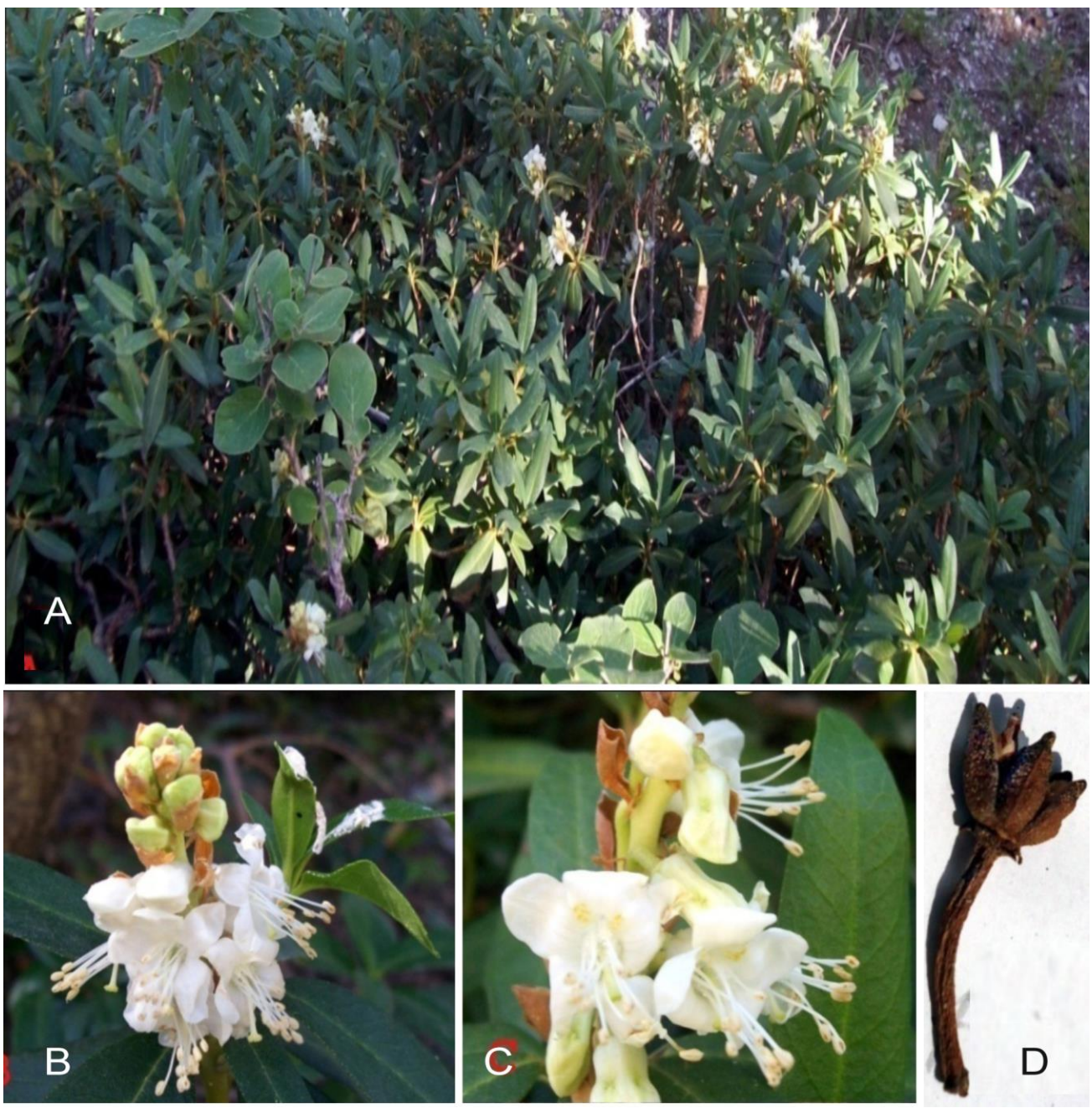

Fig 1. *Rhododendron afghanicum*: A, Habitat; B, Flower & Bud; C, Flower; D, Fruit.

Table 1. Observed associates of *Rhododendron afghanicum* along their habit and life form.

S. No.	Family	Name	Habit	Life Form
1.	Eracaceae	*Rhododendron afghanicum* Aitch. & Hemsl.	Shrub	Phanerophyte
2.	Fagaceae	*Quercus baloot* Griff.	Tree	Phanerophyte
3.	Rosacea	*Spiraea pilosa* French.	Tree	Phanerophyte
4.	Pinaceae	*Pinus wallichiana* A. B. Jackson	Tree	Phanerophyte
5.	Saxifragaceae	*Bergenia ciliata* (Haw.)Sternb.	Herb	Hemicryptophyte
6.	Euphorbiaceae	*Euphorbia wallichii* Hook. F.	Perennial herb	Hemicryptophyte
7.	Oleaceae	*Syringa emodi* Wall. ex Royle.	Shrub	Phanerophyte
8.	Primulaceae	*Cortusa 1389hapsus* Pax ex Lipsky.	Perennial Herb	Hemicryptophyte
9.	Ranunculaceae	*Paraquilegia anemonoides* (Willd.) Ulbr.	Perennial herb	Hemicryptophyte
10.	Papilionaceae	*Indigofera heterantha* Well.ex Brandis	shrub	Phanerophyte
11.	Primulaceae	*Primula denticulate* Smith	Perennial herb	Hemicryptophyte
12.	Pinaceae	*Abies pindrow* Royle	Tree	Phanerophyte
13.	Crassulaceae	*Rhodiola pachyclados* (Aitch. & Hemsl.) H.	Perennial herb	Hemicryptophyte
14.	Papilionaceae	*Sophora mollis* (Royle) Baker	Shrub	Chamaephyte
15.	Rosaceae	*Rosa webbiana* Wall.ex Royle	Shrub	Phanerophyte
16.	Fagaceae	*Quercus robour* L.	Tree	Phanerophyte
17.	Valerianaceae	*Valeriana jatamansi* Jones.	Herb	Geophyte
18.	Fagaceae	*Quercus semicarpifolia* Smith	Tree	Phanerophyte
19.	Fagaceae	*Quercus dilatata* Lindl. ex Royle	Tree	Phanerophyte
20.	Ranunculaceae	*Aquilegia moorcroftiana* Wall. ex Royle	Herb	Hemicryptophyte
21.	Anacardiaceae	*Schinus molle* L.	Tree	Phanerophyte
22.	Asteraceae	*Anthemus cotula* L.	Annual herb	Therophyte
23.	Boraginaceae	*Cynoglossum glochiadum* Wall.ex Benth.	Biennial herb	Hemicryptophyte
24.	Fagaceae	*Castanea sativa* Mill.	Tree	Phanerophyte
25.	Asteraceae	*Artemisia absinthium* L.	Perennial herb	Chamaephyte
26.	Thymelaeaceae	*Daphne mucronata* Royle	Shrub	Phanerophyte
27.	Rosaceae	*Potentilla gerardiana* Lindl. ex Lehm.	Perennial herb	Chamaephyte
28.	Saxifragaceae	*Bergenia stracheyi* (Hook.f. & Thorns.) Engl.	Perennial herb	Hemicryptophyte
29.	Caryophyllaceae	*Silene longicarpophora* (Kom.) Bocquet.	Perennial herb	Chamaephyte
30.	Rosaceae	*Cotoneaster microphyllus* var. *thymifolius.*	Shrub	Phanerophyte
31.	Labiatae	*Perovskia atriplicifolia* Benth.	Shrub	Phanerophyte
32.	Labiatae	*Thymus linearis* subsp. *hedgei* Jalas in Ann.	Perennial herb	Hemicryptophyte
33.	Asteraceae	*Blumea membranacea* DC.	Herb	-
34.	Scrophulariaceae	*Verbascum thapsus* L.	Biennial herb	Hemicryptophyte
35.	Labiatae	*Nepeta erecta* (Royle ex Benth.) Benth.	Perennial herb	Hemicryptophyte
36.	Poaceae	*Poa aitchisonii*	Herb	-
37.	Labiatae	*Prunella vulgaris* L.	Perennial Herb	Hemicryptophyte
38.	Caryophyllaceae	*Dianthus orientalis* Adams.	Perennial herb	Chamaephyte
39.	Labiatae	*Nepeta kurramensis* Aitch. & Hemsl.	-	Hemicryptophyte

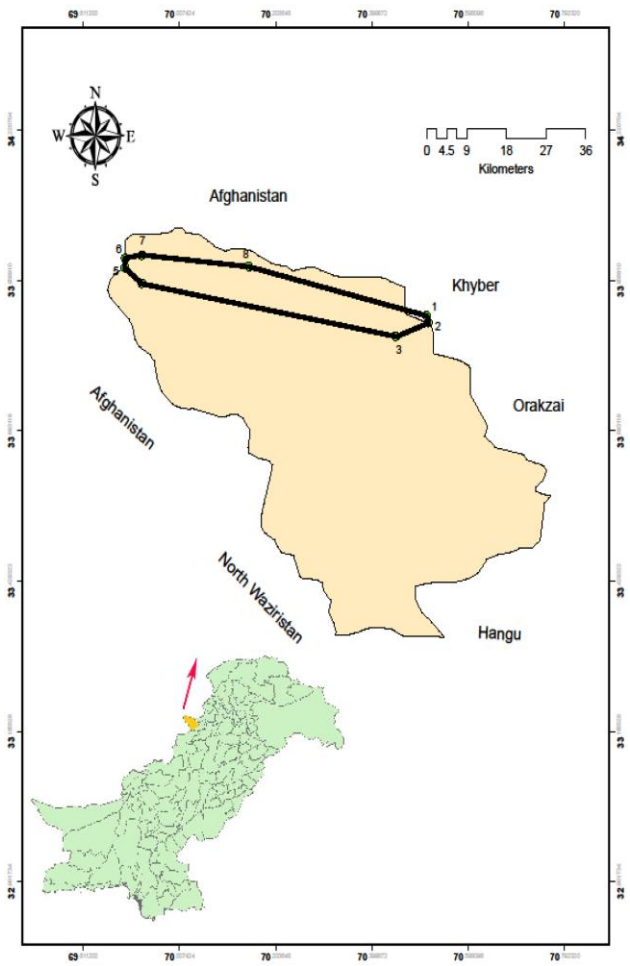

Fig. 2. Area of occupancy of *Rhododendron afghanicum* in different localities of Koh-i-Sufaid range in Kurram Agency.

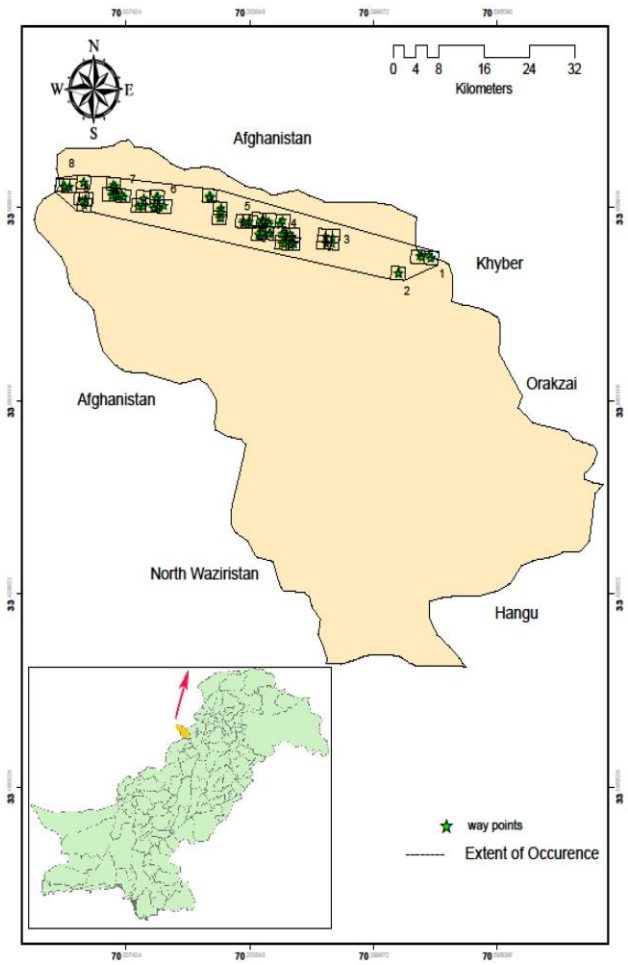

Fig. 3. Distribution and Extent of Occurrence of *Rhododendron afghanicum* in different localities of Koh-i-Sufaid range in Kurram Agency.

2. Distribution: Generally, this taxon is confined to Koh-i-Safad mountain range in the area. During study period it was found on 27 spots in these 7 localities (Table 3). Distribution of the species was mostly confined on slope and rocky area even within the distribution area. However, in certain cases, some individuals of the taxon were also found to occur in dense forest of *Pinus wallichiana*, *Qurcus baloot* and *Abies pindrow* the species is strictly narrow endemic to the study area.

All these localities collectively encompass an area of approximately 354.881 km^2 as extent of occurrence. The highest area of occupancy was observed in locality 4 followed by locality 6 and the remaining localities were less than 11 km^2 area. The estimate area of occupancy in the observed localities was about 116.511 km^2 (Table 2 and Fig. 2).

Table 2. *Rhododendron afghanicum* Aitch. & Hemsl.: Summary of geographical range (i.e. Extent of occurrence & Area of occupancy in km^2).

Extent of occurrence in km^2	Area of occupancy in km^2
354.881	116.511

3. Population size: The observed population size of the taxon in 7 different localities is given in the Table 3. In total, 949 individuals were seen in these localities. Locality-wise, the highest number of plant individuals were observed in Daradar, upper hills i.e., 194 (19.81%), proceeding 180 (18.38%) in Koh-i-Sufaid range and Gandaw 168 (17.16%). The remaining localities had less than 166 plants each (Table 3).

4. Mode of reproduction: Both type of reproduction were observed during the study period i.e. sexual and asexual reproduction as well.

i. Sexual reproduction: It reproduces through sexual reproduction. The flowering period starts from the end of May and extends to August. Peak flowering period was observed from 20th June to 30th July. An average number of fruits per individual were observed to be 13 on the same plant (Table 4).

ii. Asexual reproduction: *Rhododendron afghanicum* also reproduce through vegetative mode of reproduction, during favourable season. The perinnating buds appear on the branches and new branches also appear from the root stock as well giving rise to new individual.

iii. Threats

iiia. Natural threats: As *R. afghanicum* inhabit in the subalpine zone where heavy snowfall damages the plant as the seedling and young branches inclined due to the snow avalanches. Heavy rainfall is also a severe threat because of the greater run-off at higher altitude. The top soil of the habitat is eroded due to heavy rainfall.

Table 3. *Rhododendron afghanicum:* Details of population size in different known spots.

S. No.	Locality	Altitude (m)	GPS Value	Population size	% of the population size
1.	Awidara, Koh-i- sufaid range	2661	33°53.386E-70°29.449N	31	3.16
2.	Awidara, Upper hills	2431	33°52.021E-70°26.315N	36	3.67
3.	Daradar (Sarabi) upper kurram	2930	33°56.422E-70°13.412N	50	5.10
4.	Gandaw E. hills	2530	33°56.422E-70°13.412N	41	4.18
5.	Gandaw, Koh- i- sufaid range	2731	33°57.531E-70°13.793N	42	4.29
6.	Gandaw, upper hills	2675	33°56.772E-70°15.045N	20	2.04
7.	Khapar Banda	2585	33°56.402E-70°14.116N	39	3.98
8.	Khawri, E. hills	2385	33°56.591E-70°15.139N	29	2.96
9.	Khewas, upper hills	2365	33°57.524E-70°01.223N	23	2.34
10.	Koh- i-Sufaid range	2721	33°56.429E-70°13.414N	31	3.16
11.	Koh- i-Sufaid range	2924	33°55.277E-70°19.347N	28	2.86
12.	Koh- i-Sufaid range footsteep	2917	33°58.539E-70°02.562N	31	3.16
13.	Koh- i- Sufaid range	3045	33°56.250E-70°14.035N	47	4.80
14.	Koh- i-Sufaid range	2747	33°54.405E-70°16.345N	43	4.39
15.	Malana, upper Kurram	2509	33°57.437E-70°03.112N	51	5.20
16.	Malana, upper Kurram	2880	33°57.536E-70°04.047N	50	5.10
17.	Maloota, upper hills	2521	33°56.311E-70°14.009N	37	3.77
18.	Mir Janam Kali	2585	33°57.030E-70°13.465N	36	3.67
19.	Said Mir Banda	2920	33°56.420E-70°13.415N	39	3.98
20.	Shalozan, E.Hills	2513	33°59.325E-70°02.488N	31	3.16
21.	Shalozan, S.hills	2566	33°59.012E-69°59.539N	41	4.18
22.	ShalozanTangi	2802	33°58.541E-69°59.930N	30	3.06
23.	Shalozan, upper hills	2910	33°59.070E-69°59.327N	41	4.18
24.	SpeenaShaga	2783	33°59.141E-69°56.502N	23	2.34
25.	SpeenaShaga	2854	33°59.073E-69°57.169N	47	4.80
26.	SpeenaShaga	2925	33°59.499E-69°56.327N	33	3.37
27.	Ziran, upper hills	2397	33°56.431E-70°13.429N	29	2.96

Table 4. *Rhododendron afghanicum*: variation in the fruit per individual.

Maximum	Average	Minimum
16	13	10

iiib. Anthropogenic impact: As this taxon is growing at high altitude in subalpine zone of the Koh-i-Sufaid range therefore facing serious anthropogenic disturbances, which are as under:

Deforestation: Due to the harsh climatic condition and chilling weather in winter, the inhabitants mostly depend upon the fuel wood due to the lack of other alternative facilities. The woods are also sold to the settle area, as *R. afghanicum* grows in association with the *Quercus baloot*, *Quercus robour*, *Abies pindrow* and *Pinus wallichiana.* Their wood is sold both for construction as timber as well as fuel wood.

Uprooting pressure: Habitat of the species is used as pasture land during summer, the gazing pressure is increased in August, as these are well pasture area the shepherds moves towards the *Rhododendron* rich habitat, as the *Rhododendron afghanicum* is a poisonous plant, therefore, the shepherds uproot it before the grazing. In the mountainous area the Sheppards build small huts and stay for three months (July, August, September). During stay in the research area 200 goats, 120 sheep and 20 cows were observed. The grazing pressure usually increases when the Afghan sheppards cross the border with their cattles in August.

Road construction: Road construction is under process by the contractor to excavate the soapstone from their mine, the road passes through the habitat rich spots which add a serious threat in this connection.

Soapstone excavation: The soapstone and dolomite is an imperative mineral naturally occurring as a mining of the area. As the taxon grows near the soapstone area, the excavation causes alarming threat to the taxon.

Discussion and Conclusion

This paper deals with biodiversity loss which is considered to be one of the most serious issues around the world (Leakey & Lewin, 1995; Sala, 2000) as conservation of species ensures the survival of human being itself. Unfortunately, this issue has not been taken seriously till now particularly in third world including Pakistan. In the case of Pakistan, only 54 taxa have been evaluated in connection to investigate extinction risk in the last decade (Abbas *et al*., 2010, Alam & Ali, 2009, 2010; Ali & Qaiser, 2010a, 2010b, 2010c; Muhammad, 2013; Shaheen *et al.*, 2016). Moreover, of these, 50 taxa (92.60%) are endemic to Pakistan, while the remaining 4 taxa are rare for Pakistan.

Endemic species usually have less ability to compete as compared to widely distributed species (Rabinowitz, 1981; Kruckeber, 1985; Mills & Schwartz, 2005). Therefore, they preferred harsh habitats like rocks. In the case of *Rhododendron afghanicum*, distribution of the individual restricted to subalpine zone as distributed between 2000-3000m. Keeping in view that, this taxon grows in association of about 40 species having different habit and life form, belonging to 20 families and 35 genera, which suggest particular species co-exist with this taxon. The taxon grows in association with *Quercus baloot*, *Quercus robour*, *Abies pindrow*, *Pinus wallichiana*, and *Pinus roxburgii* etc. The plant enjoys their existence in the Cliffs and dense forests. However some individuals were also seen in snow-melting stream bank, the species is restricted to sloppy area. These results suggest that *R. afghanicum* has the ability of competition and can easily survive in different sub habitats.

Distribution pattern in connection with survival of a species in a habitat is a key component and strong and important parameter (Anon., 2001). As *Rhododendron afghanicum* encompasses an area of about 354.881 km^2. Distribution of the taxon is not uniform even in the observed area. Individuals are distributed in small patches having c. 3 km an average distance. Moreover, it is estimated that only c. one-third area (i.e. 32.34%) is occupied (area of occupancy) by the individuals of this species in the total distribution range. These results suggest that, distribution pattern is not uniform and in major portion of the distribution range, individuals of this species are absent.

Fragmentation is also considered to be a primary serious threat for survival of species (Anon., 2001). So far as population size of *Rhododendron afghanicum* is concerned, 27 spots are known and these spots are distributed within 7 localities. These known localities are collectively support for 949 individuals only. It is also observed that, Daradar, Gandaw, Ziran and Shalozan Tangi are the centre of the survival of this species. However, these areas are alarmingly exposed to uprooting pressure by the shepherd and deforestation. Subpopulation sizes range from 20 (2.05%) to 51 (5.20%) individuals per spot. and population size (i.e. total 949 mature individuals) suggest that the population size seem to be small and highly fragmented in nature and conservation initiation need on priority basis.

Owing to its distribution pattern *R. afghanicum* faces severe natural and anthropogenic impact. As grows in the pasture and grassland, the shepherd used to move and uproot the individuals of taxon. Furthermore, deforestation, soil erosion and habitat fragmentation put severe pressure in this connection. In rugged mountainous slope and rock edges the specie is safe from anthropogenic disturbance and stable.

When the conservation status of the taxon is evaluated according to IUCN Red List Categories and Criteria (Anon., 2001), the extent of occurrence of the species is 354.881 km^2 (less than 5000 km^2) as shown in figure 3. *Rhododendron afghanicum* should be assigned under the B1 of the Endangered category. Similarly the area of occupancy is approximately 116.511 km^2 (less than 500 km^2) as given in Table 5. Therefore, this species is also kept under the criterion of B2 of the Endangered category. Moreover, this species is severely fragmented in 7 different localities and is facing many anthropogenic threats (Tables 5 and 6).

Table 5. Summary of known localities, population size, geographical range and various anthropogenic and natural threat observed in the study taxa.

Taxa	Known localities	Population size	Geographic range		Anthropogenic and natural threat					
			E.O Km^2	A.O Km^2	A	B	C	D	E	F
Rhododendron afghanicum	07	979	354.881	116.511	+	+	+	–	+	+

Key: E.O; Extent of occurrence, A.O; Area of occupancy, A, Deforestation, B, Uprooting pressure, C, Soil erosion, D, Medicinal uses, E, Grazing, F. Road construction. (+ present: – absent)

Table 6. *Rhododendron afghanicum:* Summary of the stands in the known localities.

S. No.	localities	Number of individuals	% of individuals
1.	Speena Shaga	103	10.52
2.	ShalozanTangi upper Hills	166	16.95
3.	Malana, upper Kurram	101	10.31
4.	Awidara, upper Hills	67	6.84
5.	Gandaw, upper Hills	168	17.16
6.	Daradar, upper Hills	194	19.81
7.	Koh-i-Sufaid range	180	18.38

The following is the alphanumerical hierarchical numbering system of the criteria (IUCN, 2001). The evaluation of the conservation status of *Rhododendron afghanicum* is summarized as: EN B1b (i) (ii) (iii) (v) 2b (iii) (iv) (v), where: EN: Endangered; B, Geographic range in the form, extent of occurrence estimated to be less than 5000 km2.; (i) extent of occurrence; (ii) area of occupancy; (iii) number of locations or subpopulations ;2 = area of occupancy estimated to be less than 500 km^2; b, continuing decline, observed, inferred or projected; (iii) area, extent and/or quality of habitat; (iv), number of location and subpopulations;(v), number of mature individuals.

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