

## IMPORTANT PLANT AREAS IN THE ARABIAN PENINSULA: 3. ‘URUQ BANI MA‘ARID

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‘Uruq Bani Ma‘arid in Saudi Arabia is an Important Plant Area (IPA) in the Arabian Peninsula. This paper describes the flora of ‘Uruq Bani Ma‘arid, provides an up-to-date botanical checklist of the area, and gives background information on the geology and fauna. It designates the locality as an IPA due to the highest known levels of plant species diversity in the Empty Quarter and the presence of endemic Arabian taxa. In addition to conservation assessments, this study discusses socio-economic issues, threats to biodiversity conservation on ‘Uruq Bani Ma‘arid, and the future research required to build upon these preliminary studies. A new combination is made for *Fagonia schweinfurthii*.

*Keywords.* Conservation, Empty Quarter, endemic species, Important Plant Area, Saudi Arabia, ‘Uruq Bani Ma‘arid.

### INTRODUCTION

‘Uruq Bani Ma‘arid is situated along the western edge of the Rub’ al-Khali, the only major sand desert in tropical Asia and one of the largest continuous sand seas on Earth. ‘Uruq Bani Ma‘arid is administered by the Saudi Wildlife Commission (SWC) as a protected area, covering 12,658 km<sup>2</sup> of the Empty Quarter directly to the east of the Tuwayq escarpment. The protected area is centred on 19°20’N and 45°30’E (Fig. 1) and is divided into three zones: a core nature reserve of 2400 km<sup>2</sup>, a managed grazing zone and a wider controlled hunting zone which forms the southernmost part of the protected area and the lower dunes of the eastern area.

Geologically the site is composed mainly of the Quaternary aeolian sands of the Rub’ al-Khali overlying the cuesta of Tuwayq mountain limestone. At the west of the site, the Tuwayq escarpment (running north–south) terminates a narrow limestone plateau which is dissected by numerous eastward-draining wadis. To the east of this plateau, parallel linear dunes of mobile red sand up to 165 m high separate the interdune corridors which are filled with sand, silt or gravels. The altitude of the site ranges from 1099 m on the dunes of the ‘Irq al-Khisbi near the escarpment in the southwest to

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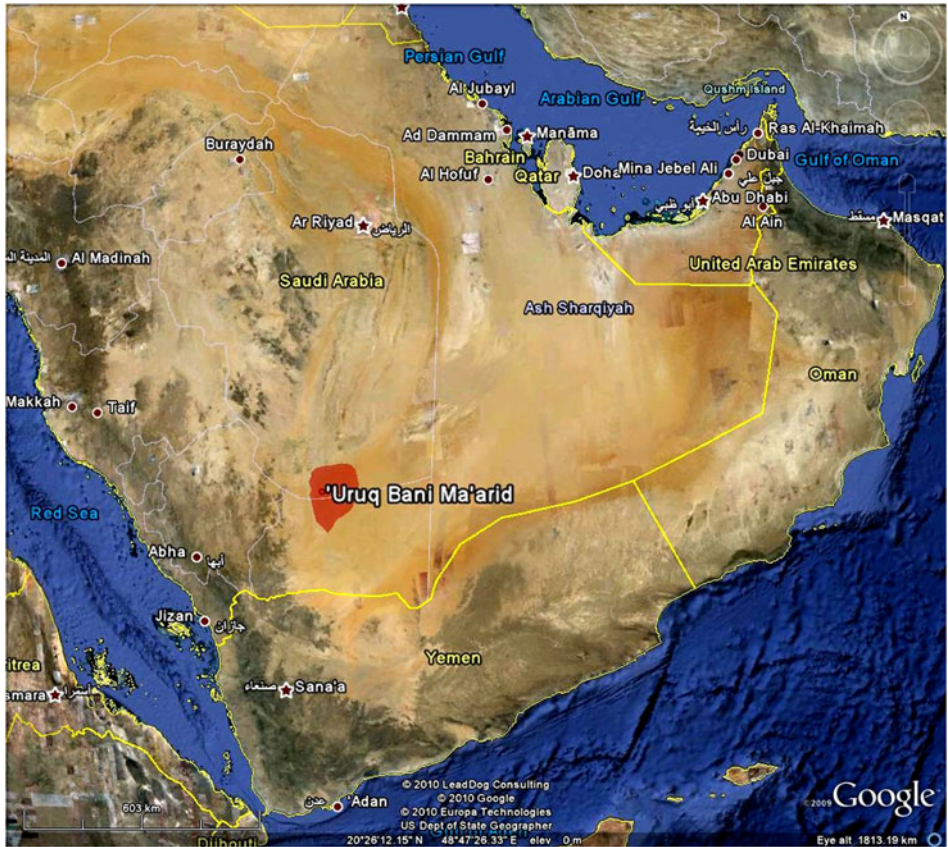


FIG. 1. The 'Uruq Bani Ma'arid protected area covers 12,658 km<sup>2</sup> of the Empty Quarter.

640 m in the interdune corridors of the northeast. The climate of 'Uruq Bani Ma'arid is arid and hot. There is no permanent meteorological station in the protected area, but the nearest weather station at Sharurah records an annual mean temperature of 27.5°C and a mean annual rainfall of 36 mm (Table 1).

'Uruq Bani Ma'arid contains some of the Earth's most spectacular desert landscapes (Fig. 2) and the highest known level of plant diversity in the Empty Quarter. Mandaville (1986) recorded 37 plant species in the Rub' al-Khali from an area of 500,000 km<sup>2</sup>. Robinson & Al-Harbi (2004) recorded 25 plant species from 277 survey sites in the eastern Rub' al-Khali. The checklist of vascular plants from 'Uruq Bani Ma'arid in Appendix 1 contains 112 recorded plant species.

#### METHODOLOGY

The most recent botanical surveys of 'Uruq Bani Ma'arid were conducted for the Arabian Peninsula Important Plant Area (IPA) programme in May 2009. Survey

TABLE 1. Comparative measurements from seven major meteorological stations in Saudi Arabia. The nearest station to ‘Uruq Bani Ma’arid is Sharurah. Data adapted from Ghazanfar & Fisher (1998)

Meteorological station	Location	Altitude (m)	Annual rainfall (mm)	Maximum temperature (°C)	Minimum temperature (°C)	Mean temperature (°C)	Mean fog days
Sharurah	17°29’N, 47°06’E	725	36	45.3	0.8	27.5	0.1
Riyadh	24°42’N, 46°43’E	614	126	47.4	-4.4	24.8	5.1
Jeddah	21°33’N, 39°10’E	4	47	49.0	9.8	28.4	4.8
Jazan	16°52’N, 42°34’E	7	129	45.3	11.8	30.6	1.4
Najran	17°30’N, 44°12’E	1212	50	42.0	-0.5	24.7	0.5
Tabuk	28°23’N, 36°34’E	768	46	44.4	-3.7	22.0	0.5
At-Ta’if	21°16’N, 40°25’E	1453	204	39.5	-1.2	22.9	12.1

methodology involved recording the presence of all vascular plant species at 11 selected waypoints during three days of surveying accompanied by the SWC rangers stationed at ‘Uruq Bani Ma’arid. Vegetation in the Rub’ al-Khali is generally very sparse, but the May 2009 IPA surveys followed good spring rains. Waypoints were selected in areas of good vegetation within the three main topographical ‘zones’ in ‘Uruq Bani Ma’arid: the limestone plateau, the high sand dunes and the interdune corridors. Voucher herbarium specimens and field photographs were collected and deposited at the Royal Botanic Garden Edinburgh (E). A further set of voucher specimens were deposited at the Saudi Wildlife Commission, Riyadh.

RESULTS

From these surveys and from data in NCWCD (1987), 112 species have been recorded from the area. Phytogeographically, the flora of ‘Uruq Bani Ma’arid has affinities with the Arabian regional subzone of the Saharo-Sindian regional zone (Ghazanfar & Fisher, 1998). However, Mandaville (1986) treats the flora of the Rub’ al-Khali as part of Sudanian floristic territory. Although the flora of the western Rub’ al-Khali is relatively species poor, ‘Uruq Bani Ma’arid is an important location for a number of endemic plant taxa. Using the data gathered during the IPA surveys in May 2009, the following descriptions detail the vegetation of the three major topographical zones in ‘Uruq Bani Ma’arid.



FIG. 2. The dune areas of 'Uruq Bani Ma'arid provide some of the most dramatic desert landscapes in the world, representing a significant ecotourism opportunity for the area. This image is a 360° panorama of an area in the upper dunes.

### Limestone plateau

In the absence of rain, large areas of the limestone plateau (the highest elevation on the escarpment is 1062 m) appear barren. However, after rains in areas where sufficient groundwater collects, interesting patches of vegetation occur. In the incised wadis and sandy plains, a sparse *Acacia* woodland predominates, with *Acacia tortilis*, *A. oerfota*, *A. ehrenbergiana* and *A. hamulosa* all present (for species' authors see Appendix 1). Other notable tree species in the wadis include *Ziziphus spina-christi* and *Maerua crassifolia* as well as single stands of *Moringa peregrina* and *Commiphora myrrha*, respectively. In such areas of the plateau are found the shrub species *Leptadenia pyrotechnica*, *Haloxylon salicornicum*, *Ephedra foliata* and herbaceous species such as *Haplophyllum tuberculatum*, *Dipterygium glaucum*, *Leucas inflata*, *Fagonia indica*, *Limeum arabicum* and *Tribulus macropterus* var. *arabicus* (Fig. 3) as well as perennial grass species including *Panicum turgidum*. Although Ghazanfar & Fisher (1998) state that annual plants are relatively unimportant in 'Uruq Bani Ma'arid, after rains the sandy plains overlying the limestone are covered in a sward of annual species including *Monsonia nivea*, *Astragalus hauarensis*, *Cleome amblyocarpa*, *Polygala erioptera* and *Fagonia indica* as well as annual grass species such as *Aristida adscensionis*.

In the red sands overlying limestone at the junction of the Rub' al-Khali sands and the Tuwayq escarpment there are areas of very open *Acacia* woodland comprised of



FIG. 3. *Tribulus macropterus* var. *arabicus* is one of a number of endemic plant taxa in the Empty Quarter.

*Acacia tortilis* and *A. oerfota*. Also present are *Haloxyton salicornicum*, *Rhazya stricta*, *Tribulus macropterus* var. *arabicus*, *Dipterygium glaucum*, *Farsetia burtoniae* and the perennial grass species *Panicum turgidum* and *Lasiurus scindicus*.

#### *Rare plant taxa*

A number of rare and endemic plant taxa occur on the limestone plateau in 'Uruq Bani Ma'arid. *Limeum arabicum* and *Tribulus macropterus* var. *arabicus* are Arabian endemics known from Saudi Arabia, Yemen, Oman and the United Arab Emirates.

#### **Sand dunes**

Covering approximately 60% of 'Uruq Bani Ma'arid, the parallel high sand dunes represent the largest plant habitat in the protected area. The plant communities of the red dunes are typical of the Rub' al-Khali. The woody shrub *Calligonum crinitum* subsp. *arabicum* occupies the unstable sand habitats in the crests of the high dunes, producing a community of very widely spaced shrubs (see Fig. 4). On the lower slopes of the dunes a sparse herbaceous community occurs with a number of species including *Cornulaca arabica*, *Limeum arabicum*, *Moltkiopsis ciliata*, *Neurada procumbens*, *Dipterygium glaucum*, *Corbichonia decumbens*, *Tephrosia uniflora*, *Farsetia*



FIG. 4. The woody shrub *Calligonum crinitum* subsp. *arabicum* occupies the unstable sand habitats in the crests of the high dunes, producing a community of very widely spaced shrubs.

*longisiliqua* and *Farsetia burtoniae*. Common grasses include *Panicum turgidum* and *Lasiurus scindicus* along with *Centropodia fragilis* and *Stipagrostis drarii* which are rarely found growing on the dunes in the other areas of the Rub' al-Khali.

In the sands, *Tribulus macropterus* var. *arabicus* and *Cyperus macrorrhizus* often dominate large areas within the sparse herbaceous communities. The latter species, a drought-adapted sedge, is one of the most important biomass producers in the Rub' al-Khali. On the western edge of the sands in Wadi Ghudayy there is an extensive stand of *Haloxylon persicum*.

#### Rare plant taxa

*Calligonum crinitum* subsp. *arabicum*, *Cornulaca arabica*, *Tribulus macropterus* var. *arabicus* and *Limeum arabicum* are all Arabian endemics.

#### Interdune corridors

The vegetation of the interdune corridors has much in common with that of the limestone plateau and the lower sand dunes. On the sands and gravels between the towering red sand dunes the vegetation is very sparse and scattered individuals of *Acacia tortilis* form the dominant tree flora (Fig. 5). In the surveyed areas in the west of 'Uruq Bani Ma'arid, the dwarf shrub layer is composed of sparsely distributed *Haloxylon salicornicum* along with woody-based herbaceous species *Dipterygium glaucum*, *Limeum arabicum*, *Fagonia indica* and *Tribulus macropterus* var. *arabicus* and the grass species *Panicum turgidum* and *Stipagrostis* spp.

#### Rare plant taxa

*Tribulus macropterus* var. *arabicus* and *Limeum arabicum* both occur in this habitat.

#### IPA ASSESSMENT

'Uruq Bani Ma'arid is an important site for wild plant conservation. Using the Important Plant Area criteria which have been adapted for the Arabian Peninsula (Al-Abbasi *et al.*, 2010) 'Uruq Bani Ma'arid qualifies as an IPA under criteria A and B (see Table 2).

#### OTHER TAXA

Perhaps the most significant animal species in the protected area is the Arabian oryx (*Oryx leucoryx* Pallas), which was successfully reintroduced into 'Uruq Bani Ma'arid in 1995 along with the Arabian sand gazelle (reem) (*Gazella subgutturosa marica* Gldenstdt) and mountain gazelle (idmi) (*Gazella gazella* Pallas) (Dunham *et al.*, 2001). Other prominent mammals include the sand cat (*Felis margarita harrisoni* Hemmer, Grubb & Groves), the Rub al-Khali hare (*Lepus capensis arabicus*



FIG. 5. On the sands and gravels between the towering red sand dunes the vegetation is very sparse, with scattered individuals of *Acacia tortilis* forming the only tree cover.

Ehrenberg) and the Arabian wolf (*Canis lupus arabs* Pocock) which intermittently enters the rocky western part of the reserve. Around 16 bird species are considered resident in ‘Uruq Bani Ma‘arid, including brown necked raven (*Corvus ruficollis* Lesson), sand partridge (*Ammoperdix heyi* Temminck), trumpeter finch (*Bucanetes githagineus* Lichtenstein), Egyptian vulture (*Neophron percnopterus* L.) and Barbary

TABLE 2. ‘Uruq Bani Ma‘arid qualifies as an IPA under criteria A (4) and B

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**Criterion A**

A4 – National endemic, near endemic, regional endemic and/or regional range-restricted taxa

Four endemic plant taxa are recorded from ‘Uruq Bani Ma‘arid: *Limeum arabicum*, *Cornulaca arabica*, *Calligonum crinitum* subsp. *arabicum* and *Tribulus macropterus* var. *arabicus*.

**Criterion B**

B – The site has an exceptionally rich flora in a regional context in relation to its biogeographic zone

There are 112 plant species recorded from ‘Uruq Bani Ma‘arid. This species diversity makes ‘Uruq Bani Ma‘arid the richest known area of the Empty Quarter, Asia’s only tropical sand desert.

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falcon (*Falco pelegrinoides* Temminck) (Jennings, 2010). There are also populations of globally threatened bird species including the lappet faced vulture (*Torgos tracheliotus* Forster) which is listed as Vulnerable on the IUCN Red List (IUCN, 2009).

### SOCIO-ECONOMIC ISSUES

The protected area lies within the traditional tribal territories of the Yam in its southern parts, and in its northern parts, the Dawasir. The main resource use in the area is the grazing of domestic livestock (camels and sheep) by the nomadic herdspeople who live within the area. In addition, dead trees and shrubs are used as firewood. No traditional *himas* have been recorded in the ‘Uruq Bani Ma‘arid area (Llewellyn, in press). The ‘Uruq Bani Ma‘arid protected area is divided into management zones, with a strictly protected core area occupying approximately 2400 km<sup>2</sup>, an area designated for managed grazing (although grazing management has not yet begun), and in the south and east, a zone in which SWC management is restricted to the control of hunting.

More than any other biotope, the large sand seas of the Empty Quarter represent the wilderness of Arabia in the eyes of the world. With iconic animal species and landscapes, ‘Uruq Bani Ma‘arid potentially has a high value for nature-based tourism and recreation activities such as wildlife viewing and wilderness camping. Under the current management strategy of the protected area such activities would be outside the core zone. ‘Uruq Bani Ma‘arid also contains sites of archaeological and cultural interest, including cairns, standing stones, and lines of rocks overlooking the ruins of the ancient city of Al-Faw which lie close to the northwestern edge of the protected area. The development of low-impact nature-based tourism in ‘Uruq Bani Ma‘arid has the potential to benefit local communities and provide incentives for increased local participation in conservation activities (Irani & Johnson, 2000). The dramatic landscapes of ‘Uruq Bani Ma‘arid will be attractive not only to foreign tourists, but also to people from throughout Saudi Arabia and the Gulf countries, including locals from the nearby city of Najran (within 200 km).

### THREATS TO CONSERVATION

There are a number of existing and potential threats to the conservation of ‘Uruq Bani Ma‘arid as an Important Plant Area and as a protected area for biodiversity conservation. Moderate threats to the area include overgrazing in the grazing zones of the reserve, encroachment of livestock into the non-grazing zones of the reserve and disturbances associated with increased tourist activity such as increased off-road driving. Local people have expressed the need for more grazing opportunities in the ‘Ushayran area in spring, and grazing access issues are likely to become increasingly important with the onset of climatic changes. Other threats to conservation include poaching, disturbance of ungulates, off-road driving, and litter throughout the

reserve, as well as rubbish dumps, road construction, settlement and agricultural expansion below the escarpment.

#### FURTHER RESEARCH

The predicted climatic changes of reduced precipitation and increased temperatures (Dawson, 2007) are likely to have a significant impact on all plant communities in the Arabian Peninsula. An important line of future research in 'Uruq Bani Ma'arid will be to model the impact of global climatic change on the distribution of key plant species such as the endemic (and dominant) dune species *Calligonum crinitum* subsp. *arabicum* and *Tribulus macropterus* var. *arabicus*. Such studies will be critically important for the development of a long-term management strategy for protecting the plants, the animals, and the people of this hyper-arid area. Socio-economic research should be directed towards establishing local income generation in this wilderness area. Key issues in this regard will be establishing an ecologically sensitive, low-impact tourism strategy for 'Uruq Bani Ma'arid and exploring the nomination of 'Uruq Bani Ma'arid as a UNESCO Natural World Heritage Site under criteria VII–X.

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## APPENDIX 1

*Checklist of plant taxa from 'Uruq Bani Ma'arid. Family delimitation follows APG II (Angiosperm Phylogeny Group, 2003)*

This checklist is compiled from survey data, literature sources and herbarium specimens. The principal source for each record is noted in superscript next to each name.

- 1 – IPA survey data, May 2009
- 2 – Collenette & Tsagarakis (2001)
- 3 – NCWCD (1987)
- 4 – Llewellyn (in press)
- 5 – Strauss (1995)

### **Acanthaceae**

*Blepharis ciliaris* (L.) B.L.Burt<sup>1</sup>

### **Amaranthaceae**

*Aerva javanica* (Burm.f.) Juss. ex Schult.<sup>2</sup>

*Anabasis setifera* Moq. (syn. *Hammada scoparia* sensu Collenette<sup>3</sup>)

*Cornulaca arabica* Botsch.<sup>1</sup>

*Halothamnus bottae* Jaub. & Spach<sup>2</sup>

*Haloxylon persicum* Bunge ex Boiss. & Buhse<sup>3</sup>

*Haloxylon salicornicum* (Moq.) Bunge ex Boiss.<sup>1</sup>

*Salsola* sp.<sup>2</sup> (Collenette & Tsagarakis (2001) record a *Salsola spinescens*?)

**Apocynaceae**

- Glossonema varians* (Stocks) Hook.f.<sup>2</sup>  
*Leptadenia pyrotechnica* (Forssk.) Decne.<sup>1</sup>  
*Pergularia tomentosa* L.<sup>3</sup>  
*Rhazya stricta* Decne.<sup>1</sup>

**Boraginaceae**

- Anchusa hispida* Forssk. (syn. *Gastrocotyle hispida* (Forssk.) Bunge<sup>2</sup>)  
*Arnebia hispidissima* (Sieber ex Lehm.) A.DC.<sup>1</sup>  
*Echium* sp.<sup>3</sup>  
*Heliotropium crispum* Desf. (syn. *Heliotropium ramosissimum* (Lehm.) DC.<sup>2</sup>)  
*Heliotropium digynum* (Forssk.) C.Chr.<sup>1</sup>  
*Heliotropium rariflorum* Stocks<sup>2</sup>  
*Moltkiopsis ciliata* (Forssk.) I.M.Johnst.<sup>3</sup>  
*Trichodesma africanum* (L.) Sm.<sup>2</sup>

**Brassicaceae**

- Eremobium aegyptiacum* (Spreng.) Asch. & Schweinf. ex Boiss.<sup>2</sup>  
*Farsetia burtoniae* Oliv.<sup>1</sup>  
*Farsetia* sp. aff. *burtoniae*/*Farsetia* sp. aff. *dhofarica*<sup>1</sup> (see Miller & Cope (1996: 423))  
*Farsetia longisiliqua* Decne.<sup>1</sup>  
*Farsetia stylosa* R.Br.<sup>1</sup>  
*Morettia parviflora* Boiss.<sup>1</sup>

**Burseraceae**

- Commiphora myrrha* (Nees) Engl.<sup>4</sup>

**Capparaceae**

- Capparis spinosa* L. (syn. *Capparis sinaica* Veill. ex Duhamel<sup>2</sup>)  
*Dipterygium glaucum* Decne.<sup>1</sup>  
*Maerua crassifolia* Forssk.<sup>3</sup>

**Caryophyllaceae**

- Polycarpaea repens* (Forssk.) Asch. & Schweinf.<sup>1</sup>  
*Sclerocephalus* sp.<sup>2</sup> (Collenette & Tsagarakis (2001) record a *Sclerocephalus arabicus*?)

**Cleomaceae**

- Cleome amblyocarpa* Barratte & Murb.<sup>1</sup>

**Compositae (Asteraceae)**

- Atractylis carduus* (Forssk.) C.Chr.<sup>2</sup>  
*Centaurea pseudosinaica* Czerep.<sup>1</sup>  
*Iphiona scabra* DC.<sup>2</sup>  
*Launaea mucronata* (Forssk.) Muschl.<sup>1</sup>  
*Pulicaria glutinosa* (Boiss.) Jaub. & Spach<sup>2</sup>  
*Pulicaria undulata* (L.) C.A.Mey. (syn. *Pulicaria crispa* (Forssk.) Benth. ex Oliv.<sup>2</sup>)  
*Rhanterium epapposum* Oliv.<sup>3</sup>  
*Scorzonera tortuosissima* Boiss.<sup>2</sup>

**Convolvulaceae**

- Convolvulus asyrensis* Kotschy<sup>2</sup>  
*Convolvulus auricomus* (A.Rich.) Bhandari var. *auricomus*<sup>2</sup>  
*Convolvulus buschiricus* Bornm.<sup>5</sup>

**Cucurbitaceae**

- Citrullus colocynthis* (L.) Schrad.<sup>1</sup>

**Cynomoriaceae**

- Cynomorium coccineum* L.<sup>2</sup>

**Cyperaceae**

- Cyperus macrorrhizus* Nees.<sup>1</sup>  
 Collenette & Tsagarakis (2001) record *Cyperus aucheri* Jaub. & Spach (syn. *Cyperus conglomeratus* var. *aucheri* (Jaub. & Spach) C.B.Clarke), a misidentification of the species above.

**Ephedraceae**

- Ephedra foliata* Boiss. ex C.A.Mey.<sup>1</sup>

**Euphorbiaceae**

- Chrozophora oblongifolia* (Delile) A.Juss. ex Spreng.<sup>3</sup> (A possible misidentification for the species below)  
*Chrozophora tinctoria* (L.) A.Juss.<sup>1</sup>

**Geraniaceae**

- Monsonia nivea* (Decne.) Decne. ex Webb<sup>1</sup>

**Gisekiaceae**

- Gisekia pharnaceoides* L.<sup>1</sup>

**Gramineae (Poaceae)**

- Aristida adscensionis* L.<sup>1</sup>  
*Cenchrus ciliaris* L.<sup>2</sup>  
*Centropodia forskalii* (Vahl) Cope<sup>2</sup>  
*Centropodia fragilis* (P.Guinet & Sauvage) Cope<sup>1</sup>  
*Chrysopogon plumulosus* Hochst.<sup>2</sup>  
*Dichanthium foveolatum* (Delile) Roberty<sup>1</sup>  
*Echinochloa* sp.<sup>5</sup>  
*Enneapogon desvauxii* P.Beauv.<sup>2</sup>  
*Lasiurus scindicus* Henrard<sup>1</sup>  
*Panicum turgidum* Forssk.<sup>1</sup>  
*Pennisetum divisum* (J.F.Gmel.) Henrard<sup>1</sup>  
*Stipa* sp.<sup>2,3</sup> (Collenette & Tsagarakis (2001) suggest that their record may be *Stipa hohenackeriana* Trin. & Rupr.)  
*Stipagrostis drarii* (Tackh.) De Winter<sup>3</sup>  
*Stipagrostis foëxiana* (Maire & Wilczek) De Winter<sup>2</sup>  
*Stipagrostis obtusa* (Delile) Nees<sup>3</sup>  
*Stipagrostis* sp.<sup>1,2</sup>  
*Tragus racemosus* (L.) All.<sup>1</sup>

**Hyacinthaceae**

*Dipcadi erythraeum* Webb & Berthel. (syn. *Dipcadi unicolor* (Stocks) Baker<sup>2</sup>)

**Labiatae (Lamiaceae)**

*Leucas inflata* Benth.<sup>1</sup>

*Salvia aegyptiaca* L.<sup>2</sup>

**Leguminosae**

*Acacia ehrenbergiana* Hayne<sup>1</sup>

*Acacia hamulosa* Benth.<sup>1</sup>

*Acacia oerfota* (Forssk.) Schweinf.<sup>1</sup>

*Acacia tortilis* (Forssk.) Hayne<sup>1</sup>

*Astragalus hauarensis* Boiss.<sup>1</sup>

*Astragalus spinosus* (Forssk.) Muschl.<sup>2</sup>

*Astragalus tribuloides* Delile<sup>5</sup>

*Astragalus vogelii* (Webb) Bornm.<sup>1</sup>

*Crotalaria aegyptiaca* Benth.<sup>2</sup>

*Crotalaria* sp. aff. *leptocarpa* Balf.f.<sup>1</sup>

*Indigofera spinosa* Forssk.<sup>1</sup>

*Rhynchosia pulverulenta* Stocks<sup>2</sup>

*Rhynchosia schimperi* Hochst. ex Boiss.<sup>2</sup>

*Senna holosericea* (Fresen.) Greuter<sup>1</sup>

*Senna italica* Mill.<sup>3</sup>

*Tephrosia uniflora* Pers.<sup>1</sup> (*Tephrosia* sp. recorded by SWC field study is likely to be *Tephrosia uniflora*)

**Menispermaceae**

*Cocculus pendulus* (J.R.Forst. & G.Forst.) Diels<sup>2</sup>

**Molluginaceae**

*Corbichonia decumbens* (Forssk.) Exell<sup>1</sup>

*Limeum arabicum* Friedrich<sup>1</sup>

**Moringaceae**

*Moringa peregrina* (Forssk.) Fiori<sup>2</sup>

**Neuradaceae**

*Neurada procumbens* L.<sup>1</sup>

**Nyctaginaceae**

*Boerhavia elegans* Choisy<sup>1</sup>

**Orobanchaceae**

*Cistanche phelypaea* (L.) Cout.<sup>2</sup>

**Polygalaceae**

*Polygala erioptera* DC.<sup>1</sup>

*Polygala irregularis* Boiss.<sup>2</sup>

**Polygonaceae**

*Calligonum crinitum* Boiss. subsp. *arabicum* (Soskov) Soskov<sup>1</sup>

**Resedaceae**

*Ochradenus baccatus* Delile<sup>1</sup>

*Reseda muricata* C.Presl<sup>3</sup>

**Rhamnaceae**

*Ziziphus spina-christi* (L.) Desf.<sup>1</sup>

**Rubiaceae**

*Kohautia caespitosa* Schnizl.<sup>2</sup>

**Rutaceae**

*Haplophyllum tuberculatum* (Forssk.) A.Juss.<sup>1</sup>

**Solanaceae**

*Lycium shawii* Roem. & Schult.<sup>3</sup>

**Zygophyllaceae**

*Fagonia indica* Burm.f.<sup>1</sup>

*Fagonia schweinfurthii* (Hadidi) M.Hall<sup>1\*</sup>

*Seetzenia lanata* (Willd.) Bullock<sup>2</sup>

*Tetraena simplex* (L.) Beier & Thulin<sup>5</sup>

*Tetraena* sp.<sup>2</sup> (Collenette & Tsagarakis (2001) record a *Zygophyllum hamiense*?)

*Tribulus macropterus* Boiss. var. *arabicus* (Hosni) F.Al-Hemaid & Jacob Thomas<sup>1</sup> (syn.

*Tribulus arabicus* Hosni)

*Tribulus pentandrus* Forssk.<sup>1</sup>

\* **Fagonia schweinfurthii** (Hadidi) M.Hall, **comb. nov.** – *Fagonia indica* Burm.f. var. *schweinfurthii* Hadidi, Fl. Iranica 98: 6 (1972). – Type: *Schweinfürth* 365 (holo K).