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Habitat Diversity of the Most Common Wild Plant In Qatar, *Zygophyllum qatarense*

Abstract: *Zygophyllum qatarense* Hadidi maintains enormous ecological plasticity. It is the most widespread, succulent shrubby species in Qatar, adapted to various habitats and a wide range of soil types: sandy, sandy-rocky, and sandy-loam; and inhabits dry areas which receive sporadic scanty winter rain, as well as permanently moist soil. It stands soil salinity ranges from non-saline to very strongly saline (1.0 - 11.85 dS/m), and pH ranging from 7.5 to 7.8. However, it evades mobile sands, highly saline salt flats (Sabkha), depressions of fine-textured soil (Rawda), agricultural land and stagnant waters.

Keywords: Qatar, *Zygophyllum Qatarense*, Ecological plasticity, Phytogeography Environment, diversity, Widespread.

Zygophyllum qatarense القطني

تنوع بيئات الهرم القطني
أكثر الأنواع النباتية البرية إنتشاراً في دولة قطر

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المستخلص: يعتبر نباتات الهرم القطنية *Zygophyllum qatarense* Hadidi من أكثر النباتات انتشاراً في دولة قطر. حيث يوجد في أغلب المناطق القطرية، ويظهر مرونة بيئية فائقة لا يجاريه فيها أي نبات آخر. وهو نبات معمر، قصير، نصف الأعلى عصاري غض ونصفه الأسفل خشبي. ويعيش في بيئات متنوعة، فمنها الرملية والرملية المزيجية والصخرية، كما يتأقلم مع درجات متفاوتة من رطوبة التربة، فيوجد في مناطق جافة وأخرى شديدة الرطوبة. ويمكن للهرم القطني تحمل درجات متفاوتة من ملوحة التربة، حيث ينمو في أراضي قليلة الملوحة وأراضي شديدة الملوحة (1 - 11.85 ديسيمنز/ المتر). وينمو في تربة يتراوح الأس الهيدروجيني فيها (7.5 - 7.8). والمناطق التي يتغادها الهرم القطني تشتمل على الرمال المتحركة، والمسطحات الملحية شديدة الملوحة، والمنخفضات ذات التربة الناعمة والتي تغمرها المياه في فصل الأمطار (الروضات)، والمناطق الزراعية، والمياه الراكدة.

كلمات مدخلة: دولة قطر، نبات الهرم، جغرافيا نباتية، مرونة، تنوع بيئي، إنتشار واسع.

Introduction

The genus *Zygophyllum* (family Zygophyllaceae) constitutes tens of species found in arid, semi-arid and temperate regions. However, roughly ten species have been commonly recorded in the Arab countries, including: *Z. album*, *Z. berenicense*, *Z. coccineum*, *Z. decumbens*, *Z. dumosum*, *Z. fabago*, *Z. geslini*, *Z. propinquum*, *Z. qatarense* and *Z. simplex*.

The genus *Zygophyllum* occupies saline as well as non-saline soils worldwide. Qatar has two of these species, including the widespread perennial *Zygophyllum qatarense*, and the annual

Zygophyllum simplex, which is restricted mostly to disturbed moderately saline soils around farms.

Zygophyllum qatarense Hadidi (locally called Haram Qatari), is a dwarf, half-succulent half-woody shrub. Phenologically, the closest species to *Zygophyllum qatarense* is *Zygophyllum coccineum*, which is common in the neighboring countries, occupying mostly saline soils (Abulfatih, 1991, 1997).

Zygophyllum qatarense has been dealt with botanically and ecologically by a number of authors (Abdel-Raziq and Ismail, 1990; Abulfatih, 2000; Abulfatih *et al.* 1999; 2001; Batanouny, 1981; Batanouny and Turki, 1983; Ismail, 1983, 1990; Ismail and El-Ghazaly, 1990).

In the present study a survey was carried out to study the habitat types in Qatar preferred by *Zygophyllum qatarense* and its associate species and to determine the type of habitats lacking *Zygophyllum qatarense*. Hence soil types, moisture content and salinity were evaluated in the selected habitat. As *Zygophyllum qatarense* is the most

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dominant on rocky soils that cover over 80% of Qatar, it was interesting to peruse a study focusing on its autecology and associate species.

Materials and Methods

The study was conducted at various seasons between 1998 and 2000. Selected habitats were studied by examining their floristic composition and vegetation cover in relation to habitat attributes. Soil types were identified by studying five soil samples from each habitat, from the top 20-cm layer. These were analyzed for their physical and chemical properties. Soil texture was measured by the sieve method. Soil salinity was evaluated by the conductivity bridge method, using saturated soils. Data concerning pH and soil salinity were based in part on the study by Abulfatih *et al.* (2001). Soil classification by FAO (1973) was consulted during the process of soil identification.

Plant collection and identification was carried out by Dr. Hussain A. Abulfatih (plant ecologist) and Dr. Ikhlas M. Abdel Bari (plant taxonomist). Plant identification was based upon the specimens deposited at the herbarium of the Department of Biological Sciences, Faculty of Science, University of Qatar.

Land Form and Climate

The peninsula of Qatar is located between 24° 27' and 26° 10' north and at 50° 45' and 51°40' east. It is approximately 180 km long and 85 km wide. It covers an area of 11,437 km² including its islands (ESCWA 1996, Abulfatih *et al.* 1999). Qatar has a number of islands mostly to the east and west of the country. The Arabian Gulf surrounds the Qatar peninsula, except at the southern end where it is linked to Saudi Arabia. Land elevation ranges from sea-level to 103-m. The landscape is generally flat with slight undulations. Rocky hills and sand dunes are confined to the southern parts of the country. Saline swampy areas and salt flats are common along the coastal areas (Abulfatih *et al.* 1999, 2001, Batanouny, 1981).

The climate plays a major role in controlling the distribution of wild plants in Qatar. According to its geographical location and climate Qatar is classified as a hot subtropical desert. Average annual rainfall recorded in three places consecutively from the north to the south of the country is as follows: in the

northern part at Rawdat Al-Faras (107.7mm), in the central part at Al-Otoriyah (104.3mm), and in the southern part at Abu-Samrah (70.7mm) (Abulfatih *et al.* 1999). In all these stations rainfall is expected between October and May. More rainfall is expected between December and March. Air temperature is slightly different at each of these stations, increasing slightly as we proceed southward. Such slight differences in climatic factors from north to south are attributed to the flatness and the smallness of the country.

Results

Zygophyllum qatarense Hadidi is found in the following habitats:

1. Inland rocky deserts of shallow compact soils.
2. Inland rocky desm clay loam soils.
3. Inland disturbed areas.
4. Inland Depressions of Shallow silty clay loam to clay loam soils.
5. Inland depressions of sandy to sandy loam soils.
6. Inland immobile sandy mounds.
7. Coastal sandy shores.
8. Coastal sandy-rocky shores.

Zygophyllum qatarense is found in a wide range of soil types: sandy, sandy-rocky, and sandy-loam; in dry areas, areas receiving sporadic scanty winter rain, and permanently moist soil. It stands soil salinity ranging from non-saline to very strongly saline (1.0 - 11.85 dS/m), and pH ranging from 7.5 - 7.8 (see Table 1). However, it evades mobile sands, highly saline salt flats (Sabkha), depressions of fine-textured soil (Rawda), agricultural land and stagnant waters.

Zygophyllum qatarense and its associate species fall mostly in the Chamaephyte life-form type. Chamaephytes are defined as woody plants or herbaceous evergreen perennials whose mature branch or shoot system remains perennially within 50 cm above the ground surface (Raunkiaer 1937). Species associated with *Zygophyllum qatarense* include Therophytes (annuals), followed by few species of Phanerophytes (shrubs and trees) and Hemicryptophytes (plants losing their aerial parts during the drought period).

Table 1. The association between plant communities of *Zygophyllum qatarense*, soil moisture, soil salinity and soil pH of the top 20-cm.

Communities of <i>Zygophyllum qatarense</i>	Soil Moisture (dS/m)	Soil Salinity Classes*	Soil salinity	PH
1. Communities of inland rocky deserts of shallow compact soils	Dry	3.2 ± 3.38	Slightly saline	7.5 ± 0.5
2. Communities of inland rocky deserts interchanging with sandy mounds	Dry	1.51 ± 0.22	Non-saline	7.6 ± 0.1
3. Communities of inland disturbed rocky areas	Dry	3.1 ± 3.4	Slightly saline	7.5 ± 0.33
4. Communities of inland depressions of shallow silty clay loam to clay loam soils	Dry-Moist	1.48 ± 0.65	Non-saline	7.6 ± 0.37
5. Communities of inland depressions of sandy to sandy loam soils	Dry-Moist	1.0 ± 0.84	Non-saline	7.8 ± 0.32
6. Communities of inland immobile sandy mounds	Dry-Moist	0.32 ± 0.54	Non-saline	7.5 ± 0.3
7. Communities of coastal sandy shores	Dry-Moist	11.85 ± 18.1	Strongly saline	7.5 ± 0.28
8. Communities of coastalsandy-rocky shores	Dry-Moist	6.25 ± 4.16	Moderately saline	7.6 ± 0.12
Communities free of <i>Zygophyllum Qatarense</i>				
1. Depressions of deep silty clay loam clay loam soils (Rawda)	Dry-Moist	0.88 ± 0.48	Non-saline	7.7 ± 0.37
2. Sand dunes	Dry-Moist	0.43 ± 0.16	Non-saline	7.7 ± 0.37
3. Salt flats	Moist-Wet	61.10 ± 10.2	Very strongly saline	7.7 ± 0.32
4. Wastewater and stagnant water pools	Moist-Wet	11.77 ± 18.5	Strongly saline	7.75 ± 0.4
5. Intertidal coastal areas	Wet	36.4 ± 20.5	Strongly saline	7.5 ± 0.32
6. Cultivated land	Dry-Moist	0.88 ± 0.48	Non-saline	7.5 ± 0.37

*Soil Salinity Classes: None Saline (0-2), Slightly Saline (2-4), Moderately Saline (4-8), Strongly Saline (8-16), Very Strongly Saline (>16 dS/M). After Abrol et. al, 1988.

Habitats Having *Zygophyllum qatarense*

The study revealed that many physiographic areas in Qatar have *Zygophyllum qatarense*, as shown in the following habitats.

1. Inland rocky deserts of shallow compact soils.

This habitat is characterized by little soil mixed with solid or broken rocks. The rocks are often exposed. Soil is slightly saline (3.2 ± 3.38 dS/m) with pH (7.5 ± 0.5). Such type of habitat is very common in the inland parts of Qatar. Various assemblages of species are found in this type of habitat, in various parts of Qatar. Species associated with *Zygophyllum qatarense* are listed in (See, Table 2).

2. Inland rocky deserts interchanging with sandy mounds .

This habitat varies in formation. It contains rocky spots interchanging with thin compact soil, and sandy mounds. Soil is non-saline (1.51 ± 0.22 dS/m) with pH (7.6 ± 0.1). Succulent dwarf shrubs and annuals represent the main plant cover of this community, which is common in the inland areas. Various assemblages of species are found in this type of habitat, in various parts of Qatar. Species associated with *Zygophyllum qatarense* are listed in (See, Table 2).

3. Inland disturbed rocky areas.

This type of habitat is common around construction sites. Soil is slightly saline (3.1 ± 3.4 dS/m) and pH (7.5 ± 0.33). Various assemblages of species are found in this type of habitat, in various parts of Qatar. Species associated with *Zygophyllum qatarense* are listed in (See, Table 2).

4. Inland depressions of shallow silty clay loam to clay loam soils.

These depressions are referred to as "Rawda", and in many places have been converted into farmlands. Such depressions are common in the northern and central parts of Qatar. Soil is 20-50 cm deep and is non-saline (1.48 ± 0.65 dS/m) with pH (7.6 ± 0.37). Various assemblages of species are found in this type of habitat, in various parts of Qatar. Species associated with *Zygophyllum qatarense* are listed in (See, Table 2).

5. Inland depressions of sandy to sandy loam soils.

Such depressions are widely scattered in the country, especially in the western and southern regions. They are mainly of sandy soils, but occasionally maintain a mosaic of soil types: sandy, silty, loamy, broken small-sized rock, and large-sized rocks. Soil is non-saline (1.0 ± 0.48 dS/m) with pH (7.8 ± 0.32). Grasses are common in such type of habitats; yet, other types of plants were encountered. Various assemblages of species are found in this type of habitat, in various parts of Qatar. Species associated with *Zygophyllum qatarense* are listed in (See, Table 2).

6. Inland immobile sandy mounds.

Zygophyllum qatarense is found on small sandy mounds covered with a crust of sand and organic matter created as a result of leaf shedding and the condensation of water vapor. Sandy mounds are common in the southeastern and western regions, and near the coastal areas in various parts of the country. Grasses and sedges are the common associate species in this type of habitat. Soil is non-saline ($0.32-0.54$ dS/m) with pH (7.5 ± 0.3). Various assemblages of species are found in this type of habitat, in various parts of Qatar. Species associated with *Zygophyllum qatarense* are listed in (See, Table 2).

7. Coastal sandy shores.

Dwarf succulent perennials, grasses and sedges are common on sandy shores. Such type of habitats are found in various places along the coastal areas of Qatar, especially in the southeastern region. Soil is strongly saline (11.85 ± 18.1 dS/m) with pH (7.5 ± 0.28). Various assemblages of species are found in this type of habitat, in various parts of Qatar. Species associated with *Zygophyllum qatarense* are listed in (See, Table 2).

8. Coastal sandy-rocky shores.

Dwarf succulent perennial plants are common on the sandy-rocky shore. Such habitats are found in a number of places along the coastal areas. Rocky shores are rare. Soil is moderately saline (6.25 ± 4.16 dS/m) with pH (7.6 ± 0.12). Various assemblages of species are found in this type of habitat, in various parts of Qatar. Species associated with *Zygophyllum qatarense* are listed in (See, Table 2).

Table 2. Species associated with *Zygophyllum qatarense* in eight different habitats.

Species	Family	Habitat							
		1	2	3	4	5	6	7	8
<i>Abutilon fruticosum</i> Guill. et Perr.	Malvaceae			X					
<i>Abutilon pannosum</i> (Forst. f) Schlecht.	Malvaceae			X					
<i>Acacia ehrenbergiana</i> Hayne	Leguminosae (Mimosaceae)	X	X	X	X	X	X		
<i>Acacia tortilis</i> (Forssk.) Hayne	Leguminosae (Mimosaceae)	X	X	X	X	X	X		
<i>Aeluropus lagopoides</i> (L.) Trin ex Th.	Gramineae			X	X	X	X	X	
<i>Aerva javanica</i> (Burm.F.) Juss. ex J. A. Schultes	Amaranthaceae				X	X	X		
<i>Aizoon canariense</i> L.	Aizoaceae			X					
<i>Anabasis setifera</i> Moq.	Chenopodiaceae	X		X				X	X
<i>Anastatica hierochuntica</i> L.	Brassicaceae (Cruciferae)	X	X	X	X	X			
<i>Andrachne telephioides</i> L.	Euphorbiaceae			X					
<i>Arnebia hispidissima</i> (Spreng.) DC.	Boraginaceae	X	X	X	X	X	X		
<i>Arthrocnemum glaucum</i> (Del.) Ung. Sternb.	Chenopodiaceae			X					

Species	Family	Habitat							
		1	2	3	4	5	6	7	8
<i>Astragalus tribuloides</i> Del.	Leguminosae (Papilionaceae)	X	X	X		X			
<i>Atractylis carduus</i> (Forssk.) Christ.	Compositae	X	X	X		X			
<i>Atriplex leucoclada</i> Boiss.	Chenopodiaceae			X					
<i>Beta vulgaris</i> L.	Brassicaceae (Cruciferae)			X					
<i>Blepharis ciliaris</i> (L.) B.L. Burt	Acanthaceae	X	X		X	X			
<i>Capparis spinosa</i> L.	Capparaceae (Capparidaceae)			X					
<i>Cassia italica</i> (Mill.) Lam. ex DC. Steud.	Leguminosae (Caesalpiaceae)			X		X			
<i>Chenopodium murale</i> L.	Chenopodiaceae			X					
<i>Chloris virgata</i> Sw.	Gramineae			X					
<i>Chrysopogon aucheri</i> (Boiss.) Stapf.	Gramineae	X	X		X	X	X		
<i>Cistanche phelypaea</i> (L.) Cout., Total	Orobanchaceae		X						X
<i>Citrullus colocynthis</i> (L.) Schrad.	Cucurbitaceae			X	X	X			
<i>Convolvulus arvensis</i> L.	Convolvulaceae			X					
<i>Convolvulus glomeratus</i> Choisy.	Convolvulaceae		X						
<i>Convolvulus pilosellifolius</i> Desv.	Convolvulaceae			X		X	X		
<i>Convolvulus prostratus</i> Forssk.	Convolvulaceae				X	X	X		
<i>Corchorus depressus</i> (L.) Stocks	Tiliaceae		X	X	X	X			
<i>Cornulaca aucheri</i> Moq.	Chenopodiaceae	X	X			X	X	X	
<i>Cymbopogon commutatus</i> Stapf. (Syn. <i>Cymbopogon parkeri</i>)	Gramineae	X		X		X			
<i>Cynodon dactylon</i> (L.) Pers.	Gramineae				X	X			
<i>Cynomorium coccineum</i> L.	Cynomoriaceae		X						X
<i>Cyperus conglomeratus</i> Rottb.	Cyperaceae		X			X			X
<i>Cyperus rotundus</i> L.	Cyperaceae			X					
<i>Dicanthium annulatum</i> (Forssk.) Stapf.	Gramineae					X			
<i>Dichanthium foveolatum</i> (Del.) Stapf.	Gramineae	X	X	X	X	X			
<i>Eleusine compressa</i> (Forssk.) Asch. et Schwinf.	Gramineae	X	X			X			
<i>Emex spinosus</i> (L.) Campd.	Polygonaceae			X					
<i>Ephedra foliata</i> Boiss. Ex C.A. Mey.	Ephedraceae				X				
<i>Euphorbia granulata</i> Forssk.	Euphorbiaceae			X		X			
<i>Euphorbia hirta</i> L.	Euphorbiaceae			X					
<i>Euphorbia peplus</i> L.	Euphorbiaceae			X					
<i>Euphorbia prostata</i> Ait.	Euphorbiaceae					X			
<i>Fagonia indica</i> Burm. f.	Zygophyllaceae	X	X	X		X			
<i>Fagonia ovalifolia</i> Hadidi	Zygophyllaceae							X	
<i>Filago spathulata</i> Presl.	Compositae				X	X			
<i>Frankenia pulverulenta</i> L.	Frankeniaceae				X				
<i>Glossonema edule</i> N. E. Br.	Asclepiadaceae	X	X	X		X			
<i>Hammada elegans</i> (Bunge) Botsch.	Chenopodiaceae	X	X			X			
<i>Haplophyllum tuberculatum</i> (Forssk.) A. Juss.	Rutaceae			X					
<i>Helianthemum kahiricum</i> Del.	Cistaceae			X					
<i>Helianthemum lippii</i> (L.) Dum. Cours.	Cistaceae	X	X	X		X			
<i>Heliotropium bacciferum</i> Forssk.	Boraginaceae	X	X	X	X			X	
<i>Herniaria hemistemon</i> J. Gay.	Caryophyllaceae	X	X	X	X	X			
<i>Ifloga spicata</i> (Forssk.) Sch. Bip.	Compositae	X	X		X	X			
<i>Indigophera articulata</i> Gouan.	Leguminosae (Papilionaceae)		X			X			
<i>Juncus rigidus</i> Desf.	Juncaceae					X	X		
<i>Lactuca saligna</i> L.	Compositae			X					
<i>Lappula spirocarpos</i> Forssk. Aschers.	Boraginaceae					X			
<i>Lasiurus scindicus</i> Henr. (Syn. <i>Lasiurus hirsutus</i>)	Gramineae	X	X			X			
<i>Launaea capitata</i> (Spreng.) Dandy	Compositae			X	X	X			

Species	Family	Habitat							
		1	2	3	4	5	6	7	8
<i>Launaea nudicaulis</i> (L.) Hook. f.	Compositae	X		X		X			
<i>Leptadenia pyrotechnica</i> (Forssk.) Decne.	Asclepiadaceae			X					
<i>Limonium axillare</i> (Forssk.) O. Kuntze	Plumbaginaceae							X	X
<i>Lotus halophilus</i> Bois. et Sprun.	Leguminosae (Papilionaceae)		X			X			
<i>Lycium shawii</i> Roem. et Schult.	Solanaceae	X	X	X	X	X			
<i>Malva parviflora</i> L.	Malvaceae			X					
<i>Medicago laciniata</i> (L.) Mill.	Leguminosae (Papilionaceae)	X		X		X			
<i>Mesembryanthemum nodiflorum</i> L.	Aizoaceae			X					
<i>Mollugo cerviana</i> (L.)	Molluginaceae			X					
<i>Moltkiopsis ciliata</i> (Forssk.) Johnst.	Boraginaceae			X					
<i>Neurada procumbens</i> L.	Neurodaceae (Rosaceae)		X						
<i>Oligomerus subulata</i> (Del.) Boiss.	Resedaceae			X					
<i>Panicum turgidum</i> Forssk.	Gramineae	X	X			X		X	
<i>Pennisetum divisum</i> (Gmel.) Hern.	Gramineae		X	X		X	X		
<i>Phoenix dactylifera</i> L.	Palmae							X	
<i>Plantago ciliata</i> Desf.	Plantaginaceae	X			X	X			
<i>Polycarpaea spicata</i> Wight et Arn.	Caryophyllaceae				X	X			
<i>Polygala erioptera</i> DC.	Polygalaceae					X			
<i>Pulicaria crispa</i> (Forssk.) Bent. (Syn. <i>Francoeria crispa</i>)	Compositae	X	X	X	X	X			
<i>Pulicaria gnaphalodes</i>	Compositae	X	X	X	X	X			
<i>Reichardia tingtana</i> (L.) Roth.	Compositae			X					
<i>Reseda muricata</i> Presl.	Resedaceae	X		X		X			
<i>Rhanterium epapposum</i> Oliv.	Compositae			X					
<i>Rumex vesicarius</i> L.	Polygoniaceae			X					
<i>Salsola baryosma</i> (Roem. Et Schult) Dandy (Syn. <i>Salsola imbricata</i>)	Chenopodiaceae		X	X				X	X
<i>Salsola cyclophylla</i> Baker	Chenopodiaceae	X			X		X		
<i>Salvia aegyptiaca</i> L.	Labiatae	X		X		X			
<i>Sclerocephalus arabicus</i> Boiss.	Caryophyllaceae	X		X	X	X			
<i>Scrophularia deserti</i> Del.	Caryophyllaceae	X		X	X				
<i>Seidlitzia rosmarinus</i> Bunge. ex. Boiss.	Chenopodiaceae							X	
<i>Sonchus oleraceus</i> L.	Compositae			X					
<i>Spergula fallax</i> (Lowe) Krause	Caryophyllaceae			X		X			
<i>Sporobolus arabicus</i> Boiss.	Gramineae							X	
<i>Sporobolus spicatus</i> (Vahl) Kunth	Gramineae	X		X	X			X	
<i>Stipa capensis</i> Thumb.	Gramineae	X		X	X				
<i>Stipagrostis obtusa</i> (Del.) Nees	Gramineae		X	X					
<i>Suaeda aegyptiaca</i> (Hasselq.) Zoh. (Syn. <i>Schanginia aegyptiaca</i>)	Chenopodiaceae			X				X	X
<i>Suaeda vermiculata</i> Forssk. ex J. F. Gmel.	Chenopodiaceae			X			X	X	X
<i>Tamarix passerinoides</i> Del. Ex. Desr.	Tamaricaceae				X				
<i>Teucrium polium</i> L. Agg.	Labiatae			X					
<i>Trigonella hamosa</i> L.	Leguminosae (Papilionaceae)			X					
<i>Trigonella stellata</i> Forssk.	Leguminosae (Papilionaceae)			X					
<i>Urospermum picroides</i> (L.) Scop. ex. Schmidt.	Compositae			X					
<i>Zygophyllum qatarense</i> Hadidi	Zygophyllaceae	X	X	X	X	X	X	X	X
<i>Zygophyllum simplex</i> L.	Zygophyllaceae	X	X	X		X			

(1) Inland rocky deserts of shallow compact soils, (2) Inland rocky deserts interchanging with sandy mounds, (3) Inland disturbed areas, (4) Inland depressions of shallow silty clay loam to clay loam soils, (5) Inland depressions of sandy to sandy loam soils, (6) Inland immobile sandy mounds, (7) Coastal sandy shores, and (8) Coastal sandy-rocky shores. Species presence marked by X

Habitat Free of *Zygophyllum qatarense*

The study revealed that many physiographic areas in Qatar are free of *Zygophyllum qatarense*, as described in the following habitats.

1. Depressions of deep silty clay loam to clay loam soils (Rawda).

This type of depression is called locally "Rawda", where the soil is 50-150 cm deep. Rawdas are common in the northern half of the country and are flooded during the rainy seasons. Soil is non-saline (0.88 ± 0.48 dS/m) with pH (7.7 ± 0.37). Fresh water desert plants common in such habitat: few tree species (*Acacia tortilis*, *A. ehrenbergiana* and *Ziziphus nummularia*) and many winter annual species.

2. Sand dunes.

Sand dunes are most common in the southeastern regions, and can rise up to one hundred meters above sea level. Soil is non-saline (0.43 ± 0.16 dS/m) with pH (7.7 ± 0.37). Sporadic grasses and sedges occur at the bases of these dunes where moisture is often retained.

3. Salt flats.

Salt flats are found in lowlands along or near coastal areas affected by seawater intrusion. Also, they are found in inland low areas affected by water logging. The soil is sandy to sandy-loam, 10-150 cm deep and very strongly saline (61.1 ± 10.2 dS/m) with pH (7.7 ± 0.32). Such areas are usually barren, with a few species living around their edges, mainly *Aeluropus lagopoides*.

4. Wastewater and stagnant water pools.

Zygophyllum qatarense avoids water catchment areas and the edges of wastewater dumping sites around cities. These wetlands in most cases have rocky ground with little soil on top, but after a period of time the top layer becomes thicker as a result of litter accumulation and decomposition. Some have olive green colored soils. Soil is strongly saline (11.77 ± 18.5 dS/m) with pH (7.75 ± 0.4). Such depressions are well suited for the growth of *Phragmites australis* and *Tamarix* sp.

5. Intertidal coastal areas.

Intertidal areas are either without vegetation or occupied by mangrove. Mangrove vegetation (*Avicennia marina* and associate species) lives on seawater, in lagoons of fine sediments and calm waters. Soil is strongly saline (36.4 ± 20.5 dS/m) with pH (7.5 ± 0.32).

6. Cultivated land.

Zygophyllum qatarense seldom grows around farms where soils experience constant disturbance. Such areas are mostly occupied by annual weeds. Soil is non-saline (0.88 ± 0.48 dS/m) with pH (7.5 ± 0.37).

Discussion

Zygophyllum qatarense Hadidi, is the most widespread species in Qatar. It is a perennial dwarf succulent species adapted to a wide range of habitats. It is found on a wide range of soil types: sandy, sandy-rocky, and sandy-loam; in dry areas, areas receiving sporadic winter rain, and permanently moist soil. It stands soil salinity ranging from non-saline to strongly saline (1.0 to 11.85 dS/m) and pH ranging from 7.5 to 7.8. *Zygophyllum qatarense* avoids stagnant waters, mobile sands and agricultural land.

Succulent leaves of *Zygophyllum qatarense* tend to appear in various colors: green, bluish green or red. The reason behind such coloration is not yet known.

The plant is unpalatable to grazing animals. It helps stabilize the soil and reduces wind and water erosion. It creates proper shelter for many soil-burrowing lizards and rodents. Analysis of various parts of *Zygophyllum qatarense* is needed to determine if the species contains some important chemicals.

Physiological, chromosomal and DNA studies are required to explain the reasons behind the vigor and versatility of this species, which stretches over a wide range of habitats and occupies nutrient-poor soils.

Acknowledgements

We are grateful to the University of Qatar for offering the necessary facilities to conduct this project. The project was supported in part by the Scientific and Applied Research Center, University of Qatar (Reference HE 10/98).

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Received 13/05/2001, in revised form 10/02/2002