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## **Conservation Status of *Astragalus gilgitensis* ALI (*Fabaceae*): a Critically Endangered Species in the Gilgit District, Pakistan**

By

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With 3 Figures

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**Key words:** *Astragalus gilgitensis*, *Fabaceae*, *Papilionaceae*, conservation status, critically endangered, deforestation, over-grazing, population size. – Gilgit, Pakistan.

### Summary

ALAM J. & ALI S. I. 2009. Conservation status of *Astragalus gilgitensis* ALI (*Fabaceae*): a critically endangered species in Gilgit district, Pakistan. – *Phyton* (Horn, Austria) 48(2): 211–223, with 3 figures.

*Astragalus gilgitensis* ALI (*Fabaceae*, *Papilionaceae*) is distributed in Afghanistan (Kail, Laghman district) and Pakistan (Nomal, Naltar and Chalt, Gilgit district). Originally, it was reported from the Gilgit district. In Pakistan, a current five-year re-assessment reveals that this species has now become restricted to Naltar only. Ten field surveys were conducted from 2003 to 2007 in order to study its distribution, population size, the severity of threats like erosion and anthropogenic impacts i.e. over-grazing, deforestation for fuel wood and recreational activities in the natural habitat of the species. The conservation status of this species according to IUCN Red list Categories and Criteria 2001 should be regarded as critically endangered (CR) in Pakistan.

### Zusammenfassung

ALAM J. & ALI S. I. 2009. Conservation status of *Astragalus gilgitensis* ALI (*Fabaceae*): a critically endangered species in Gilgit district, Pakistan. [Schutzstatus von *Astragalus gilgitensis* ALI (*Fabaceae*): eine kritisch gefährdete Art im Gilgit Distrikt, Pakistan] – *Phyton* (Horn, Austria) 48(2): 211–223, mit 3 Abbildungen.

*Astragalus gilgitensis* ALI (*Fabaceae*, *Papilionaceae*) kommt in Afghanistan (Kail, Provinz Laghman) und Pakistan (Nomal, Naltar und Chalt, Gilgit Distrikt) vor.

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Ursprünglich wurde er von Gilgit beschrieben. In Pakistan hat eine aktuelle, fünfjährige Studie ergeben, daß die Art heute auf Naltar beschränkt ist. Zehn Felddaufnahmen wurden von 2003 bis 2007 durchgeführt, um Verbreitung, Populationsgröße, Schwere der Gefahren wie Erosion und menschlicher Einfluß (Überweidung, Abholzung für Brennholz, Nutzung als Erholungsraum) im natürlichen Verbreitungsgebiet der Art zu studieren. Der Schutzstatus der Art nach den IUCN Rote Liste Kategorien und Kriterien 2001 ist in Pakistan als kritisch gefährdet (CR) zu betrachten.

## 1. Introduction

The planet earth is the homeland of more than 270,000 vascular plant species (WALTER & GILLET 1998), which are surviving in various ecosystems. Due to the tremendous increase in human population, urbanization, fragmentation of the habitat and over-exploitation of natural resources (HEYWOOD 1995), the natural flora is rapidly disappearing. WALTER & GILLET 1998 have listed 33798 (i.e. 12.5% of the flora) vascular plant species as threatened on the global scale. However, this figure is likely to be an underestimation in view of lack of taxonomic knowledge, critical studies of plant populations over a number of years and lack of realization on the part of administrators, particularly in the developing world. The most alarming factor in this context is the irreversible loss of biodiversity.

Pakistan is under tremendous pressure concerning its population explosion, unplanned urbanization, deforestation and over-exploitation of natural resources (ALI 2000, Anonymous 2000, SHEIKH & al. 2002, AHMAD & al. 2005, EBERHART & al. 2006, SCHICKHOFF 2006). Unfortunately, no critical work has been done on threatened plants of Pakistan and very little information is available on this subject. According to NASIR 1991, 580–650 flowering plant species (i.e. 12%) are expected to be threatened. In contrast, WALTER & GILLET 1998 have listed only 14 flowering plant species as threatened from Pakistan. Of these 2 are said to be already extinct, 2 endangered, 2 vulnerable, 5 are rare and 5 indeterminate. This is merely 0.3% of the total number of species known from Pakistan. However, in the current red list (IUCN 2008), 19 flowering plant species are listed from Pakistan. Of these, 2 are vulnerable, 13 lower risks/least concern, 1 near threatened and the remaining 3 were classified as data deficient. Two species i.e. *Holarrhena pubescens* (BUCH.-HAM.) ex G. DON and *Ulmus wallichiana* PLANCHON were kept under endangered category (WALTER & GILLET 1998), of these, *U. wallichiana* is shifted to the vulnerable category, while *H. pubescens* is re-classified as least concern. Likewise previously 2 as rare considered species i.e. *Juniperus torulosa* D. DON and *Pinus gerardiana* WALLICH ex D. DON are also reclassified as data deficient (IUCN 2008).

In order to determine the conservation status of a taxon, it is necessary to determine the fluctuation in its population size, the area that is occu-

pied by the taxon and to maintain long-lasting observations (IUCN 2001). Such studies have never been done in Pakistan.

Endemic and rare taxa of an area are most vulnerable because these plants occupy small geographic ranges and specific habitats. However, these populations are fundamental evolutionary elements that may be the basis for the founder effect and allopatric speciation, evolutionary processes that give birth to new species or may lead to relict taxa (MAUCHAMP & al. 1998). Furthermore, narrow endemics and threatened species contain genetic material which may be useful in breeding programs (KRUCKEBERG & RABINOWITZ 1985). Hence, keeping in mind the above facts, endemic and rare species, particularly narrow endemic species of Pakistan deserve our immediate attention.

Gilgit is located in the Northern Areas of Pakistan between 35.6°–37° N and 74°–75.2° E with a total area of 18292 sq. km. Gilgit is bordering China on the eastern side connected through the Khunjerab pass, has Central Asian states on its northern frontiers, Afghanistan as northwestern border while the western and southern sides are delimited by means of Ghaizer, Astore and the valleys of Baltistan (M. ALI 2000). The Gilgit district is situated in the well-known mountain range Karakorum (Figure 1). Many peaks above 7000 m are found here, like Rakaposhi (7788 m), Deran peak (7268 m). The Hispar glacier is one of the largest glaciers, which extends for about 49 km and covers an area of 343 sq. km (PERKIN 2003).

Based on the population census 1998, the population of the Gilgit district is 243,324. Of this total, 56,701 (i.e. 23.30%) people were classified as urban while the rest of the population (186,623 i.e. 76.69%) was classified as rural. The annual population growth for the whole Northern Areas (of Pakistan) was estimated to be 2.47 % (PERKIN 2003).

Climatic changes are vertically influenced due to high mountain ranges. The valleys have mild summers, and cool winters, while mountaintops experience arctic climate (KHAN 1995: 50). Below 3000 m, precipitation rarely exceeds 200 mm annually. However, there is a strong gradient with altitude, and at 6000 m, the snow fall is equivalent to 2000 mm per year. Temperatures in valley bottoms can range from extremes of nearly 40 °C in summer to less than -10 °C in winter (PERKIN 2003).

Due to the highly rugged mountainous topography a large proportion of the region is uninhabitable. In most cases the land consists primarily of small terraces. The agriculture varies significantly with the variation in altitude. At the lower altitude i.e. Gilgit town, lower Hunza, both summer and winter crops are grown, while at higher altitude like in Misgar, only summer crops are grown. Wheat, maize, barley, potato are common (PERKIN 2003).

*Astragalus gilgitensis* was previously reported from three small adjacent localities, namely, Chalt, Nomal and Naltar valley (ALI 1966: 135,

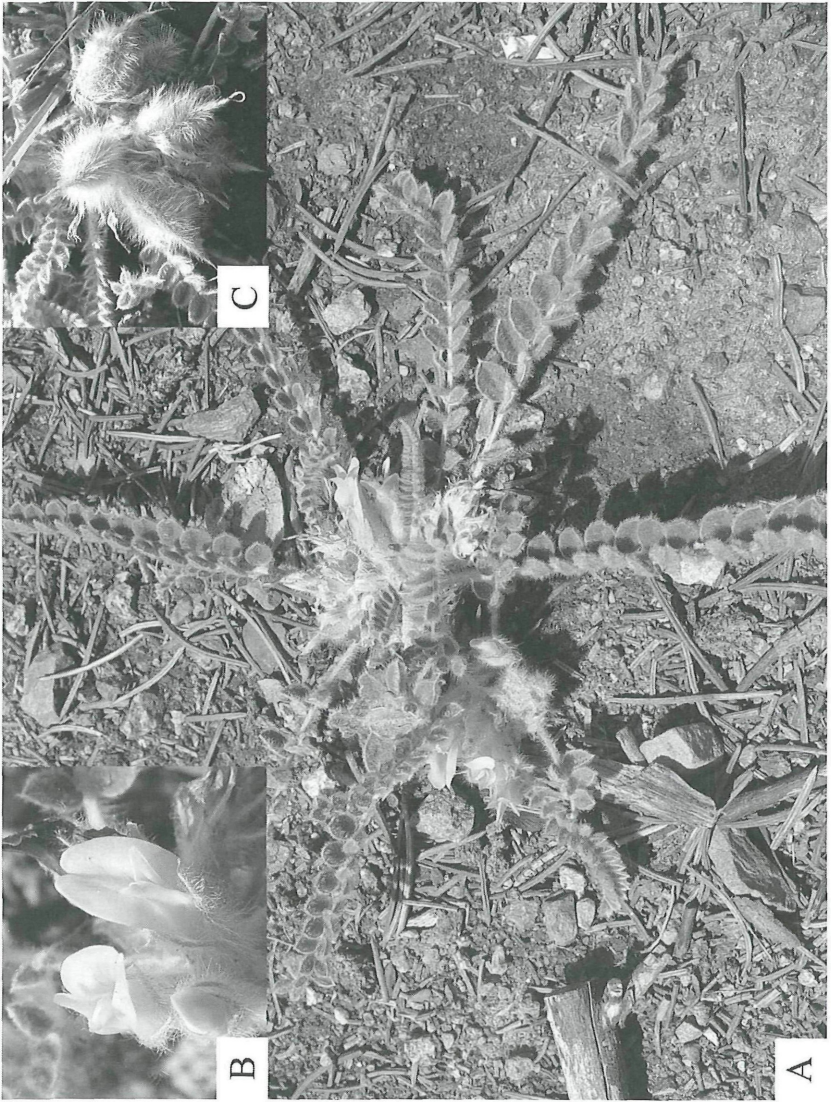


Fig. 1. *Astragalus gigitensis*: A habit, B flowers and C fruits.

1977: 183). Until 1999, this species was known only from the above mentioned localities. However, in 1999, it was also reported from Afghanistan: Kail, Laghman District (PODLECH 1999: 193).

*Astragalus gilgitensis* (Fabaceae or Papilionaceae) is a perennial herb (ALI 1977). The stem is reduced. The leaves are imparipinnately compound, having 45–59 leaflets. Each leaflet is c. 8–14 mm long and 4–8 mm broad, elliptic to oblong in shape with acute apex. Each leaflet is hirsute on both surfaces. Pilose stipules range from 10–14 mm long. The inflorescence is axillary umbellate. The flowers are yellow, with c. 3–4 mm long pubescent pedicels. The calyx is 18–19 mm long, pilose; teeth c. 9–10 mm long. The vexillum is 21 mm long. Wing and keel are 18 mm and 15 mm, respectively. Ovary c. 5–6 mm (ALI 1977: 183) while the mature fruit is 11–13 mm long 6–8 mm broad and pilose (Fig. 1).

This species is closely related to *A. rhizocephalus* BAKER ex AITCHISON from which it differs mainly in the shape of the vexillum. In *A. rhizocephalus* a panduriform vexillum is present; in *A. gilgitensis* the vexillum is ovate to subovate (ALI 1966: 136, 1977: 183). In PODLECH 1999: 190–195 *A. gilgitensis* appears in the *A. rhizanthus*-Group within *A. sect. Caprini* DC. subsect. *Caprini*, not in the *A. rhizocephalus*-Group (p. 256–261).

In the present study, an attempt has been made to determine the conservation status of *Astragalus gilgitensis*.

## 2. Material and Methods

Ten field trips were arranged from 2003 to 2007 in order to study and collect the concerned species as per details given in Table 1. Habit, habitat, altitudinal range, population size, mode of reproduction, range of distribution and severity of threats like grazing, erosion and deforestation have been studied for five years (2003–2007) in the natural populations.

Table 1. Details of field trips.

S. No.	Duration
1.	June 13, 2003 to June 16, 2003
2.	September 15, 2003 to September 18, 2003
3.	July 4, 2004 to July 8, 2004
4.	September 9, 2004 to September 12, 2004
5.	June 19, 2005 to June 21, 2005
6.	September 19, 2005 to September 22, 2005
7.	September 02, 2006 to September 05, 2006
8.	June 18, 2007 to June 22, 2007
9.	August 26, 2007 to August 28, 2007
10.	October 11, 2007 to October 14, 2007

- (i) For population size, mature individuals of *Astragalus gilgitensis* were counted. Here, those individuals which were found in flowering or fruiting condition were considered as mature individuals.
- (ii) The known distribution area was measured by encircling three known localities of the species on the map of the project area (M. ALI 2000).
- (iii) In Pakistan, the area of occupancy i.e. the actual occupied area by a taxon within the extent of occurrence (IUCN 2001) was roughly estimated through extensive walks by encompass marginal individuals of the species in their habitat.
- (iv) Nature of habitat i.e. quality of habitat was determined by considering grazing impact, accessibility to the locality, soil erosion and other anthropogenic impacts.
- (v) In order to analyze the grazing pressure, grazed individuals were counted and their average percentage was calculated.
- (vi) The altitudinal range was recorded by global positioning system (Lawrence iFinder).
- (vii) The number of fruits per individual and number of seeds per fruit of 100 individual plants were counted. These individual plants were randomly selected from the population in 2004 and 2005.
- (viii) Seeds were also collected in order to calculate the rate of germination. 100 seeds were selected in order to calculate the average weight of each seed. However, we could not germinate the seeds in the lab; hence the reproductive capacity could not be calculated.

Herbarium material was collected and deposited at Karachi University Herbarium (KUH) in each case. Photographs were also taken. The herbarium material was properly identified with the help of the Flora of Pakistan [NASIR & ALI 1970–1989, (Nos. 1–190); ALI & NASIR 1989–1991, (Nos. 191–193); ALI & QAISER 1993–2007, (Nos. 194–214)]. Finally, the data were analyzed in the light of IUCN Red List Categories & Criteria (IUCN 2001).

### 3. Results

#### 3.1. Habitat and their Altitudinal Range

*Astragalus gilgitensis* was observed in Naltar Valley on grassy gentle slopes among open places (gaps) in sub-alpine forest of *Picea smithiana* (WALL.) BOISS., *Pinus wallichiana* A. B. JACKSON, *Betula utilis* D. DON and *Juniperus communis* L. from 3000 m to 3600 m. *Juniperus excelsa* L. was also found in very small proportion. It has been observed that the lower portion (below c. 3600 m) of the forest is occupied by *Picea smithiana* and *Pinus wallichiana*, while the upper portion of the forest (i.e. above 3600 m) is exclusively occupied by *Betula utilis*. The locality represents one of the richer mountainous habitats of Northern Areas of Pakistan. The forest in this area is fragmented and small open places (gaps) are present, which extend vertically up to the alpine region. Associated species like *Fragaria nubicola* LINDL. ex LACAITA, *Hedysarum falconeri* BAKER, *Salvia nubicola* WALL. ex SWEET, *Onosma hispida* WALL. ex DON, *Poa annua* L., *Poa alpina*

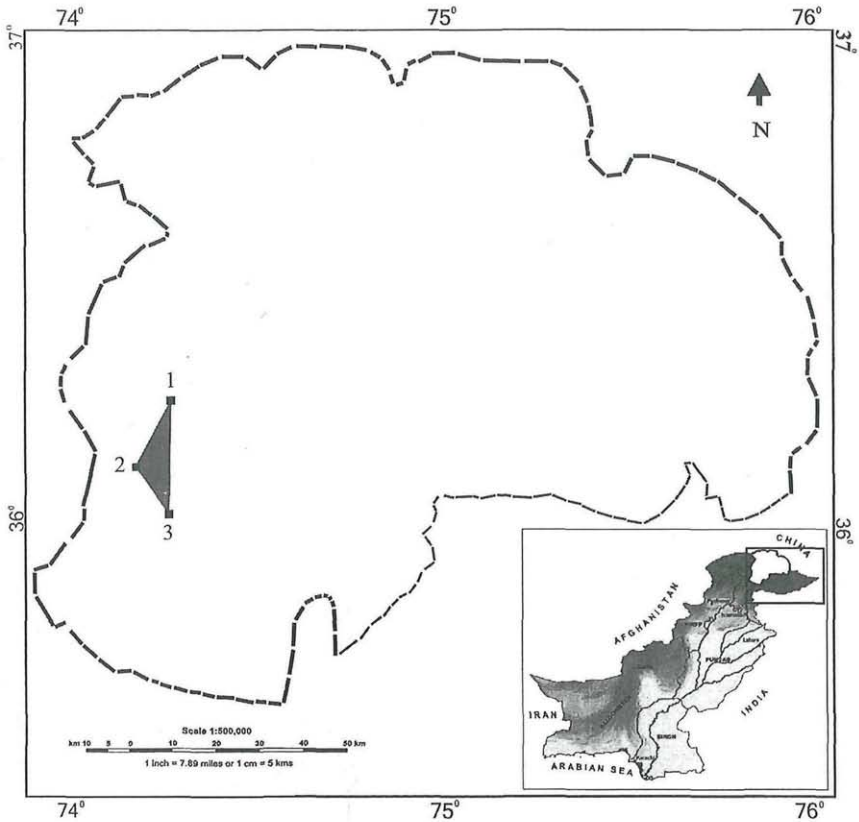


Fig. 2. Distribution of *Astragalus gilgitensis* in the Gilgit district, Pakistan: 1: Chalt, 2: Naltar, 3: Nomal.

L., *Aquilegia nivalis* FALC. ex JACKSON, *Aquilegia fragrans* BENTH. var. *fragrans*, *Gentianodes tianshanica* OMER, QAISER & ALI, *Ribes alpestre* DECNE. and *Lonicera heterophylla* DECNE. etc. were found.

### 3.2. Previous and Current Distribution

*Astragalus gilgitensis* was originally reported from Naltar to Nomal, Gilgit (ALI 1966: 135). Later on, this species was reported from Chalt also (ALI 1977: 183). However, during field studies this species was found only in Naltar. Based on these three small adjacent localities (by considering other previous localities along with Naltar), its distribution within the area adds up to 8.84 km<sup>2</sup> (Fig. 2). However, the populations from other localities have completely vanished and the species is restricted to a specific and fragile habitat in Naltar and only occupying an area of about 2.0 km<sup>2</sup>.

### 3.3. Population Size

Observations of the population size of the species from 2003 to 2007 are shown in Table 2. The highest number of individuals of the taxon, i.e. 906 plants, were observed in 2006, while in the remaining years, 600 to 898 individuals per year were found. All individuals are restricted to gaps of the forest. An average 16.6 immature individual plants were also found at the end of the season (i.e. October).

### 3.4. Grazing Impact

The Naltar is used as a pasture. In summer approximately 250 cows, 500 goats and 200 sheep were observed every year in the area. An average of 657 individual plants (i.e. 79.2%) were found grazed per year during the study period (Table 2). The grazing impact became more serious at the end of summer season when the livestock was brought down from alpine pastures. In September, in most of the cases the plants were grazed along with the fruits. Moreover, during grazing, young individuals were preferred while sometimes they were uprooted wholly from the soil due to their weak rooting system (Fig. 3).

Table 2. Population size and grazing impact analysis of *Astragalus gilgitensis* from 2003–2007.

Year	2003	2004	2005	2006	2007	% of grazed individuals
Population size	600	882	898	906	788	79.2
Grazed individuals	554	750	646	721	633	

### 3.5. Phenology and Mode of Reproduction

This perennial herb reproduces sexually and flowers from July to September. The average number of fruits per individual plant is 9.5. Similarly, an average number of seeds per fruit were counted to be 7 (Table 3). Some damaged seeds (i.e. 5%) were also observed. However, the responsible insects for damaging seeds could not be collected. The average weight of the seed was calculated to be 0.0052g.

Table 3. Variation in the number of fruits per plant and the number of seeds per fruit in *Astragalus gilgitensis*.

	Maximum	Minimum	Average
Fruits	15	4	9.5
Seeds	12	2	7



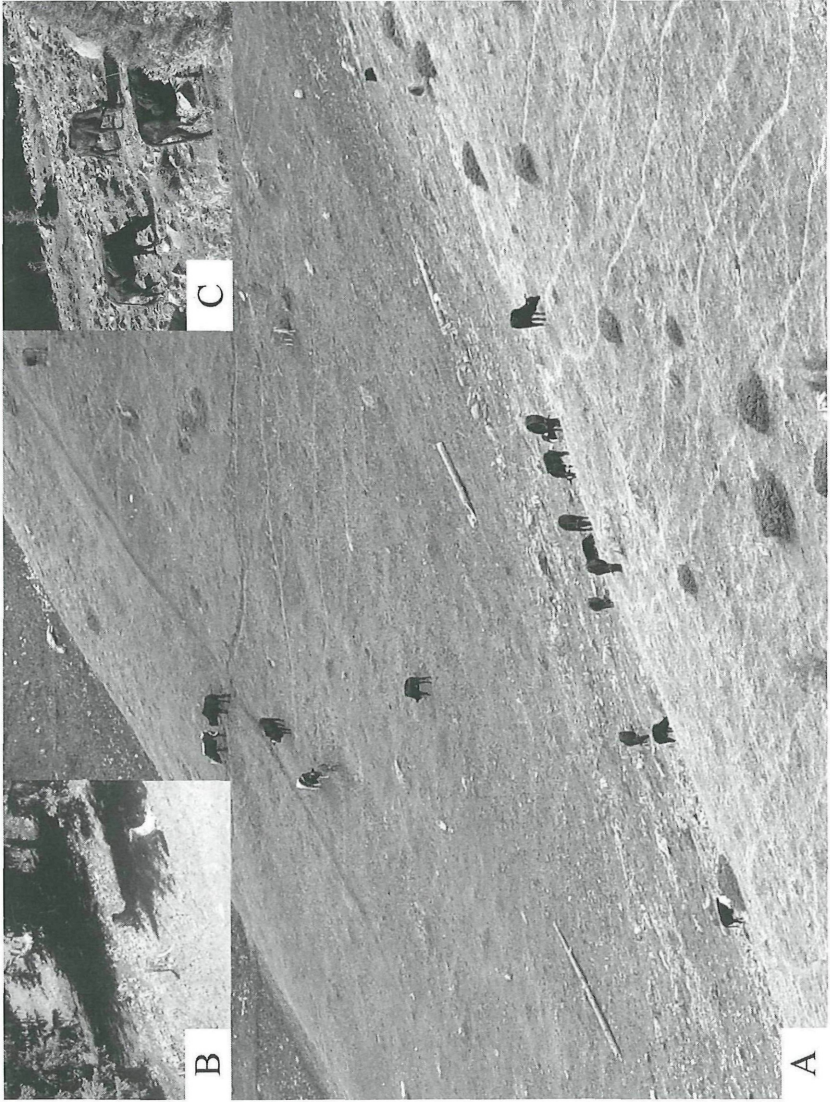


Fig. 3. *Astragalus gilgitensis*: A and C grazing impact, B deforestation in the core habitat.

### 3.6. Erosion

Erosion, caused by the runoff of water from melting snow in the form of streams was a threat to individuals, which grow at margins of the stream bank.

### 3.7. Recreational Activities

Naltar is visited by foreigners and local tourists for its beauty as well as for skiing during winter particularly in the lower limit of the area of the present population of the species. Although this place is the core habitat of the taxon only five individuals were observed in the skiing area due to disturbance in the habitat.

### 3.8. Deforestation

Though Naltar is a wildlife sanctuary (PERKIN 2003) and the forest is protected, however, some deforestation was observed. Collectively 220 cut tree trunks of *Pinus wallichiana*, *Picea smithiana*, *Betula utilis* and *Juniperus excelsa* were observed in the habitat of the species. The local inhabitants use forest trees as firewood. Particularly during winter, the consumption of fire wood becomes serious due to very low temperatures in the area (local informant).

## 4. Discussion and Conclusion

From two previously known localities, i.e. Chalt and Nomal, not even a single individual of *Astragalus gilgitensis* could be found. Hence, this taxon is confined to a single locality, exclusively in patches (i.e. open places) in the highly specific habitat from 3000 m to 3600 m only (i.e. narrow altitudinal range), indicating that this species is a very rare species. Previously it was present in three localities, collectively covering an area of about 8.21 km<sup>2</sup>. However, presently this species is confined to about 2 km<sup>2</sup> in Naltar only. The reduction in distribution area was 75% with an average reduction rate of c. 0.123 km<sup>2</sup> per year. Based on this reduction rate, we may predict that within the coming two to three decades, the species is likely to be extirpated from the remaining habitat.

The whole geographic range of the species is fragmented into two subpopulations, i.e. in Afghanistan and in Pakistan. Mindful of the extremely disturbed conditions in Afghanistan, our observations are confined only to Pakistan.

In the core habitat of *A. gilgitensis*, approximately 800 head of cattle have been observed. Consequently, an average 661 individual plants (i.e. 79.2%) were grazed in the studied period. Likewise, those individuals, which grow at the margins of the stream bank, were eroded. Moreover, c. 200 forest trees of *Pinus wallichiana*, *Picea smithiana*, *Betula utilis* and

*Juniperus excelsa* were also exploited (personal observation). All the above results suggest that this species is under tremendous pressure so far as its survival is concerned. Uncontrolled livestock grazing not only inhibits regeneration of individual plants but it also leads to range land degradation; the loose soil triggers erosion and landslide.

According to an estimate (PERKIN 2003), about 99.6% of the population of Northern Areas uses firewood for domestic purposes. The mean consumption of firewood was found to be 755 kg per household per month during the summer and 1172 kg in winter. Furthermore, the whole valley seems to be under pressure in view of over-grazing, soil erosion through water and deforestation for household activities. These results are also applicable in the case of Naltar valley. Similar observations were also made by SHEIKH & al. 2002. Such extensive pressure on fuel wood is directly threatening the survival of this rare species in its remaining restricted habitat.

Hence, extensive grazing and deforestation should be minimized because these factors may lead to further fragmentation and degradation of the habitat, especially since fragmentation is considered to be the primary cause of species extirpation (SALA & al. 2000).

When we evaluated the conservation status of *A. gilgitensis* using IUCN Red List Categories and Criteria (IUCN 2001), the maximum population size of the species was found to be 850 mature individuals. This falls under the criterion C of endangered category (i.e. less than 2500 mature individuals). However, its area of occupancy is less than 10 km<sup>2</sup> (i.e. c. 2 km<sup>2</sup>), a continuing decline in quality of the habitat due to grazing pressure, deforestation impact of recreational activities and presence in only one locality in the country lead us to keep this species under the Critically Endangered (CR) category. Although its population size falls only under the endangered category but as suggested in the criteria (IUCN 2001), it is necessary to consider the most serious extinction risk. Hence, *A. gilgitensis* should be regarded as Critically Endangered (CR) in Pakistan. By following the hierarchical alphanumeric numbering system of the criteria (IUCN 2001), the evaluation of the conservation status of *A. gilgitensis* can be summarized as follows: CRB2ab (ii, iii, iv) whereas:

B = Geographic range, 2 = Area of occupancy, a = severely fragmented or known to exist at only a single location, b = continuing decline, observed, inferred or projected, ii = area of occupancy, iii = area, extent and/or quality of habitat, iv = number of locations and sub locations.

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

- (i) *A. gilgitensis* should be included in the Red Data List of threatened species.

- (ii) Anthropogenic impacts like over-grazing, deforestation and recreational activities should be reduced as much as possible.
- (iii) *A. gilgitensis* should also be introduced in botanical gardens.
- (iv) The biology of the species should be investigated.
- (v) Permanent monitoring programmes should be developed.
- (vi) Conservation status assessment of the species in Afghanistan should also be immediately taken up in order to assign the proper category at international levels.

#### 5. Acknowledgement

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## Recensio

**WILHALM Thomas, NIKLFELD Harald & GUTERMANN Walter. 2006. Katalog der Gefäßpflanzen Südtirols.** – Lex. 8<sup>0</sup>, 215 Seiten, 5 Abb.; geb. – In: Veröffentlichungen des Naturmuseums Südtirol, 3. – Folio Verlag, Wien/Bozen – € 28,-. – ISBN 978-3-85256-325-1.

„Nach aktuellem Wissensstand kommen im Südtirol derzeit 2578 [Tabelle 1: 2579] Arten und Unterarten von Gefäßpflanzen vor. Davon werden 84% als einheimisch (oder alteingebürgert) eingestuft, der Rest als neophytisch (eingeschleppt oder verwildert). Von 100 einheimischen Taxa, die aus der Literatur für das Gebiet angegeben sind, fehlen aktuelle Nachweise, von 51 Taxa wurde ein Vorkommen als irrig und von weiteren 80 als fraglich angesehen.“ (p. 13).

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