NOTE

Conservation Threat Assessment of *Commiphora wightii* (Arn.) Bhandari - an Economically Important Species

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ABSTRACT: In the present study, habitat, distribution and regeneration of *Commiphora wightii* (Arn.) Bhandari (Burseraceae) was explored in Rajasthan, India, to support conservation actions. Twenty-six sites were identified for sampling the populations of *C. wightii* in the desert region and in Aravallis. *Commiphora wightii* prefers rocky substratum and grows in shallow, gravelly, unfertile soils, hilly terrains and under open canopies. The number of saplings was only 5.68 % as compared to its adult population. Population densities of *C. wightii* were 25 stems ha^{-1} in desert and 40 stems ha^{-1} in Aravallis of Rajasthan, India. Over-exploitation, narrow extent of occurrence, small area of occupancy, severe fragmentation of populations, very low regeneration and invasion of alien species to its habitat revealed that *C. wightii* is facing severe conservation threat and extinction risk. It should be prioritized for "endangered category" by ensuring the habitat conservation, sustainable utilization and cultivation of this economically important species.

KEY WORDS: *Commiphora wightii*, conservation, endangered, threat, guggal.

INTRODUCTION

A threatened condition may be defined when natural regeneration of a species is not able to keep pace with its exploitation or destruction by anthropogenic or natural means, and as a consequence there is serious decline in the population (Jain, 1992). Destructive harvesting for pharmaceutical and industrial uses is one major cause of such decline in plant population (Rao *et al*., 1983). Invasive species cover may create demographic instability among the species and reduce diversity which may lead to changes in the structure of the forest (Sharma and Raghubanshi, 2007). Phytosociological studies provide baseline information on structure and floristic composition, particularly important for rare species and have been strongly recommended as a prerequisite for conservation of these species (Gunnatilleke and Gunnatilleke, 1985).

The genus *Commiphora* Jacq. (Burseraceae) includes about 185 species, native to Africa, Arabia, and the Indian subcontinent. Among these, *Commiphora wightii* (Arn.) Bhandari popularly known as '*guggal*' and '*Indian Bdellium'* is an indigenous threatened plant species of arid and semi-arid regions of India and Pakistan and extended to Saudi Arabia. In India, it grows wild in parts of Rajasthan, Gujarat and Karnataka (IUCN, 2010). It is a spinous bushy deciduous shrub or small tree (Fig. 1). Recent studies reveal it is now confined to a smaller area of northern Gujarat in the districts of Kachchh and Jamnagar (Sabins and Rao, 1983). In Rajasthan, the distribution range of this species is in Indian Desert region and Aravallis (Shetty and Singh, 1987). Stem yields 'guggal' the gum resin, which is pale brown in color is used commercially in perfumery, calico-printing, medicine, fumigation, dyeing silk and cotton and as incense. This species is also being used as fire-wood extensively due to the presence of gum-resin and even fresh green twigs burn easily. The rural people are aware of its market value and therefore collect the gum-resin by making cuts in the stem and sell it in the urban markets. They are extracting gum-resin by making cuts on the stem in non scientific way. During recent years they started applying Copper sulphate on the cuts to enhance yield, may be lethal for plant (Singh and Singh, 2006). The annual production of gum-resin was estimated to be 25-50 tons in Pakistan Desert (http://tribune.com.pk). The Forest Department of Gujarat collected 30 tons of gum-resin in 1963, which was drastically reduced to 2.42 tons in 1999 (Dixit and Rao, 2010). This sharp decline in collection of gum-resin by the Forest Department was attributed to mass destruction of plants. According to Tajudin (1995) India used to produce guggul up to 500 tons per annum in early 60's which was reduced to around 5 quintals per annum in the year 2001-02.

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Fig. 1. Habitat of *Commiphora wightii*. Lower left: Fruits

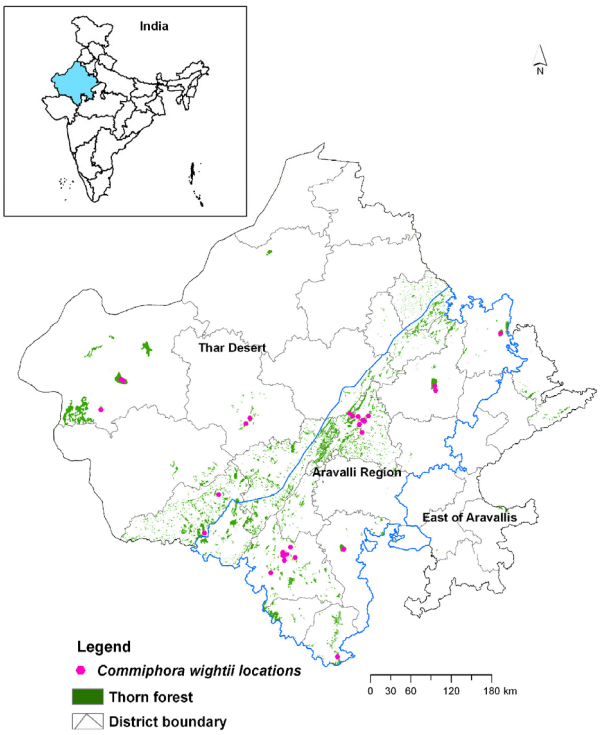
Overexploitation of this species has brought its population in threatened condition, included in the *Data Deficient* category of IUCN (IUCN, 2010). Observations revealed that this species is under threat in its entire range of distribution in Rajasthan and Gujarat. It has been estimated that within a period of 10 years or so, as a whole, the population has been shrunk to less than 50 % with scattered and dissected subpopulations of few mature individuals in each (Parmar, 2003). The study conducted in 1980's reported 10 plants per hectare in Falna Aravalli range of Pali district and Mevanagar hills of Barmer district (Kumar and Shanker, 1982). The tribals and other natives believe that fumes of gum-resin ward off evil spirits and please their God. The twigs are used as tooth brush. It has wide ethnobotanical usage by Garasias, Saharia and Kalbelia (Singh and Pandey, 1998). Recently, some efforts are made for effective conservation by promoting community participation and through planting schemes in Aravallis (Soni, 2010).

MATERIAL AND METHODS

In the present study, information of *C. wightii* (i.e., its habitat, distribution, regeneration and association with different species) was studied to support actions to protect and restore its habitat. Vegetation type mapping of Rajasthan was carried out using multi-season remote sensing (IRS P6 LISS III) data of 2007. Visual interpretation technique was used to delineate various vegetation types. The selection of sampling sites is based on field surveys conducted throughout Rajasthan during 2007-2009. Published reports were also consulted to identify the sites. There are 26 sites were identified forsampling the populations of *C. wightii* in the desert region and in Aravallis. At each site two sample plots (each 0.04 ha) were laid. In addition to these, data collected from 1800 plots sampled from entire Rajasthan, does not represent this species. This means the species is present only in 2 % of sample plots and confirms its rarity. The habitat conditions were recorded. Computation of analytical features such as density, frequency, basal area and importance value index (IVI), was carried out (Curtis and McIntosh, 1950). In each quadrat, girth at breast height for all the woody species with >10 cm circumference was measured and recorded. Species structure and associations was also analyzed. Similarity index for populations of different sites was determined as per the formula given by Sorenson (Sorensen, 1948).

C. wightii is distributed in Alwar, Jaipur, Ajmer, Chittaurgarh, Udaipur, Banswara districts (Aravallis) and Jaisalmer, Jodhpur and Jalore districts (Indian Desert region) (Fig. 2). The phytosociological sampling was carried out in Jaisalmer: Akal WFP, Devikot, Pithla; Jodhpur: Kailana; Jalore: Govindgarh, Jaswantpura; Ajmer: Thanwa to Pushkar, Nagpahar, Nasirabad valley, Near Chachiyawas, Near Maya mandir, Pitamber-ki-gal, Shrinagar RF; Alwar: Prithripura; Jaipur: Amer RF, Jhalana; Banswara: Kushalgarh; Udaipur: Baghdara to Jamerkotra, Balicha, Bhanki RF, Ekling Ji Road,

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Kamalnath, Kayler RF, Macchla Mangra, Nai and Chittorgarh: Bhadesar. Extent of occurrence and area of occupancy were important criteria for qualifying the threatened categories. We have calculated the Extent of occurrence and Area of occupancy was calculated based on IUCN criteria (IUCN, 2010). Extent of occurrence is defined as the area contained within the shortest continuous imaginary boundary which can be drawn to encompass all the known, inferred or projected sites of present occurrence of a taxon. Extent of occurrence (EOO) is a parameter that measures the spatial spread of the areas currently occupied by the taxon. Area of occupancy is defined as the area within its 'extent of occurrence' which is occupied by a taxon. Area of Occupancy (AOO) is a parameter that represents the area of suitable habitat currently occupied by the taxon.

RESULTS AND DISCUSSION

Habitat: It shares common habitat both in desert region and in Aravallis. It is preferential species of rocky substratum and found to grow in shallow, gravelly, unfertile soils, hilly terrains and open canopies (Kumar and Shanker,1982; Sabins and Rao, 1983; Singh and Pandey, 1998; Soni, 2010). The annual rainfall of sites varies from 200 mm (Indian desert) to 800 mm (southern Aravallis) and situated in elevation range of 300 m to 600 m. It is distributed mainly in thorn forest and thorn scrub. But its spatial distribution pattern was random due to multifarious factors of threat and habitat specificity.

Based on classified data of remote sensing, thorn forests of Rajasthan represents an area of 2,536 km². The area under thorn forests of Gujarat was 905 km² (IIRS, 2011). In the present study, the extent of occurrence was measured by drawing a polygon which contains all the sites of species occurrence. The area was estimated as <5000 km². As per IUCN the geographic range of species in terms of extent of occurrence with <5000 km² was considered as 'endangered category'. The mean patch size of thorn forests was found to be 3 km². It was based on calculation of 700 polygons of thorn forests, varies from patch of 2 ha area to 50 km² area. The total area of occupancy was determined as <500 km² which confirms the status as 'endangered' (IUCN, 2010).

Floristic Composition: Altogether 218 species pertaining to 40 tree species, 33 shrubs, 133 herbs and 20 climbers were identified from sample plots having an area of 2.1 ha. A total of 1,248 stems of woody species (>10 cm gbh) representing 73 species were recorded. Of these 109 stems (8.73%) belongs to *C. wightii.* Region-wise analysis shows 193 species in Aravallis and 50 species in desert region. The most frequently occurring species is *C. wightii*, in both desert region and in Aravallis because study concentrates only on the representative locations of it. The floristic associations of *C. wightii* provide interesting results. *Salvadora oleoides* Decne. and *Acacia senegal* (L.) Willd. are the predominant species of *C. wightii* habitat in Desert region. Due to high relative density and relative frequency, *Euphorbia caducifolia* Haines and *Ziziphus nummularia* (Burm.f.) Wight & Arn. have the highest importance value of 54.66 and 40.08 respectively in desert region (Table 1). Ecological importance of *Acacia senegal* (L.) Willd., and *Anogeissus pendula* Edgew. was high in Aravallis with IVI values 29.80 and 27.98 respectively (Table 2). A large group of species (59) are represented by a single individual (26) and double individuals (33).

Six species, i.e. *Euphorbia caducifolia* Haines, *Ziziphus nummularia* (Burm.f.) Wight & Arn., *Acacia senegal* (L.) Willd., *Grewia tenax* (Forssk.) Fiori, *Prosopis juliflora* (Sw.) DC., *Maytenus emarginata* (Willd.) Ding Hou are the common associates in both desert and in Aravallis. The similarity index of two regions (desert and Aravallis) was estimated as 20.34 % for *C. wightii* sampling areas. Population density of *C. wightii* was computed which is 25 stems ha^{-1} in desert and 40 stems ha^{-1} in Aravallis. The results from this were compared with the study conducted in Gujarat where 49 stems ha^{-1} were reported (Dixit and Rao, 2000). It infers that populations of *C. wightii* are severely fragmented.

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Table 1. Occurrence of *Commiphora wightii* and its associated species in Desert region, Rajasthan.

Species	Frequency (%)	Stems/ha	Basal area m^2 /ha	IVI
Salvadora oleoides	7.69	60	1.03	36.29
Acacia senegal	13.85	54	0.64	35.32
Euphorbia caducifolia	4.62	17	1.41	28.73
Ziziphus nummularia	3.08	38	1.16	28.30
Grewia tenax	6.15	33	0.19	16.51
Commiphora wightii	7.69	25	0.01	12.55
Capparis decidua	7.69	21	0.01	12.55
Maytenus emarginata	1.54	15	0.49	11.91
Leptadenia pyrotechnica	4.62	8	0.37	11.86
*Prosopis juliflora**	1.54	21	0.37	11.62
Prosopis cineraria	6.15	23	0.01	11.46
Ziziphus mauritiana	6.15	15	0.06	10.25
Calotropis procera	3.08	21	0.00	7.85
Cordia gharaf	1.54	6	0.33	7.67
Other species	24.53	65	1.00	57.10
Total	100	417	6.93	300

*** invasive alien species**

Vegetation structure: The individuals of *C. wightii* in gbh category of 10-30 cm represents height of 1-3 m,possess 61.36 % of population, gbh category of >30 cm have height of 3-5 m recorded with 32.95 % population. The number of saplings (<10 cm gbh) recorded were only 5.68 % as compared to its adult population. The sites of regeneration were found only in Udaipur district. No regeneration was recorded in Alwar, Jaipur, Ajmer, Chittaurgarh, Banswara districts (Aravallis), and Jaisalmer, Jodhpur and Jalore districts (Indian Desert region) revealed high risk of survival. The regeneration of *C. wightii* is trivial in Gujarat. During the survey, hardly any seedlings/saplings of *C. wightii* were recorded from the Kachchh district, which was attributed to overgrazing (Dixit and Rao, 2000). The regeneration of other woody species pooled together for study sites represents value of 19.75 % indicates good regeneration capacity.

Invasion of *Prosopis juliflora*: Plants of *C. wightii* are adapted to grow in open conditions. *Prosopis juliflora,* an invasive alien species was also identified as frequent associate in similar habitat. The populations of this species are expanding rapidly. Analysis for *Prosopis juliflora* indicates that 35.38 % of its population is in regeneration category, followed by 33.85 % in gbh class of 10-30 cm and 30.77 % in >30 cm category. Therefore, invasion of *Prosopis juliflora,* synergistically affects the regeneration of *C. wightii* along with grazing pressure and over-exploitation. *Lantana camara,* L. is another worst weedy species also invading four sites in Aravallis of Udaipur district. It is obvious that species with few individuals would be highly vulnerable due to impact of invasive species.

This ecological survey has provided quantitative information on the *C. wightii* which is relevant for further research and planning. The results based on regeneration, highly fragmented populations with very low density, over-exploitation, grazing pressure, impact of biological invasion, extent of occurrence and less occupancy at the sites, we suggest to include this plant under 'Endangered' category. The only way of ensuring the survival of *C. wightii* is by habitat conservation, sustainable utilization and cultivation of species. The isolation of species populations point urgent conservation measures to be taken. An immediate attention must be paid to conserve and protect the declining populations of this valuable plant species.

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Table 2. Occurrence of *Commiphora wightii* and its associated species in Aravallis, Rajasthan.

Species	Frequency (%)	Stems/ha	Basal area m^2 /ha	IVI
Acacia senegal	7.41	73	0.86	29.8
Anogeissus pendula	2.96	55	1.39	28
Commiphora wightii	11.85	40	0.57	25.9
Acacia leucophloea	3.7	38	0.74	18.5
*Prosopis juliflora**	5.93	42	0.37	17.4
Euphorbia caducifolia	7.78	43	0.17	17.3
Ziziphus nummularia	3.33	45	0.19	13.3
Rhus mysorensis	3.33	39	0.06	10.9
Grewia tenax	3.33	47	0.15	13.2
Grewia flavescens	3.33	29	0.12	9.89
Wrightia tinctoria	2.96	13	0.37	9.32
Acacia nilotica	2.96	10	0.37	8.82
Maytenus emarginata	2.96	29	0.05	8.72
Butea monosperma	1.11	9	0.37	6.7
Other species	37.06	47	3.38	82.08
Total	100	563	9.15	300

*** invasive alien species**

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重要經濟物種：懷特沒藥之保育威脅評估

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摘要：本文研究懷特沒藥（橄欖科）在印度拉賈斯坦邦之生長棲地、族群分佈及自然更新，以支持對此物種之保育行動。本實驗在印度艾拉瓦里斯及沙漠區域共設置了 26 個樣區以調查懷特沒藥之族群；懷特沒藥偏好生長於岩層基質、淺層多石之貧瘠土壤以及丘陵地形，且喜好開闊之樹冠層。在本調查中，幼苗的個體數與成熟個體相比只占 5.68%；植株密度在不同環境也有不同：在沙漠中的密度為 25 stems ha^{-1}，在拉賈斯坦邦艾拉瓦里斯地區則為 40 stems ha^{-1}。由於過度開發、生長範圍狹窄化、族群面積縮減、族群破碎化、極低的自然再生率和外來種的入侵等原因，讓懷特沒藥面臨嚴重的保育問題及滅絕風險。本文建議優先將此物種列入瀕危等級，以確保此重要經濟物種之棲地保育及永續利用。

關鍵詞：懷特沒藥、保育、瀕危、威脅、香膠。

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