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Coastal Vegetation of Oman

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An analysis of the coastal vegetation of higher plants in the intertidal and spray zone shows four vegetation types. Species composition of each type is dependent on the topography, salinity and substrate of the coast and the level and frequency of inundation by the sea. Each vegetation type included some indicator species which had only limited use in the classification of the coastal vegetation into biogeographic zones; however, there was a boundary in the distribution of tropical and extra-tropical species. This indicated that climate and geomorphological factors had the major influence on the composition of species. The four vegetation types are as follows: (1) The *Limonium–Zygophyllum* community is characteristic of the coastal vegetation of northern Oman. The coasts are mainly sandy and interspersed with rocky limestone headlands. The dominant vegetation consists of *Limonium stocksii* and *Zygophyllum qatarense*. (2) The *Suaeda–Limonium* community characterizes the vegetation of the north-eastern coast. This type of vegetation is present in rocky shores with narrow beach areas and a wide spray zone. *Limonium* cf. *stocksii* and *Suaeda vermiculata* form the dominant species. (3) The *Atriplex–Suaeda* community is characteristic of the vegetation of the offshore islands, flat sandy beaches and sabkhas. The sand is usually fine, graded with mud and has a high content of marine carbonates. This complex consists of the dominant and associated species comprising, *Atriplex coriacea*, *A. farinosum*, *A. leucoclada*, *Suaeda vermiculata*, *S. monoica*, *S. moschata* and *Arthrocnemum macrostachyum*. (4) The *Limonium–Sporobolus–Urochondra* community is characteristic of the vegetation of the southern coasts. The dominant species, *Limonium axillare*, *Urochondra setulosa* and *Sporobolus* spp. are associated with several others depending on the geomorphology of the area. Coastal lagoons consists of *Sporobolus virginicus*, *S. iocladus* and *Paspalum vaginatum* as the main species. A single species of mangrove, *Avicennia marina*, occurs throughout coastal Oman in discontinuous patches and in a wide range of water salinities.

Keywords: biogeography; coastal vegetation; geomorphology; Oman; TWINSPAN classification

Introduction

Coastal regions and beaches are important to the Sultanate of Oman for several reasons. Socio-economically they are important for fisheries, as fish landing sites (Salm, 1992), local recreation and tourism (Salm, 1991). Of biological interest, they support the largest population of loggerhead turtles in the world and extensive coral reefs (Salm *et al.*, 1993). Some tidal mudflats and coastal lagoons form feeding grounds essential to the survival of thousands of wintering migratory birds (Uttley *et al.*, 1990).

Over the last two decades rapid socio-economic development has brought many inevitable changes. Several such changes have, unfortunately, proved detrimental to the natural coastal environment. Developmental projects, waste disposal, pollution, beach vehicular traffic, oil and tar spills, have all led to coastal erosion and damage to the flora and fauna.

Beach and coastal vegetation has had little attention in Oman. Studies relating to coastal vegetation are few and are usually a part of other projects (Barratt *et al.*, 1984; Kürschner, 1986; Ghazanfar, 1991; Ghazanfar & Rappenhöner, 1994). Relatively detailed studies exist for Dhofar (southern Oman), with emphasis on the vegetation of saline and brackish coastal lagoons (Ghazanfar, 1996).

In this paper, data on coastal species of higher plants of the intertidal and spray zones are analysed and presented. The main objective is to determine plant species complexes in relation to the geomorphology and substrate of the coasts of Oman.

The coastline of Oman

The coastline of Oman has a diversity of geomorphological and marine habitats along its 1800-km length. It comes under the influences of two major weather influences and three biogeographic zones. During the winter months, tidal range in the northern and southern regions can be over 1·5 m which may have a limiting effect on the establishment of flora and fauna. In central Oman, where the shoreline is low with flat, sandy beaches, tides can reach up to several hundred metres inshore (Sheppard, 1992; pers. obs.). There the vegetation experiences severe insolation, desiccation and high soil salinities.

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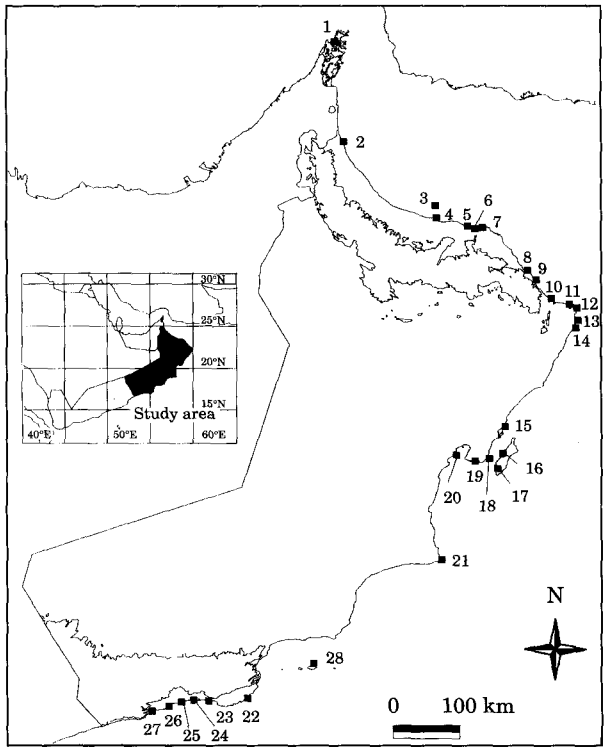

FIGURE 1. Sultanate of Oman: the northern and southern mountains are shown by the 500 m contour. Musandam: 1; Khawr Nejd; Batinah coast: 2, Shinas. Daymaniyat Islands: 3, Daymaniyat Islands. Batinah coast: 4, Al Swadi, 5, Seeb (a), 6, Seeb (b), 7, Qurm Nature Reserve. Eastern Hajar mountain coast: 8, Dibab, 9, Bimah, 10, Tiwi-Sur, 11, Sur; 12, Ras al Had. Ramlat Wahibah coast: 13, Al Ashkhara, 14, Ras Jifn, 15, Ras Nukdah. Islands: 16, Shagaf, 17, Masirah. Bar al Hikman peninsula: 18, Bar al Hikman (a), 19, Bar al Hikman (b). South eastern coast: 20, Khaluf, 21 Ras Madraka. Dhofar and Salalah coast: 22, Qinqari, 23, Taqah, 24, Rawri, 25, Baleed, 26, Khawr Salalah, 27, Mughsayl. Halaniyah Islands: 28, Al Halaniyah.

Geomorphology

Beginning at the northern end, the Musandam coast (see Figure 1 for place names) is characterized by precipitous slopes that continue below water to depths exceeding 40 m (Mandaville, 1985; Clarke, 1986). Fjord-like bays are present in the northern part. A few shores are accessible by land and these are primarily composed of rocks, pebbles and gravel. Vegetation is sparse and restricted to small sandy pockets.

The Batinah coast is predominantly sandy with some scattered lagoons and sea inlets. A mixture of sandy beaches, rocky limestone headlands and coastal cliffs continue southwards from Muscat area to Ras al Hadd and finally disappear where Ramlat Wahibah reaches the coast. The substrate in this region is coarse sand (Clarke, 1986) and vegetation is varied, influenced in some areas by overland water runoff from *wadis*. Irrigation, plantations, pollution, developmental projects, and the heavy use of beaches for recreation, have altered the natural composition of vegetation on the Batinah and other beach areas on the north-eastern coast.

The coast from Ramlat Wahibah to the Barr al Hikman peninsula is sandy, becoming fine and coralline and graded with mud in the region of Khawr Masirah and Ghubbat Hashish. The Barr al Hikman peninsula is low lying, with vast inland sabkhas. A belt of vegetation is present on the coast and there is a patchy distribution of vegetation inland (Ghazanfar, 1995). Two species of sea grasses, *Halophila ovalis* (R. Br.) Hk. f. and *Halodule uninervis* (Forssk.) Bge. occur in the channel between Barr al Hikman and Masirah island (Jupp *et al.*, 1996) and at Ghubbat Hashish. These constitute, along with algae, an important component of the diet of the green turtle (Ross, 1985) and a nursery habitat for penaeid prawns (Mohan & Siddeek, 1996).

South of the Peninsula, up to Ras Madrakah, the coast is characterized by low cliffs and small sandy bays, but beyond Ras Madrakah, the coast becomes flat and sandy (Clarke, 1986). The Kuria Muria Bay is bordered mainly by steep limestone cliffs which descend into the sea. Small sandy beach areas occur on the eastern side of the bay. Vegetation is limited to the beaches in this region.

South of the Kuria Maria Bay, the shore is rocky and, in part, composed of metamorphic rocks. The habitat there is topographically different and supports a different composition of plant (algae) and animal species (Barrat *et al.*, 1984). West of this area is the Salalah Plain, a flat, low lying area which is predominantly sandy. Several brackish and saline coastal lagoons (called *khawrs*) are present on the coast. *Khawrs* occur at the mouth of *wadis* which flow out of the southern escarpment mountains which lie 30 km to 50 km inland from the sea. The *khawrs* are unique coastal water bodies, separated from the sea by sandbars and fed by overground and underground fresh water from the land, and underground seawater from the sea. The salt level in *khawrs* varies from being brackish at the landward side to saline towards the seaward side. The salinity also varies with season, local rainfall and the amount and quality of groundwater seepage (Ghazanfar, 1996).

From the Salalah plain west up to the border of Yemen, the coast is rocky with steep slopes descending into the sea. The sandy coast is vegetated but, except in narrow sandy pockets, higher plants are virtually absent on the rocky shores.

Climatic influences

Mean annual temperatures recorded in coastal towns range from 26 °C in Salalah (in the south) to 28 °C in Khasab, Musandam (in the north). Highest temperatures are recorded during June and July and lowest during December and January. Mean annual rainfall ranges between 124 mm in Salalah to 182 mm in Khasab. Two major weather systems influence Oman. The north-east winds (also referred to as the north-east monsoon) bring rain to northern Oman in winter, and the south-west monsoon influences southern Oman during June to September (Fisher, 1994). South-westerly, moisture-laden winds produce dense fogs over the seaward facing slopes of the southern escarpment mountains leading to condensation which adds significantly to total precipitation (Stanley-Price *et al.*, 1988). In addition, strong winds blow parallel to the coast, causing upwelling which brings up nutrient rich waters. This upwelling zone, ranked as one of the five most intense in the world (Currie, 1992), increases primary productivity and allows the growth of macroalgae (Barrat *et al.*, 1986; Sheppard *et al.*, 1992). From time to time, during exceptionally high tides, cyclonic rainfall events can break over sand bars and affect the topography of coasts and coastal vegetation (Macumber *et al.*, 1994).

Biogeography

The flora of Oman is classified under three phytochoria. Floristically, the southern region of Oman is predominantly an extension of the NE African flora, the Somali–Masai region of endemism, central Oman an extension of Arabian subzone of the Saharo-Sindian region and northern Oman an extension of the Iranian and Baluchistanian flora, the Nubo-Sindian region of endemism (White & Leonard, 1991; Ghazanfar, 1992*a*). In Oman, indicator species belonging to each phytochoria are represented in the coastal flora as well (discussed below).

Materials and methods

Coastal plants, in this study, are considered as those higher plants (other than the mangroves), which are directly influenced by the sea. These include plants present in the intertidal and supratidal region and xerophytic and halophytic plants present within the splash zone. Those plants which are rooted in the substrate near the shore, which is saline and contains a very high content of marine sediments, are also included. These criteria are similar to those used by Sheppard *et al.* (1992) for their description and ecology of intertidal areas.

Coastal and beach plant species were listed for 28 sites along the coast of Oman (Figure 1). These sites represent the main geomorphological features of the coastline. They also represent areas from the three biogeographic regions and the two main climatic regimes. In all 40 species were recorded (Appendix I). Data on species were collated from plant collections based on visits during 1989 to 1997 [voucher specimens are present at the herbarium, Natural History Museum, Ministry of National Heritage and Culture, Oman (ON) and herbarium at the Department of Biology, Sultan Qaboos University (SQUH)]. Site descriptions were recorded for each site. Results of soil analysis (mainly salinity levels) for some sites from published and unpublished records were used. The classification of plant communities is produced using TWINSPAN (Hill, 1979).

Results

Four groups are delimited by TWINSPAN (Appendix I) showing the respective dominant and associated plant species. The southern sites, from Ras Madrakah to Mughsayl (sites 21 to 27) are grouped together, sites on the coast of the eastern Hajar mountains (sites 8 to 11) are grouped together and the northern Oman sites on the Batinah and Ras al Had region (2 to 7 and 12 to 15) together. Except for the Daymaniyat islands where the vegetation is classified with that of the Batinah region, other islands (Masirah, Shaghaf and Al Halaniyah) and the Barr al Hikman peninsula are grouped together.

Within each vegetation group, variation is present in the species' associates. This is attributed to local relief, substrate and the frequency of inundation by the sea.

Plant communities

Limonium–Zygophyllum *community.* The coastal ecosystem in northern Oman, is characterized by two dwarf shrubs, *Limonium stocksii* and *Zygophyllum qatarense* (authorities for all species are given in Appendix I). The substrate there is sandy and small dunes are present just behind the high-tide mark. Intermittently, where *wadis* drain into the sea, pure stands of the mangrove, *Avicennia marina* occur. The seaward dunes are colonized by *Halopyrum mucronatum*, *Suaeda vermiculata*, *Sphaerocoma aucheri* and *Cornulaca monacantha*. *Cyperus conglomeratus* and *Sporobolus* spp. are present on low dunes and sandy depressions. *Cistanche tubulosa* is common, parasitic on *Zygophyllum* shrubs. Where the substrate is rocky, shrubs of *Tamarix* and *Salvadora persica* are associated with the dominant species.

Suaeda–Limonium *community*. This community is characterized by *Suaeda vermiculata*, *S. aegyptiaca* and *Limonium* cf. *stocksii* (not yet taxonomically identified, but possibly *L. pruinosum*), present throughout the north-east coastal belt adjacent to the eastern range of the northern mountains. The shores are generally rocky with sandy enclaves. The spray zone is wide and is dominated by large shrubs of *Limonium* cf. *stocksii* and *Suaeda vermiculata*. On the sandy beaches, dunes are colonized by *Halopyrum mucronatum*, *Aeluropus lagopoides* and *Sporobolus* spp. In the sandy patches, *Heliotropium fartakense* is associated with *Limonium* and *Suaeda*.

Atriplex–Suaeda *community*. The vegetation of the coastal areas of the islands (with the exception of the Daymaniyat Islands) and that of the Barr al Hikman peninsula is characterized by the *Atriplex–Suaeda* community. The substrate is sandy with a high content of marine substrates. Tidal lagoons are present on the coast where the vegetation is regularly inundated by sea. Several areas are low lying, and at high tide several hundred metres are covered by seawater. Zonation of species is apparent within this vegetation community. The first zone is made up of *Atriplex* spp., followed closely by *Arthrocnemum macrostachyum* and *Suaeda* spp. Besides *Suaeda vermiculata*, *S. aegyptiaca*, *S. moschata* and *S. monioca* are represented in this zone. *Arthrocnemum macrostachyum* is present on the banks of tidal lagoons. At the high-tide mark and well within the spray zone, *Cyperus conglomeratus*, *S. vermiculata*, *Limonium stocksii* and *Zygophyllum qatarense* dominate. The grasses, *Urochondra setulosa* and *Sporobolus virginicus* are present in sandy depressions, but not directly in the intertidal or spray zones. Salt pans or sabkhas are fringed with *Halopeplis perfoliata*. On the low coastal dunes, *Halopyrum mucronatum* is established.

Limonium–Urochondra–Sporobolus *community*. The vegetation of the southern coasts is fairly variable and depends on the topographical features of the shore. The vegetation of the coastal *khawrs*, differs from the rest of the coast due to the relatively low salinity of these water bodies. In addition, vegetation of rocky shores is different from that of sandy beaches.

The dominant vegetation is characterized by the shrubs *Limonium axillare*, *Cressa cretica* and the grasses *Sporobolus* spp. and *Urochondra setulosa*. Along the coastal dunes, *Halopyrum mucronatum*, *Sporobolus* spp. (*S. spicatus* and *S. iocladus*), *Cyperus conglomeratus*, and the trailing *Ipomoea pes-caprae* are present. *Atriplex farinosum* is present on the sandy beaches, but it is not common. On rocky shores, *Pluchea arabica*, *Salvadora persica* and *Tamarix* spp. are present. Vegetation of the *khawrs* consists of *Sporobolus virginicus* forming the dominant zone at the edge, followed by *Paspalum vaginatum* next to the water. Variation in water salinity is reflected by the presence of reed beds at the edges of *khawrs*. *Phragmites australis*, *Typha domingensis* and *Schoenoplectus litoralis* are present where salinity ranges from 3·5 to 13. *Avicennia marina* is also present at some *khawrs*, but where the salinity level is higher (>20).

Discussion

The four plant communities classified clearly reflect the coastal zone flora of Oman. Plant communities present in northern Oman differ from their southern counterparts both in the dominant and associated species. The species composition in each community reflects the response to topographical features, climate and to a lesser extent biogeographical influences of the region.

Dominant species of the four vegetation communities, such as those of *Atriplex*, *Halopyrum*, *Limonium*, *Sporobolus*, *Suaeda* and *Zygophyllum* are common coastal species in the Arabian Peninsula and the coasts of the arid regions of SW Asia (Halwagy & Halwagy, 1977; Babikir & Kürschner, 1992; Dagar, 1995; Gul & Khan, 1995; Deil & Müller-Hohenstein, 1996; Deil, 1998). *Zygophyllum qatarense* has a wide distributional and ecological range (Batanouny, 1981; Abbas & El-Oqlah, 1992). It occurs both in saline and non-saline soils (Abbas, 1995; Böer, 1996) and has a high degree of tolerance to drought and high temperatures (Sayed, 1996). In Oman, it is one of the most common and abundant xeric species which occupies a wide range of habitats from coasts to gravel deserts and is associated with several plant associations (Ghazanfar, 1991). The fact that it is unpalatable to goats and camels also plays an important role in the abundance of this species (Ghazanfar & Rappenhöner, 1994).

The coastal vegetation of the Barr al Hikman peninsula and the offshore islands of Masirah, Shagaf and Al Halaniyah show similarities in their vegetation in the dominance of *Suaeda* and *Atriplex* spp., in particular that of *S. monoica* and the endemic *S. moschata*. Additionally, the two common species of seagrasses *Halodule uninervis* and *Halophila ovalis* are present at Barr al Hikman, Shagaf and Masirah (Ghazanfar & Rappenhöner, 1994; Jupp *et al.*, 1996). The endemic species, *Salsola omanensis* occurs only on Al Halaniyah (Boulos, 1991). Species richness is poor on the Daymaniyat Islands and those which occur there are similar to those distributed on the coasts of

northern Oman. The reason for the paucity of species is primarily the geomorphology of the islands which consists of steep rocky cliffs with little or no soil cover. Plants are present only in small, sheltered sandy bays. Species such as *Atriplex*, *Limonium* and *Arthrocnemum* are absent and *Suaeda monoica* is present on only one of the smaller islands which has a cover of sandy soil on it. *Sporobolus virginicus* and *Cyperus conglomeratus* are the dominant species in soft sand at the high tide mark and *Suaeda aegyptiaca* is present in sandy crevices and sandy pockets on the rocks.

Mangroves, consisting of a single species, *Avicennia marina*, are present in patches throughout the coast of Oman. They occur in bays and creeks, some offshore islands and at several *khawrs*. Densest stands are found in the Masirah Bay, Bar al Hikman peninsula (Salm & Jensen, 1989). *Avicennia marina* is a dominant mangrove species throughout the Arabian Peninsula. It is tolerant of harsh environmental conditions, in particular low temperatures and high salinities (Sheppard *et al.*, 1992; Böer, 1996). The distribution of mangroves in the Arabian Peninsula suggests that cold winter temperatures rather than salinity limit their northernmost extent (Sheppard *et al.*, 1992).

Regional biogeography and the boundary between the tropical and extra-tropical vegetation is reflected in the distribution of coastal species, albeit a few. Freitag (1991) established that the transition from extra-tropical to tropical regions in Arabia is also reflected in the distribution of some characteristic coastal species. For example, *Sphaerocoma aucheri* and *Cornulaca monacantha* (and *Gymnocarpos decander*, *Anabasis setifera*, halophytic species often associated with coastal vegetation) are extra-tropical species which are not distributed south of the Tropic of Cancer (Kurschner, 1986; Freitag, 1991). In Oman, these species occur on the coasts of northern Oman and are absent from the southern coasts. *S. aucheri* and *C. monacantha* belong to the Nubo-Sindian phytochorion (Ghazanfar, 1992*a*) and are distributed from Baluchistan (SW Pakistan) to northern Oman, U.A.E. and Bahrain.

Since a large part of the southern coastline is rocky, examples of tropical coastal species distributed on the southern coast of Oman are few. These include *Ipomoea pes-caprae*, *Paspalum vaginatum*, *Limonium axillare*, *Cissus quadrangularis*, *Cadaba farinosa* (the last two sometimes associated with coastal species) and the SW Arabian endemic *Heliotropium fartakense*. These species belong to the Somali–Masai phytochorion and their distribution does not extend to northern Oman. *Limonium axillare* is replaced by *L. pruinosum* and *L. stocksii* in northern Oman.

Halocnemum strobilaceum, a dominant species in the littoral belt in Kuwait where it reaches cover of up to 65% (Halwagy & Halwagy, 1977) and also found commonly on the coasts of the United Arab Emirates (Western, 1989), is absent in Oman. Beach slope (Halwagy & Halwagy, 1977) and a high gypsum salt concentration (Böer 1996) have been suggested as important factors for the establishment of this species. *Halocnemum strobilaceum* is an example of an extra-tropical pluri-regional species which is distributed in the Mediterranean, Saharo-Sindian, and Irano-Turanian phytochoria (Freitag, 1991). It shows a distinct southern boundary and does not occur in southern Arabia. This, together with the fact that in northern Oman, the beaches are narrow and or rocky and lack gentle slopes could possibly explain the absence of *H. strobilaceum* in Oman.

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Appendix I. TWINSPAN classification of 40 coastal species and 28 sites (see also Figure 1). 1: Musandam, Khawr Nejd; 2: Shinas; 3: Daymaniyat Islands; 4: Al Swadi; 5: Seeb(a); 6: Seeb(b); 7: Qurm Nature Reserve; 8: Dibab; 9: Bimah; 10: Tiwi-Sur; 11: Sur; 12: Ras al Had; 13: Al Ashkharah; 14: Ras Jifn; 15: Ras Nukdah; 16: Shagaf; 17: Masirah; 18: Bar al Hikman(a); 19: Bar al Hikman(b); 20: Khaluf; 21: Ras Madrakah; 22: Qinqari; 23: Taqah; 24: Rawri; 25: Baleed; 26: Khawr Salalah; 27: Mughsayl; 28: Al Halaniyah. (Authorites follow Ghazanfar, 1992*b*)

	23	24	21	22	27	20	25	26	1	11	8	9	10	4	5	6	2	7	12	13	14	3	15	16	17	18	19	28
Limonium axillare (Forssk.) Kuntze	1	1	1	1	—	1	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
Ipomoea pescaprae (L.) Br.	1	1	1	1	—	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Phragmites australis (Cav.) Trin.	1	1	—	1	—	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Typha domingensis Pers.	1	1	—	1	—	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Salvadora persica L.	—	—	1	1	1	1	1	1	1	—	1	1	1	—	—	—	—	—	1	—	—	—	—	—	1	—	—	—
Pluchia arabica (Boiss.) Qaiser&Lack	1	1	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Urochondra setuloa (Trin.) C. E. Hubb.	1	1	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	1	—	
Heliotropium fartakense O. Schwartz	1	1	1	1	1	1	1	1	—	1	1	1	1	—	—	—	—	—	—	1	—	—	—	—	—	—	—	1
Zygophyllum qatarense Hadidi	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	—	1	1	1	1	1	1
Suaeda vermiculata Forssk.ex Gmel.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	—	1	1	1	1	1
Suaeda aegyptiaca (Hasselq.) Zoh.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	—	1	1	1	1	1
Cyperus conglomeratus Rottlb.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Indigofera intricata Boiss.	—	1	—	—	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	—	—	1	1	—	—	—
Aizoon canariensis L.	1	—	1	1	1	—	1	1	1	1	—	—	—	1	1	—	1	1	1	1	1	1	—	—	—	—	—	1
Aeluropus lagopoides (L.) Trin.ex Thw.	1	1	1	1	1	—	1	1	1	—	1	—	—	1	1	1	1	1	—	1	1	—	—	1	—	—	—	—
Sporobolus iocladus Nees	1	1	1	1	1	—	1	1	1	—	1	—	—	1	1	1	1	1	—	1	1	—	—	1	—	—	—	—
Sporobolus virginicus (L. Kunth)	1	1	—	1	1	—	1	1	1	1	—	—	—	1	1	1	1	1	—	1	1	1	—	1	1	1	1	—
Arthrocnemum macrostachyum K. Koch.	—	—	—	—	—	1	1	1	—	—	—	—	—	—	1	1	—	—	1	—	—	—	—	1	1	1	1	—
Limonium stocksii Boiss.	—	—	—	—	—	1	—	—	—	1	1	1	1	1	1	1	1	1	1	1	1	—	1	1	1	1	1	—
Heliotropium kotschyi (Ledeb.) Guerke	—	1	—	—	—	—	—	—	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	—
Halopyrum mucronatum (L.) Stapf	1	1	—	—	—	—	1	—	—	—	1	—	1	1	1	1	1	1	1	1	1	1	1	—	—	1	—	—
Crotolaria persica (Brum.f.) Merrill	—	—	—	—	—	—	—	—	1	1	1	1	1	1	1	1	1	1	1	1	1	—	—	—	—	—	—	—
Cornulaca monacantha Del.	—	—	—	—	—	—	—	—	—	—	1	1	—	1	1	1	1	1	—	—	1	—	—	—	—	—	—	—
Tamarix mascatensis Bge.	—	—	1	—	—	—	—	1	—	—	—	—	—	1	1	1	1	1	1	1	1	—	—	—	1	—	—	1
Panicum turgidum Forssk.	—	—	—	—	—	—	1	1	—	—	—	—	—	1	1	1	—	1	1	1	1	—	—	—	1	1	—	—
Cistanche tububulosa (Schrenk) Hk.f.	—	—	—	—	—	—	—	—	—	—	1	1	—	1	1	1	1	1	1	1	1	—	—	1	1	1	1	1
Taverniera spartea (Burm.f.) DC.	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	1	—	—	1	—	—	—	—	—	1	—	—	—
Sphaerocoma aucheri Boiss.	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	1	—	1	—	—	—	—	—	—	1	—	—	—
Euphorbia reibeckii Pax	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—	—	—
Halopeplis perfoliata (Forssk.) Bge.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	1	—	1	1	1	1	1	—
Avicennia marina (Forssk.) Vierh.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—	1	1	—	—	—
Halophila ovalis (R,Br.) Hk.f.	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	1	1	1	1	—
Halodule uninervis (Forssk.) Aschers.	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	1	1	1	1	—
Suaeda moschata A. J. Scott	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	1	1	1
Atriplex leucoclada Boiss.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	1	1	1
Atriplex farinosum Forssk.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	1	1	1
Suaeda monoica Forssk. ex J. F. Gmel.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	1	1	—	—	1
Salsola schweinfurthii Solms.-Laub.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
Salsola omanensis Boulos	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
Blepharis linariifolia Pers.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	0	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1
	0	0	0	0	0	1	1	1	0	0	1	1	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1