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Acacia nilotica SUBSP. HEMISPHERICA: AT THE BRINK OF EXTINCTION

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Extremely narrow distributed endemic species are more susceptible to the process of extinction. This is due to their narrow ecological amplitude and habitat specificity as compared to the widely distributed endemic taxa. *Acacia nilotica* Willd. Ex Delile subsp. *Hemispherica* Ali & Faruqi (Mimosaceae-Fabaceae, an endemic taxon with extremely confined distribution in Southern Pakistan. Based on four years extensive field studies regarding nature of habitat, population size, distribution range and anthropogenic activities, the conservation status of *Acacia nilotica* subsp. *hemispherica* have been classified as Critically Endangered (CR) according to IUCN red list categories and criteria 2001. Conservation strategies have also been suggested for avoiding extinction.

Keywords: Conservation status, endemic, critically endangered, red list categories & criteria, *Acacia nilotica* subsp. *hemispherica*, neglected germplasm

INTRODUCTION

Our globe is losing plant species at an alarming rate and this rate of extinction is considered to be a threat to mankind next only to thermo-nuclear war (Sulaiman *et al*., 1991). It is estimated that one of every eighth plant species on this globe is facing threat of extinction (Stevens, 1998), while Pitman and Jorgensin (2002) suggested as many as half of all known plant species may be qualified as threatened with extinction under the World Conservation Union (IUCN) classification scheme. Furthermore, at the global level 91% endemic threatened species belong to a single country (Pitman and Jorgensen, 2002). Therefore, we have to pay proper attention towards native plants, as they are the unique component of the global biological diversity and these plants are an integral part of our ecosystem in which they are facing multiple threats, i.e. habitat loss and degradation, introduction of alien species, pollution and diseases, over-exploitation and climatic changes (McNeely *et al*., 1995; Wilcove *et al*., 1998; Sala *et al*., 2000; Alonso *et al*., 2001; Barbosa and Marquet, 2002; Sudhersan *et al*., 2003).

Endemic species exhibit a unique evolutionary response to particular physio-geography, climatic conditions and soil characteristics in a restricted and often isolated geographical location. The specific features of restriction and isolation make these species more prone to extinction, especially in the face of rapid habitat loss or degradation (Myers, 1988; Heywood and Watson, 1995).

The scenario in Pakistan is not different from the rest of the globe, where plant biodiversity is facing multiple stresses due to its population explosion, unplanned urbanization, deforestation and over-exploitation of natural resources (Anonymous, 2000; Ahmad *et al*., 2005). Unfortunately, very little critical field work has been done on threatened plants of Pakistan according to IUCN red list categories and criteria and extremely limited information is available on this subject. Recently, only 52 flowering taxa have been evaluated according the criteria 2001 (Abbas, 2010; Abbas *et al*., 2010a; Alam, 2010; Alam and Ali, 2009, 2010; Ali and Qaiser, 2010). Of these, one taxon is said to be extinct, 2 are regionally extinct, 8 possibly extinct, 10 data deficient, 21 critically endangered (CR), 8 endangered and 2 taxa are vulnerable. This figure hardly makes 0.8% of the total known flowering plant species of Pakistan.

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 and Qaiser, 1986). Therefore, these endemic plants need immediate attention from conservation point of view. Unfortunately, no concrete field work or data is available about the conservation status of rare and endemic taxa particularly of Southern Pakistan.

Acacia nilotica is a complex species with 9 sub-species, of which 3 are native to Pakistan. *Acacia nilotica* subsp. *hemispherica* is member of the family Leguminosae (Mimosoideae) and a large shrub (Fig. 1). It is confined on the dried stream beds in and around Paradise point and adjoining areas near Karachi, Pakistan (Ali and Faruqi, 1969; Ali, 1973; Abbas, 2010; Abbas *et al*., 2010b). Current study was an effort to determine the conservation status of

the *Acacia nilotica* subsp. *hemispherica* according to IUCN red list categories and criteria in order to save it from extinction.

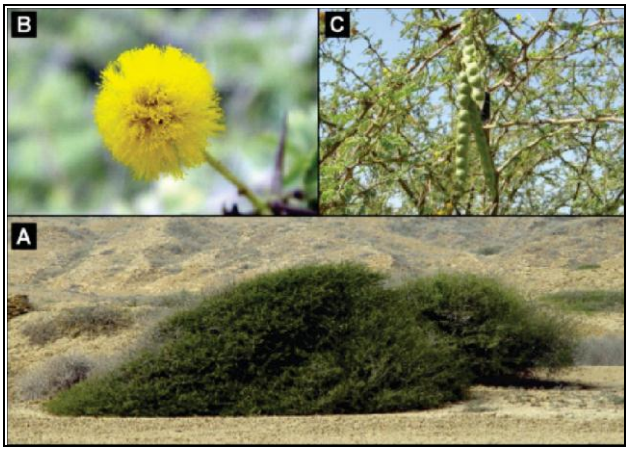

Figure 1. *Acacia nilotica* subsp. *hemispherica*: A, Habit; B, flower; C, fruits

MATERIALS AND METHODS

Detailed field surveys were conducted during 2005 to 2008 at a regular interval. Habit, habitat, altitudinal range, distribution range, impacts of multiple threats like habitat destruction, erosion, fuel wood cutting, grazing, poultry farms and invasive species were studied for four years in the habitat.

i) Distribution range of the taxon was worked out by plotting relevant GPS readings on the map. Arc GIS 9.2 version was used for this purpose.
ii) Previously known localities and surrounding regions were thoroughly surveyed to determine the exact area of occurrence and nature of distribution of *Acacia nilotica* subsp. *hemispherica.*
iii) The population size was determined by counting the mature individuals. The seedlings were also counted separately.
iv) Nature of habitat was analysed by soil erosion, invasive species and impacts of anthropogenic activities.
v) Habit and life form of associated species in the habitat was also recorded and classified according to Raunkiaer's system of classification (Raunkiaer, 1934).
vi) Information has also been collected from native people regarding the ethno-botanical usage.

RESULTS

***Habit, habitat and associated species*:** *Acacia nilotica* subsp. *hemispherica* is a large (5 m tall) shrub, semicircular in outline and main stem is not distinguished (Fig. 1). Mostly it grows on the edges of dry stream beds, plains and slopes in association with *Pluchea arguta* Boiss., *Grewia tenax* (Forssk.) Fiori and *Capparis cartilaginea* Decne. While *Euphorbia caducifolia* Haines, *Acacia senegal* (L.) Willd. and *Capparis decidua* (Forssk.) Edgew. was found dominant species in the habitat. In total 28 associated species were observed from the study area (Table 1) in the habitat, comprising of shrubs (18 spp.), herbs (7 spp.), trees (3 spp.) and annual (1 sp.). With reference to life forms, phenerophytes were found dominating having 14 species, followed by chaemophytes (9 spp.), hemicryptophytes (4 spp.) and therophytes (1 sp.).

***Area of distribution*:** *Acacia nilotica* subsp. *hemispherica* occupied 16.01 km^2 in the area around Paradise Point and in the vicinity of Naval Infrastructure, Karachi (Fig. 2).

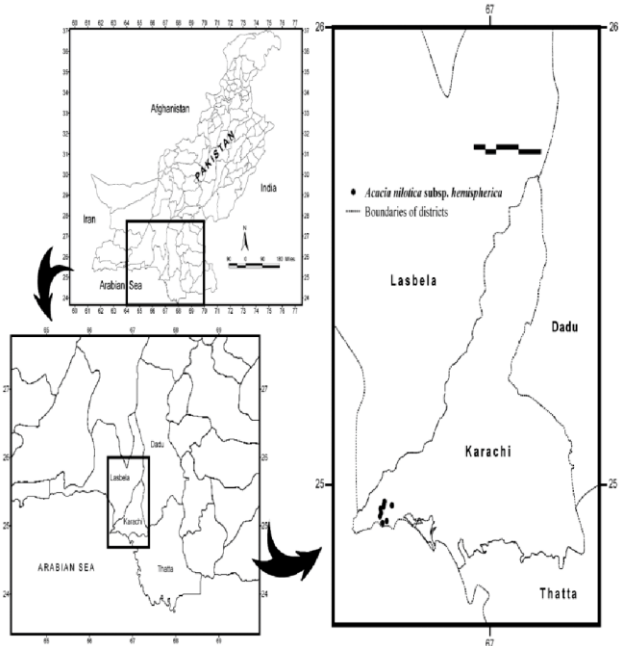

Figure 2. Distribution of *Acacia nilotica* subsp. *hemispherica* in Pakistan.

***Population size and mode of reproduction in the wild*:** The highest number of individuals during 2005-2008 was observed in 2005, i.e. 68 followed by 66, 62 and 60 in 2006, 2007 and 2008, respectively. During the entire study period no seedlings were observed.

***Fuel wood cutting*:** Severe threat for this extremely narrow endemic taxon is its over-exploitation as a fuel-wood or fire-wood, because local residents (Sindhes, Pathans and Baloch Tribes), from nearby villages (Goths/Kachi-Abadis, i.e. Goth Haji Usman, Goth Ahmed and others) have no access to energy source like natural-gas or electricity, which is fairly expansive to use for cooking purpose (local informant). Approximate population size of these Goths (small villages) altogether is around 20,000. Cutting of wood is not only for cooking purpose but the wood is also burnt in poultry sheds for maintaining temperature during the winter

Table 1. Species found in association with *Acacia nilotica* subsp. *hemispherica* from 2005 to 2008 along with their habit and life form.

#	Family	Species	Habit	Life form
1	Acanthaceae	*Barleria acanthoides* Vahl	Shrub	Chaemaphyte
2	Amaranthaceae	*Aerva javanica* (Burm.f.) Juss ex Schultes	Perennial Herb	Chaemaphyte
3	Asteraceae	*Pluchea arguta* Boiss.	Shrub	Phanerophyte
4	Asteraceae	*Echinops echinatus* Roxb.	Annual	Therophyte
5	Asteraceae	*Pulicaria boissieri* Hook.f.	Shrub	Chaemaphyte
6	Burseraceae	*Commiphora wightii* (Arn.) Bhandari	Shrub	Phanerophyte
7	Caesalpiniaceae	*Senna holosericea* (Fresen.) Greuter	Shrub	Chaemaphyte
8	Capparaceae	*Capparis cartilaginea* Decne.	Shrub	Phanerophyte
9	Capparaceae	*Capparis decidua* (Forssk.) Edgew.	Shrub	Phanerophyte
10	Capparaceae	*Cadaba heterotricha* Stocks ex Hook	Shrub to Tree	Phanerophyte
11	Chenopodiaceae	*Salsola imbricata* Forssk.	Perennial Herb	Chaemaphyte
12	Chenopodiaceae	*Suaeda fruticosa* Forssk. ex J. F.Gmelin	Shrub	Phanerophyte
13	Convolvulaceae	*Convolvulus glomeratus* Choisy	Perennial Herb	Hemicryptophyte
14	Convolvulaceae	*Seddera latifolia* Hochst. & Steud.	Shrub	Chaemaphyte
15	Euphorbiaceae	*Euphorbia caducifolia* Haines	Shrub	Phanerophyte
16	Gentianaceae	*Enicostemma hyssopifollium* (Willd.)Verdoon	Perennial Herb	Hemicryptophyte
17	Malvaceae	*Senra incana* Cav.	Shrub	Chaemaphyte
18	Malvaceae	*Abutilon fruticosum* Guill. & Perr.	Perennial Herb	Chaemaphyte
19	Leguminosae	*Acacia senegal* (L.) Willd.	Tree	Phanerophyte
20	Leguminosae	*Prosopis juliflora* (Swartz) DC.	Shrub - Tree	Phanerophyte
21	Leguminosae	*Indigofera articulata* Gouan	Shrub	Phanerophyte
22	Poaceae	*Cymbopogon jwarancusa* (Jones) Schult.	Perennial Herb	Hemicryptophyte
23	Rhamnaceae	*Ziziphus nummularia* (Burm.f.) Wight & Arn.	Shrub	Phanerophyte
24	Salvadoraceae	*Salvadora oleoides* Decne.	Tree	Phanerophyte
25	Scrophulariaceae	*Kickxia ramosissima* (Wall.) Janchen	Perennial Herb	Hemicryptophyte
26	Tiliaceae	*Grewia tenax* (Forssk.) Fiori	Shrub	Phanerophyte
27	Tiliaceae	*Grewia villosa* Willd.	Shrub	Phanerophyte
28	Zygophyllaceae	*Fagonia indica* Brum. f.	Perennial Herb	Chaemaphyte

period. The contractors of stone excavation sites provide temporary huts for their labour on site for the security and smooth running of the site. These labourers remain there for months and causing severe damage to the vegetation by using it as fuel wood for cooking purpose and by the over grazing of their livestock (Fig. 3).

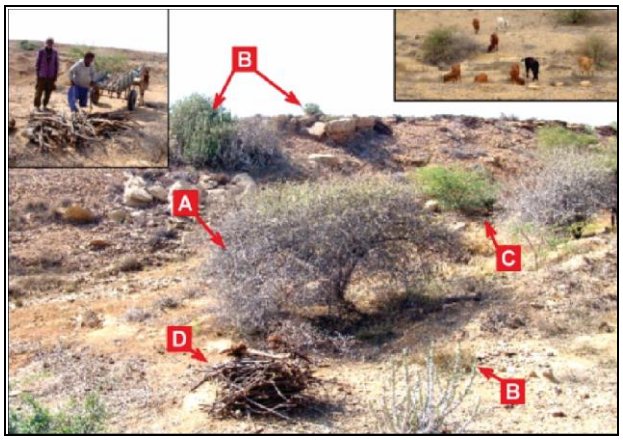

Figure 3. *Acacia nilotica* subsp. *hemispherica* (A); B, Euphorbia caducifolia; C, Acacia senegal; D, cutting material for fuel wood.

***Habitat destruction and soil erosion*:** The habitat of *Acacia nilotica* subsp. *hemispherica* has been leased for stone excavation because of a good quality stone, suitable for road construction and new-housing projects. The activities of stone excavation is carried out by huge and powerful machines like stone drillers, stones breaking machines, mechanized loaders, heavy cranes, dumpers and trucks for the breaking, filling and transportation. During detailed field survey more than 50 sites were found engaged in stone excavation activity. Before initiating the stone excavation process the contractors usually burn the existing vegetation for clearing purpose, but there is a possibility that if this fire accidentally spread in the habitat, then it will certainly destroy lot of trees. On an average from each excavation site more than three truck loads are transported on daily basis, if they are loaded manually or 15-20 trucks if machines are used. This activity is causing severe habitat loss. Usually the stone excavation going on all year round but during the summer their activities are on its peak because of supply and demand (Fig. 5).

***Grazing impact*:** Heavy grazing by the livestock like goats, camels and cows exerts tremendous pressure on the vegetation, which is another threat for its survival because in the months of severe drought the livestock feed on it, when nothing else is available. Due to heavy demand during Eid-

ul-Azha (a Muslim festival in which the livestock is sacrificed) the local people tend to purchase livestock for this special event at least three to five months before the Eid festival and this extra livestock also graze on the vegetation which is already under severe stress. Large number of livestock was observed during the field studies.

Figure 4. *Acacia nilotica* subsp. *hemispherica*: historical photograph taken in 1987, showing no *Prospis juliflora* in the entire habitat.

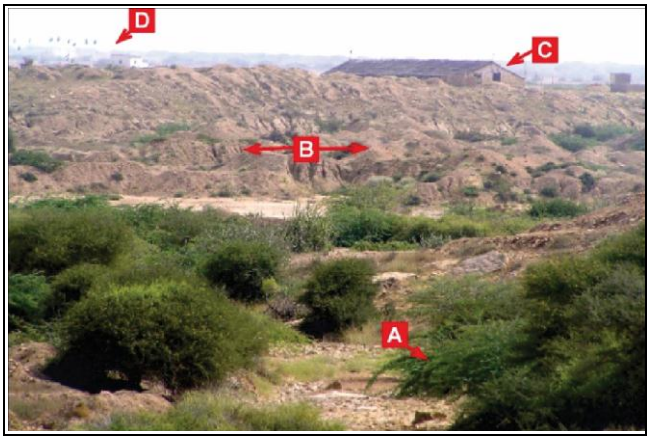

Figure 5. *Acacia nilotica* subsp. *hemispherica*: multiple threats in 2008, A, *Prosopis juliflora*; B, soil erosion; C, poultry farm; D, expansion of existing villages.

***Invasive species*:** *Prosopis juliflora*, an invasive species, is fairly common in the habitat and the population of *Acacia nilotica* subsp. *hemispherica* has been surrounded all around by *Prosopis juliflora* (Fig 5). Fig.4 presents a historical perspective of *P. juliflora* in the core habitat.

DISCUSSION

Acacia nilotica subsp. *hemispherica* an endemic taxon is mostly confined to the edges of dry stream beds near Paradise Point and adjoining areas (Ali and Faruqi, 1969; Ali, 1973; Abbas *et al*., 2010b). This taxon is mostly found on the edges of seasonal streams, which predominantly consists of calcareous rocks. Except during the rainy season, streams are usually dried throughout the year. The species occasionally grows in gravel sandy plains near dried stream beds, which are heavily flooded during the monsoon season. *Acacia nilotica* subsp. *hemispherica* grows in specific habitat as it is mostly found on the edges of calcareous dry stream beds, calcareous rocks as well as well drained soils.

Euphorbia caducifolia is a gypsum tolerant species (Gilliland, 1952). In the restricted distribution area of the taxon under question, 28 species were found as associates. Among them, *Euphorbia caducifolia* was found as dominant species of the habitat. In the study area, *Acacia nilotica* subsp. *hemispherica* was mostly found on the calcareous; solid and weathering rocks. This suggests that the taxon is calcium tolerant. It is interesting to note that both *E. caducifolia* and *Acacia nilotica* subsp. *hemispherica* are calcium tolerant but, *E. caducifolia* also grows on stony, sandy and silty clay soils. However, *Acacia nilotica* subsp. *hemispherica* was found on stony and gravel soils. The results suggest that *Acacia nilotica* subsp. *hemispherica* prefer well drained soil as compared to *E. caducifolia.*

Rarity of a taxon, may be due to low population size, restricted geographic range, habitat specificity or a combination of these attributes (Rabinowitz, 1981). Previously, Ali and Faruqi (1969) and Ali (1973) reported *A. nilotica* subsp. *hemispherica* only from Paradise Point and adjoining areas. During the study period, the study area and adjoining areas were thoroughly surveyed for the possibilities of further localities of *Acacia nilotica* subsp. *hemispherica* in the surroundings. However, we could not be able to trace out more localities for this taxon. Moreover, only 68 individuals were recorded in an area of 16.01 Km^2 (Abbas *et al*., 2010b). These results reveal that the taxon has a very restricted distribution around Paradise Point and in the vicinity of Naval Infrastructure. Hence, *Acacia nilotica* subsp. *hemispherica* is a rare species with low population size, restricted range and habitat specificity.

The taxon is facing multiple threats, one of the major concerns over its continuous decline in its population, is mainly due to cutting activities in the area (Table 1), because fuel-wood is not only supporting the domestic needs but also fulfilling the demand from growing poultry business in the area. Stone excavation and heavy traffic movement, causing habitat disturbance, which is ultimately putting stress on the taxon. During rainy season, variety of vegetation is available for the grazing activity; otherwise it presents a true picture of aridity with few species of trees and shrubs. These shrubs are already under pressure due to wood cutting for fuel purpose, but grazing in dry season makes the situation further worsen. Grazing damages the flora with no chance of recovery. Though erosion is not a common feature in the area but it has a devastating effect after torrential rains.

Invasion of invasive species (i.e. *Prosopis juliflora*) playing vital role in eliminating the natural vegetation (Noor *et al*., 1995) and it is also causing extirpation of the native flora, resulting in the reduction of species richness and diversity (El-Keblawy and Al-Rawai, 2007). The entire habitat of the taxon is surrounded and heavily infested by *Prosopis juliflora*. Hence, low population size, restricted geographic range, habitat destruction, soil erosion and habitat infestation with invasive species, these multidimensional threats, keeping *Acacia nilotica* subsp. *hemispherica* under severe stress and making the scenario susceptible for its survival.

After 4 years field study (2005-2008) the conservation status of *Acacia nilotica* subsp. *hemispherica* was evaluated using IUCN Red List Categories and Criteria (Anonymous, 2001). The final observed, mature individuals of the species were 60, as compared to 68, were counted in 2005. The figure (60) falls under the defined range (i.e. less than 250 individuals) for the "C" of the critically endangered (CR) category. Hence, final counted number of individuals led us to place the taxon under the criterion "C" of critically endangered category (i.e. population size fewer than 250 mature individuals). In the case of its extent of occurrence (i.e. 16.01 km^2) the taxon is placed under the criterion "B1" of critically endangered category (i.e. extent of occurrence estimates to be less than 100 km^2). In addition to that, a continuous degradation of the habitat due to fire, stone excavation, grazing and poultry business activities, use as fuel wood, invasion of invasive species provide further sufficient information to place the taxon under Critically Endangered (CR) Category.

On the basis of hierarchical alphanumeric numbering system of the criteria (Anonymous, 2001), *Acacia nilotica* subsp. *hemispherica* can be evaluated for the conservation status. Evaluation can be summarized as follows:

CRB1ab (iii,v); C2a (i):

Where:

CR = Critically Endangered;

B = Geographic range;

1 = Extent of occurrence estimated to be less than 100 km^2;

a = severely fragmented or known to exist at only a single location;

b = continuing decline, observed, projected or inferred, in numbers of mature individuals;

iii = area, extent and or quality of habitat;

v = number of mature individuals;

C = Population size estimated to number fewer than 250 mature individuals;

2 = continuing decline, observed, projected or inferred, in numbers of mature individuals;

a (i) = population structure, no sub population is found to contain more than 50 mature individuals.

In context with global biodiversity, conservation of a rare species at national level is very important.

Hence, urgent conservation steps should be taken as suggested below to avoid its extinction.

- The *Acacia nilotica* subsp. *hemispherica* should be included in the Red Data list of threatened species for Pakistan.
- Conservation status assessment of the *Acacia nilotica* subsp. *hemispherica* in other countries should also be initiated to assign the category in 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).
- *Acacia nilotica* subsp. *hemispherica* should be introduced in botanic gardens for public display.
- 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.
- 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 environment friendly and sustainable jobs should be provided to 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.

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