Pak. J. Bot., 43(3): 1685-1690, 2011.

CONVOLVULUS SCINDICUS: CONSERVATION ASSESSMENT AND STRATEGIES TO AVOID EXTIRPATION

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Abstract

The conservation status of *Convolvulus scindicus* Stocks in Pakistan, was assessed according to IUCN red data categories and criteria. After three years (2006-2008) of extensive field studies based on population size, distribution range, nature of habitat and anthropogenic activities, the conservation status of *Convolvulus scindicus* has been classified as an endangered (EN) species. Conservation measures are also suggested avoiding its extirpation.

Introduction

Plants are considered as a viable component, for the sustainability of an ecosystem (Rubinoff & Powell, 2004). The number of vascular plant species varies from 270,000 to 425,000 (Govaerts, 2001; Prance *et al*. 2002), with perhaps a further 10-20% yet to be discovered and described (Hawksworth & Kalin-Arroyo, 1995). However, human induced activities heading towards fragmentation (Rubinoff & Powell, 2004) and this fragmentation along with habitat degradation resulted in species extirpation (Alonso *et al.*, 2001; Barbosa & Marquet, 2002). In the light of current global extinction crises, all the remaining natural ecosystems and the native species therein should be considered for protection (Griffin, 1999) and proper documentation before their complete and permanent disappearance. However, according to Khan & Frost (2001), special attention should be given to arid environment as it is already low and continuously declining in its biodiversity, while at the same time keep it in mind that the basic resources are already over exploited.

The flora of Pakistan is represented by 5521 species distributed in 1572 genera and it is estimated that 7.6% flora of Pakistan is endemic and majority of them are confined to northern Pakistan (Ali & Qaiser, 1986). Unfortunately, very little work has been done on threatened plant germplasm of Pakistan and extremely limited information is available on this subject (Alam & Ali, 2009) particularly of Southern Pakistan, an arid region of the country (Abbas, 2010). Deserts have their own importance and peculiarities. It is presumed to be future source of food, fodder and fuel for exploding population (Khan & Frost, 2001). Therefore, the plants growing in deserts need immediate attention from conservation point of view. In view of the importance of these plants a project for assessing the conservation status of rare and endemic plants from southern Pakistan was under taken. Abbas *et al*., (2010a) classified *Cadaba heterotricha* Stocks, as an Endangered (EN) species, based on IUCN red list categories and criteria (Anon., 2001). This present paper is the second contribution of this project.

The conservation status of a species is an indicator towards its state of presence in the future (Abbas, 2010). According to Vischi *et al.* (2004) conservation assessment is a major step towards preventing its extinction or extirpation. For assessment of conservation status, several parameters should be taken into consideration, not just counting the remaining individuals, but the overall growth or decline in the population over the period of time and most importantly, known or possible threats.

Convolvulus is a fairly large genus with 250 species and almost cosmopolitan in distribution. In Pakistan it is represented by 21 species (Austin & Ghazanfar, 1979). *Convolvulus* is a fairly large genus with 250 species and almost cosmopolitan in distribution. In Pakistan it is represented by 21 species. *Convolvulus scindicus* Stocks is a sub endemic species with a narrow geographic distribution, grows in arid areas of southern Pakistan (Austin & Ghazanfar, 1979). Previous workers (Blatter *et al*., 1929; Austin & Ghazanfar, 1979; Khatoon & Akbar, 2008) considered it as endemic to Sindh but now reported from Sibi, Baluchistan, Pakistan and Thar Desert, India also (Fig. 1). Khan *et al.* (2003) considered the taxon as rare or endangered in the Indian Thar Desert, while Khatoon & Akbar (2008) reported it as a rare species in Pakistan, these conclusions were purely based on literature and not supported by any quantitative data neither followed the parameters, developed for evaluating the conservation status. As the taxon is surviving in a hostile environment with a low population size, there is a dire need for a conservation strategy to avoid its extirpation or extinction (Abbas, 2010; Abbas *et al*., 2010b). In order to determine the conservation status of the *Convolvulus scindicus* in Pakistan, present study was under taken.

Materials and Methods

Detailed field surveys were conducted during 2006 to 2008 at a regular interval. Habit, habitat, altitudinal range, population size, distribution range, impacts of multiple threats like habitat destruction, erosion, fuel wood cutting, grazing, poultry farms and invasive species have been studied for three years in the habitat.

- Distribution range of the taxon was worked out by plotting relevant GPS (Lowrance, iFinder) readings on the map. ArcGIS 9.2 version was used for this purpose.
- Previously known localities and surrounding regions were thoroughly surveyed to determine the exact area of occurrence and range of distribution of *Convolvulus scindicus.*
- Position of sites was noted with the help of global positioning system (GPS).
- The population size was determined by counting the mature individuals. The seedlings were also counted separately.
- Impact of anthropogenic activities, soil erosion and invasive species in the habitat was observed.
- Habit and life form of every associated species in the habitat was also recorded and classified according to Raunkier's System of Classification (Raunkiaer, 1934).
- Information has also been collected from native people regarding the ethno-botanical usage.

Results

Habit, habitat and associated species: *Convolvulus scindicus* is a small branched perennial herb to under shrub (Fig. 2) up to 30-60 cm tall. It occurs on dry sandy or lime soils in association with *Rhazya stricta* Decne., *Grewia tenax* (Forssk.) Fiori and *Acacia senegal* (L.) Willd. *etc*., (Figs. 3,4). In total, 34 species were found as associates in the habitat, which included 17 shrubs, 5 herbs and 2 trees. The dominant life form of associated taxa was phenerophyte, followed by chaemaphyte, hemicryptophyte and therophyte (Table 1). It has been observed that most of the individuals of *Convolvulus scindicus* grow along ephemeral water running channels (Fig. 5). While on rocky slopes, only few individuals were seen.

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Table 1. Associate species of *Convolvulus scindicus* from 2006 to 2008 along with their habit and life form.

#	Family	Species	Habit	Life form
1.	Acanthaceae	*Ruellia linearibracteolata* Lindau	Shrub	Hemicryptophyte
2.	Acanthaceae	*Barlaria acanthoides* Vahl	Shrub	Chaemaphyte
3.	Amaranthaceae	*Aerva javanica* (Burm.f.) Juss ex Schultes	Perennial herb	Chaemaphyte
4.	Apocynaceae	*Rhazya stricta* Decne.	Shrub	Phanerophyte
5.	Asclepiadaceae	*Calotropis procera* (Ait.) Ait.f. subsp. *hamiltonii* (Wight) Ali	Shrub	Phanerophyte
6.	Asclepiadaceae	*Pergularia daemia* (Forssk.) Chiov.	Perennial herb	Chaemaphyte
7.	Asclepiadaceae	*Pentatropis nivalis* (Gmel.) Field & Wood	Climber	Phanerophyte
8.	Asclepiadeceae	*Periploca aphylla* Decne.	Shrub	Phanerophyte
9.	Asteraceae	*Pluchea arguta* Boiss.	Shrub	Phanerophyte
10.	Asteraceae	*Iphiona grantioides* (Boiss.) Anderb.	Perennial herb	Hemicryptophyte
11.	Asteraceae	*Pulicaria boissieri* Hook.f.	Perennial herb	Chaemaphyte
12.	Asteraceae	*Iphiona aucheri* (Boiss.) Anderb.	Perennial herb	Hemicryptophyte
13.	Boraginaceae	*Heliotropium ophioglossum* Stocks ex Boiss.	Perennial herb	Chaemaphyte
14.	Boraginaceae	*Heliotropium subutalum* (DC.) Vatke	Perennial herb	Chaemaphyte
15.	Boraginaceae	*Heliotropium calcareum* Stocks	Perennial herb	Chaemaphyte
16.	Brassicaceae	*Physorrhynchus brahuicus* Hook.f.	Perennial herb	Hemicryptophyte
17.	Burseraceae	*Commiphora wightii* (Arn.) Bhandari	Shrub	Phanerophyte
18.	Caesalpiniaceae	*Senna holosericea* (Fresen.) Greuter	Shrub	Chaemaphyte
19.	Capparaceae	*Capparis decidua* (Forssk.) Edgew.	Shrub	Phanerophyte
20.	Convolvulaceae	*Seddera latifolia* Hochst. & Steud.	Shrub	Chaemaphyte
21.	Euphorbiaceae	*Andrachne aspera* Spreng.	Perennial herb	Chaemaphyte
22.	Mimosoideae	*Prosopis juliflora* (Swartz) DC.	Shrub-tree	Phanerophyte
23.	Labiatae	*Salvia santolinifolia* Boiss.	Perennial herb	Chaemaphyte
24.	Malvaceae	*Senra incana* Cav.	Shrub	Chaemaphyte
25.	Mimosoideae	*Acacia senegal* (L.) Willd.	Tree	Phanerophyte
26.	Papilionoidae	*Indigofera linifolia* (L.f.) Retz.	Annual	Therophyte
27.	Papilionoidae	*Indigofera oblongifolia* Forssk.	Shrub	Phanerophyte
28.	Papilionoidae	*Rhynchosia minima* (L.) DC.	Perennial herb	Chaemaphyte
29.	Poaceae	*Cymbopogon jwarancusa* (Jones) Schult.	Perennial herb	Hemicryptophyte
30.	Polygonaceae	*Pteropyrum olivieri* Jaub. & Spach	Shrub	Phanerophyte
31.	Rhamnaceae	*Ziziphus nummularia* (Burm.f.) Wight & Arn.	Shrub	Phanerophyte
32.	Solanaceae	*Lycium edgeworthii* Dunal	Herb	Phanerophyte
33.	Tiliaceae	*Grewia tenax* (Forssk.) Fiori	Shrub	Phanerophyte
34.	Zygophyllaceae	*Fagonia bruguieri* DC.	Perennial herb	Chaemaphyte

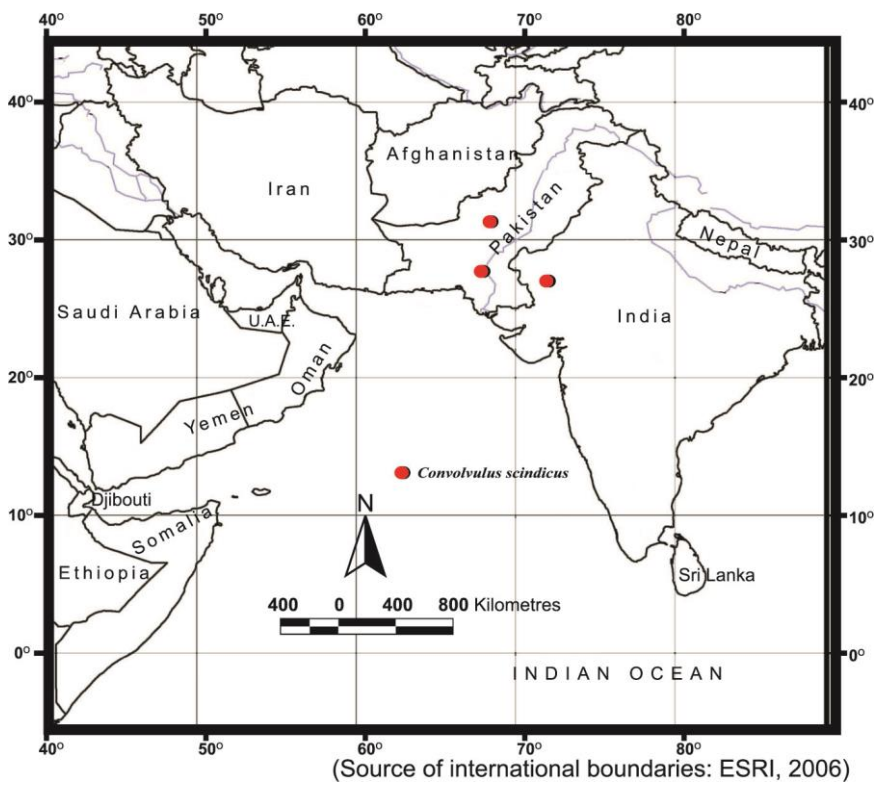

Fig. 1. Global distribution of *Convolvulus scindicus*.

Geographic range: *Convolvulus scindicus* is reported from Pakistan (Blatter *et al*., 1929; Austin & Ghazanfar, 1979; Khatoon & Akbar, 2008) and it has also been reported from Indian Thar desert (Fig. 1) adjacent to Pakistani border (Roy & Pandey, 1971; Khan *et al*., 2003; Oudhia, 2003). In Pakistan, currently, *Convolvulus scindicus* has been recorded from Sibi District (Baluchistan), while in Sindh, it has been observed in two locations *i.e*., 6 & 13 Km away from Thano Bulle Khan towards Hyderabad at the border of Dadu and Thatta (Austin & Ghazanfar, 1979; Khatoon & Akbar, 2008). Frequent field surveys confirmed the findings of earlier workers and in-addition to that an isolated population was also observed at Sujalo/Dodh, at the border of Thatta and Dadu Districts (Sindh). Observed Global Positioning System (GPS) coordinates suggested that these localities collectively occupy an area of 172.82 Km^2 (Fig. 6).

Fig. 2. *Convolvulus scindicus*: A, habit; B, flower; C, fruit

Fig. 3. *Convolvulus scindicus*: an overview of the habitat, showing high rise hills in the background, a permanent barrier between populations.

Population size and mode of reproduction in the wild: Observed population size during the study period (i.e., 2006 - 2008) is shown in Table 2. The highest number of mature individuals was found in 2008 (i.e. 600 individuals) followed by 580 and 550 plants individuals in 2007 and 2006, respectively. During studies, the highest number of immature individuals of this species were observed in 2007 (i.e. 423), followed by 420 & 330 individuals in 2006 and 2008, respectively.

Habitat disturbance: During field studies it has been observed that habitat loss is one of the serious threats to the survival of this extremely narrowly distributed rare species *Convolvulus scindicus* Stocks. Construction and excavation activities are causing disturbance in the core habitat of the taxon. The study area is also under stress because of the increasing human population and expansion activities of the existing 55 small to large villages/ Goths.

Soil erosion: In the study area, it has been found that immature individuals of *Convolvulus scindicus* grow along ephemeral rainy water running channels and during heavy rains and thunder storms it has been observed that most of the immature individuals and sometimes even mature one's, do not survive because of soil erosion.

Poultry farms: Lack of job opportunities in the area, creates an environment to motivate local people to generate living through, self employment. Poultry business is an emerging business in the area and it is causing a continuous increase in the human population by attracting labours and their families from other areas. Poultry business does not have any direct effect on this species, but the gradual increase in the human population and its activities like maintaining livestock, exerts pressure on the local vegetation (Fig. 7 A, B).

Grazing and fuel wood cutting: During field surveys, it has been found that local inhabitants (Pallari Tribe) of around 55 villages are about 20,000 (local informant). They have no access to natural gas and electricity; they maintain livestock for their living and these livestock feed on local vegetation. In the study area, no livestock (goats and cows) has been found feeding on this species, but their large numbers livestock and their massive grazing activity in the habitat exerts a pressure on this species (Fig. 7 C).

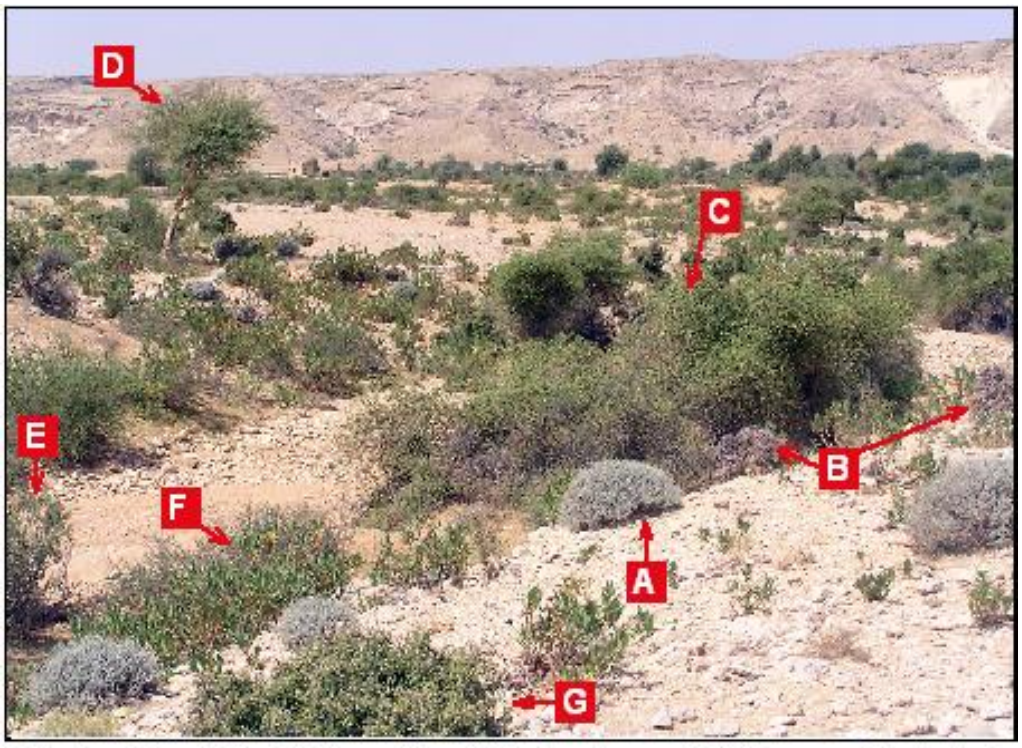

Fig. 4. *Convolvulus scindicus*: (A), in association with: B, *Grewia tenax*; C, *Ziziphus nummularia*; D, *Acacia senegal*; E, *Pteropyrum olivieri*; F, *Rhazya stricta*; G, *Lycium edgeworthi*.

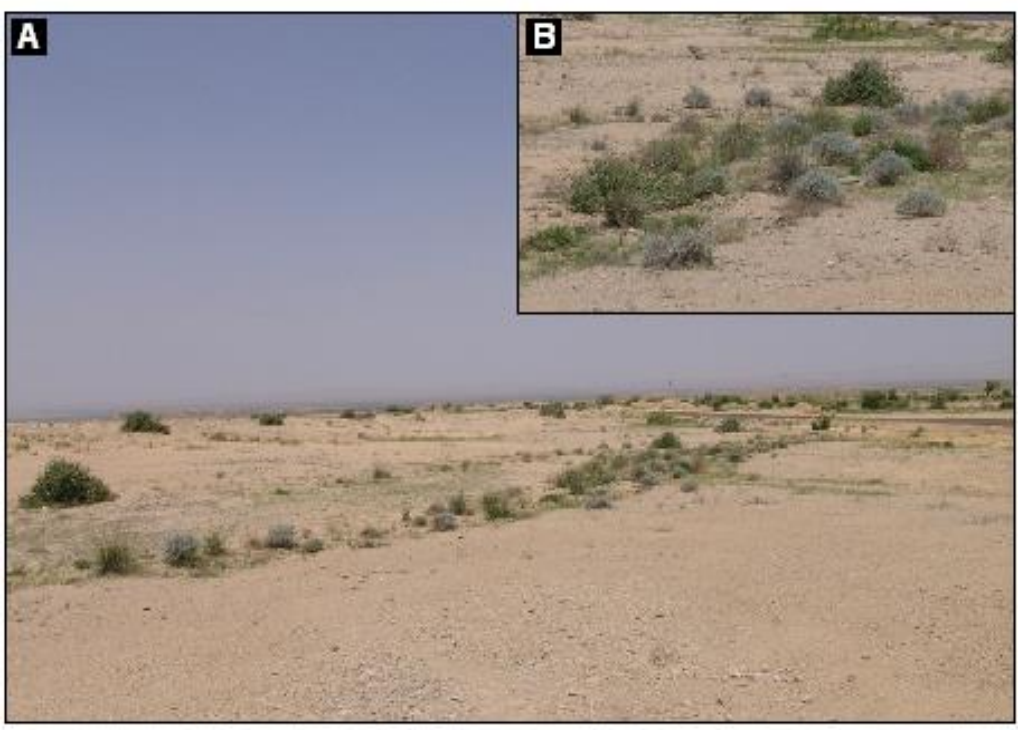

Fig. 5. *Convolvulus scindicus*: (A), dense population of mature and immature individuals, along ephemeral water running channels, indicating specific growing pattern; B, closeup of the same area.

Invasive species: In the study area, *Prosopis juliflora,* an invasive species has been observed in the core habitat of *Convolvulus scindicus.* During study period, the population of *Prosopis juliflora* has been found gradually increasing.

Discussion and Conclusion

The locus classic of *Convolvulus scindicus* was Garrah, Sindh from where it was first collected and described by Stocks (Type: Garrah, Stocks 433). However, after our repeated attempts we could not identify this locality. There are two places in Sindh named as Gharo and Gharro but the plant could not be located from either of these two localities. Blatter *et al*., (1929) also reported it on sand and sand dunes near Gharo village in the Indus Delta, While, Austin & Ghazanfar (1979) reported that it grew well on dry sandy or lime soils, in addition to that, Austin & Ghazanfar (1979) and Khatoon & Akbar (2008) recorded it from Sibi District (Baluchistan) and Dadu to Thatta Districts of Sind. It has also been reported from India - Rajasthan or Thar Desert region (Roy & Pandey, 1971; Khan *et al*., 2003; Oudhia, 2003). In the other reported locality (Thatta to Dadu Districts), taxon was mostly found growing on gravel plains having gradual slopes which encouraged speedy flow of water during rains, dry sandy soils contains weathered calcareous rocks. While, few individuals grew on the rocky slopes. It was also observed that mostly mature individuals were found growing along ephemeral rainy water running channels. Growth around sandy or calcareous soils clearly indicates that *Convolvulus scindicus* has a habitat specific nature.

Rarity in a taxon is determined based on its small population, narrow geographic range, or habitat specificity or a combination of these parameters (Rabinowitz, 1981). Reports from Indian Thar Desert, suggest that the taxon is rare or endangered in the area (Khan *et al*., 2003). Khatoon & Akbar (2008) also concluded that it was a rare species in Pakistan. However, both these reports are based on field observations and neither supported by any quantitative data, nor followed the parameters, developed for evaluating the conservation status. In the study area, the species was observed at different localities in small pockets, separated physically by the barriers like sand dunes or small hillocks. These barriers played an important role in isolating these populations from each other. These isolated, scattered and fragmented populations were found to occupy a small area (i.e. few km^2) having 200–300 individuals. Immature individuals were also observed during rainy season, but they were later found, eroded during heavy rainfall, resulting in approximately total mortality indicating that there was little natural recruitment. The presence of only 600 mature individuals, occupying 172.82 Km^2 area in isolated, fragmented and scattered populations on specific habitat, with almost nil natural recruitment, clearly indicates that, this is a rare taxon.

Habitat degradation is considered to be prime cause of species extinction (Sala *et al.*, 2000). In case of *Convolvulus scindicus*, habitat is located in the area where economic prosperity and developmental programs are initiated on a mass scale including road construction and stone excavation activities. Majority of these activities are going on in the core habitat of the taxon. Presence of human inhabitants from 50-60 Goths (villages), and their expansion, exerts pressure on the local vegetation for maintaining their living. Even, many livestock were found grazing in the study area, though not a single individual was found minimal or heavily browsed, but the presence of livestock physically damaged the populations of *Convolvulus scindicus*. Invasion of invasive species (i.e. *Prosopis juliflora*) plays a vital role in eliminating the natural vegetation (Noor *et al*., 1995) and also cause extirpation of the native flora, resulting in the reduction of species richness and diversity (El-Keblawy & Al-Rawai, 2007). Destructive effect of invasive species i.e. *Prosopis juliflora,* in the study area, is not very severe because of its quite low population, but its presence, predicts that it will cause problems for local flora with in few years when it will be established. The isolated and fragmented populations, habitat disturbance and destruction, grazing activity in the habitat, soil erosion and recent establishment of *Prosopis juliflora* in the habitat, are variety of threats for the survival of this already rare taxon..

Table 2. Summary of population size of *Convolvulus scindicus* from 2006-2008.

Population size	2006	2007	2008
Mature plants	550	580	600
Immature plants	420	423	330

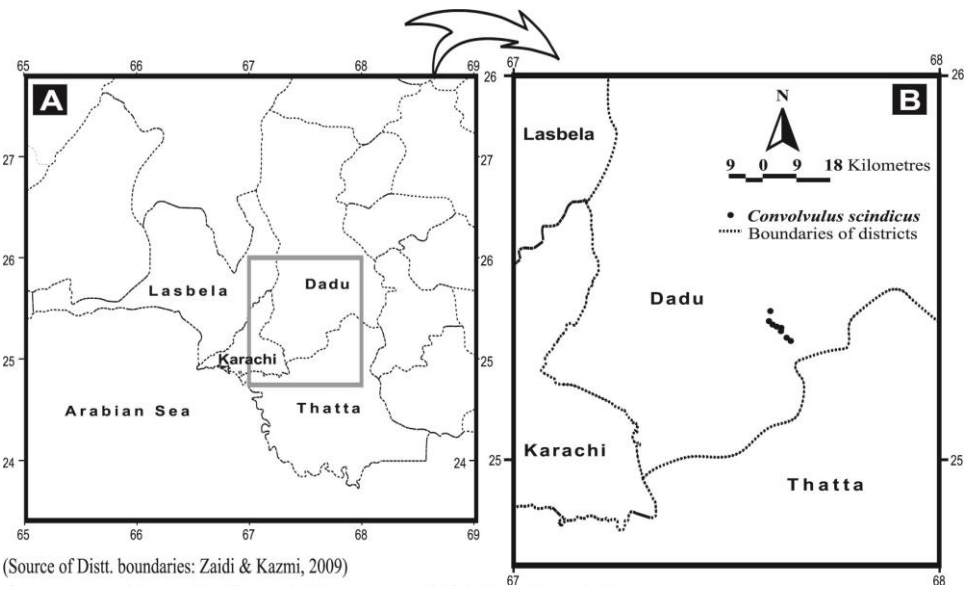

Fig. 6. *Convolvulus scindicus*: (A), study area; B, distribution in Pakistan.

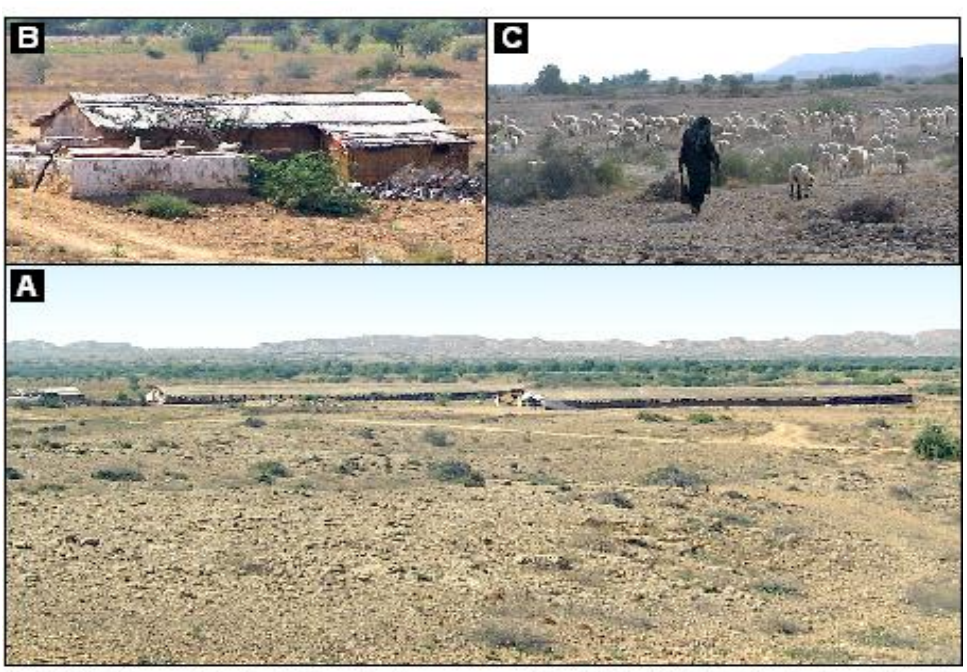

Fig. 7. Poultry farms (A), a flourishing enterprise, a permanent threat to the habitat of *Convolvulus scindicus*; B, close up of poultry farm; C, grazing phenomenon, a common feature in the habitat.

At the end of study period (2008) 600 mature individuals of *Convolvulus scindicus* were observed as compared to 550 in 2006. The conservation status of *Convolvulus scindicus* at country level was determined, using IUCN red list categories and criteria (Anon., 2001). The figure (600) falls under criterion "C" of the endangered category. In the case of its partial area of occupancy (for Pakistan) the taxon (172.82 Km^2) is placed under the criterion "B2" of endangered category (i.e. area of occupancy less then 500 Km^2). A continuous degradation of the habitat due to stone excavation, grazing activities, invasion of invasive species and isolated and fragmented populations, habitat specificity and small area in the country provide sufficient room to place the taxon under endangered category (EN). On the basis of hierarchical alphanumeric numbering system of the criteria (Anon., 2001), *Convolvulus scindicus* was evaluated for its conservation status for Pakistan. Evaluation can be summarised as follows:

ENB2ab (ii,iii,v); C2a (i): EN, Endangered; B, Geographic range; 2, Area of Occupancy; a, severely fragmented or known to exist at no more then five location; b, continuing decline, observed, inferred or projected; ii, area of occupancy; iii, area, extent and/or quality of habitat; v, number of mature individuals; C, Population size is estimated as fewer than 2500 mature individuals; 2, continuing decline, observed, projected or inferred, in numbers of mature individuals; a, population structure; i, no subpopulation estimated to contain more than 250 mature individuals.

The significance of a rare taxon is not restricted to specific region but its importance and role can be viewed in global perspective. Hence, following necessary practical conservation measures should be adopted before it disappears from this region:

- ✓ *Convolvulus scindicus* should be included in the red data list of threatened species of Pakistan.
- ✓ Conservation status assessment of the *Convolvulus scindicus* in India should also be initiated to assign the category in an international perspective.
- ✓ Efforts should be made to protect the taxon by minimizing the anthropogenic activities in the habitat (i.e. stone excavation, fuel wood cutting, grazing and poultry business).
- ✓ Seeds of the taxon should be preserved in local seed banks and also distributed to other regional conservation organizations, so that in case of any natural disaster it can be protected and recovered.
- ✓ *Convolvulus scindicus* should be introduced in botanic gardens for public display.
- ✓ It can also be introduced in the horticulture industry as an ornamental plant.
- ✓ Protocols for *in vitro* conservation as a backup support, should be designed, initiated and established on urgent basis to fulfill the *ex-situ* conservation strategy.
- ✓ Alternate environmentally friendly and sustainable jobs should be provided for the local inhabitants for maintaining their living properly.
- ✓ Alternate means of energy like electricity and natural gas should be provided in the area to reduce the wood cutting activities.

Acknowledgements

We would like to thank Dr. Jan Alam and Dr. Sher Wali Khan for their support during field visits and Mr. Abrar Ali for photographic enhancement.

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(Received for publication 17 December 2009)