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Biology of the Central Desert of Oman

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Abstract: A biological survey of the central desert of Oman was done using long distance transects. Vegetation was sparse and consisted of 200+ plant species, 22 species of mammals, 17 species of reptiles and amphibians, and more than 50 species of birds (migratory and resident). Three main vegetation types were identified based on ground substrate and the dominance of species. These were communities with *Acacia* Willd., *Zygophyllum* L., and open woodlands of *Prosopis cineraria* (L.) Druce. Over-grazing and development in the central desert has led to concerns over the conservation of the desert ecosystem in Oman.

Key Words: ARABIA OMAN, plant communities, life-forms, conservation

Introduction

i. Boundaries of the central desert

The central desert of Oman lies approximately between 18º and 22º30' N and 52º and 59º E and occupies about half of the country's land surface area (Fig. 1). It stretches in the north from the southern end of the foothills of the Hajar Mountains and reaches in the south to the edge of the north-facing slopes of the Dhofar Mountains. In the west the central desert peters into the sand sea of Rub' al-Khali, and in the east to Ramlat Wahibah and the eastern escarpments (Huqf and the hills above the Sahil al-Jazir). Generally, the central desert forms a vast featureless plain, with low gravel outcrops and gravel plains covered with aeolian sand. Broad alluvial fans, shallow wadis and drainage channels that drain the northern and southern mountains reach the northern and southern parts of the plains, with only a few reaching the central parts. In the north-east and west low stabilised and unstabilised sand dunes border the central desert. The north-western dunes seem to have been built largely by winds associated with the northern Shamal, which blows across the Arabian Gulf from the NNW and veers SW towards the mountains of Yemen (Glennie & Singhvi, 2002; Juyal & Singhvi, 1998). The sands are quite distinctive because of the presence of a coating of red iron oxide on a high proportion of the sand grains, a character far less pronounced elsewhere in the sands of Oman, such as in the eastern desert. The alluvial fan and the aeolionite in the north-west part of Oman close to the Emirates border is dated back to 104 ka, which suggests fluvial activity associated with the last interglacial climatic optimum (Glennie & Singhvi, 2002; Juyal & Singhvi, 1998).

Geologically, the underlying rock of the central desert is almost horizontal, mid-Tertiary limestone from the Oligocene and Miocene and represents sea-bed levels at the time of deposition (Hughes-Clarke, 1990). The present flatness of the limestone (rock units classified as Fars and Hadhramaut) shows that there has been little movement of earth since their deposition some 30 million years ago. In the north-western region of the central desert lies a large sabkha, the Umm as-Samim.

Several wadis drain the Hajar mountains and the southern escarpments and flow into the central plains. For most years the flow is subsurface, but when rains are exceptionally heavy or when there is a tropical storm, surface flow is present in some of these wadis. Nevertheless, vegetation in these wadis is richer than in the surrounding areas. Two main wadis flow south from the Hajar mountains and reach the central plains: Wadi Umayri, which flows west into the Umm as Samim, and Wadi Halfayn (combining with other wadis) flows southeast and reaches north of the Bar al-Hikman peninsula. In the southern part of the central plains the Mukhayzanah, Rawnab, Ghadun, Qitabit and Ribkut wadis drain the southern escarpments and flow into the central plains. Most of the area of the central desert of Oman lies between 100 and 250 m a.s.l., sloping gently

from the eastern escarpments westwards towards the sands of the Rub' al-Khali.

For most of the central desert long-term meteorological data are not available. Meteorological data from stations present at Fahud, Ja'alooni, Marmul Air Strip and Thamrait would be comparable and could be used to describe climatic conditions in the central desert (Table 1, Fig. 1).

Climatic data show the hyper-aridity of the central desert with mean annual rainfall not exceeding 48 mm and mean annual temperature of above 26 ºC. The absolute maximum temperatures reach above 50 ºC and the absolute minimum temperatures fall below 6 ºC, a feature typical to deserts. An analysis of the 12-month auto-correlation coefficient of total monthly rainfall and mean monthly temperature and coefficient of variations of mean annual rainfall and mean annual temperature shows that there is very little inter-annual variation of temperature and that total annual rainfall is exceptionally variable between years with little indication of seasonality (Fisher & Membery, 1998). Rain has been known to fall in nearly all months of the year, though the mean monthly total for 11 years of data are highest during February and April for all stations. May to December are the dry months in Marmul, Fahud and Ja'alooni and July to November in Thamrait.

Fog occurs in the eastern part of the central desert. Data on the annual mean number of fog days are not available at any of the meteorological stations mentioned in Table 1; however, fog measurements have been made for Ja'alooni on a regular basis for 1992-1993. Data for the Ja'alooni station show that fog occurred on an average of 54 days a year during every months of the year except July. Precipitation from fog measured from deposition on a multidirectional 1 m^2 mesh collector shows a maximum of 4000 cm^3 during March and a minimum of *c.* 2500 cm^3 during January, May, June and December (Fisher & Membery, 1998; Stanley-Price et al., 1988). This is a considerable amount of moisture that condenses on tree foliage and drips to the ground and is potentially available to the flora and fauna in an otherwise extremely arid region.

The main developments in the central desert of Oman are the oil drilling stations of Petroleum Development of Oman (PDO), which are located at different locations in the desert. Several human settlements and their livestock, mainly camels and goats, are also present in the central desert. Some are nomadic, such as the Harasis tribe on the Jiddat al-Harasis, while others have made permanent homes with help from the government and PDO.

As a unit, I classify the central desert of Oman as an hyper-arid area which has no natural water seepage, springs, or permanent or seasonal water bodies, and which receives only sporadic rainfall from one year to the other, often with several years between rainfall.

Method

The vegetation of the central desert was surveyed along transects made in all directions (but following track roads) from the main offices of PDO oil stations. All species were recorded and identified along the transects. As the vegetation was very sparse in most areas, species were recorded every 500 m. All species were recorded when transects crossed shallow wadis, and all woodlands were visited and species recorded, and the state of the woodland assessed. Voucher specimens were collected of species that could not be readily identified in the field. These were later identified at the National Herbarium of the Ministry of National Heritage and Culture, Oman, and at the Herbarium, Royal Botanic Gardens, Kew. The

Table 1. Climate data of the central desert of Oman based on 10-year data from 1985-1995. (From Fisher & Membery,1998).

Meterological Station	Mean rain (mm)	Mean annual temperature (ºC)	Absolute maximum temperature (ºC)	Absolute maximum temperature (ºC)	Mean monthly maximum range (ºC)
Fahud	24	28.8	50.7	5.6	19.4
Ja'alooni	39	26.6	49.0	6.5	19.3
Marmul Air Strip	41	27.7	49.0	5.4	17.3
Thamrait	48	27.1	46.0	1.6	16.8

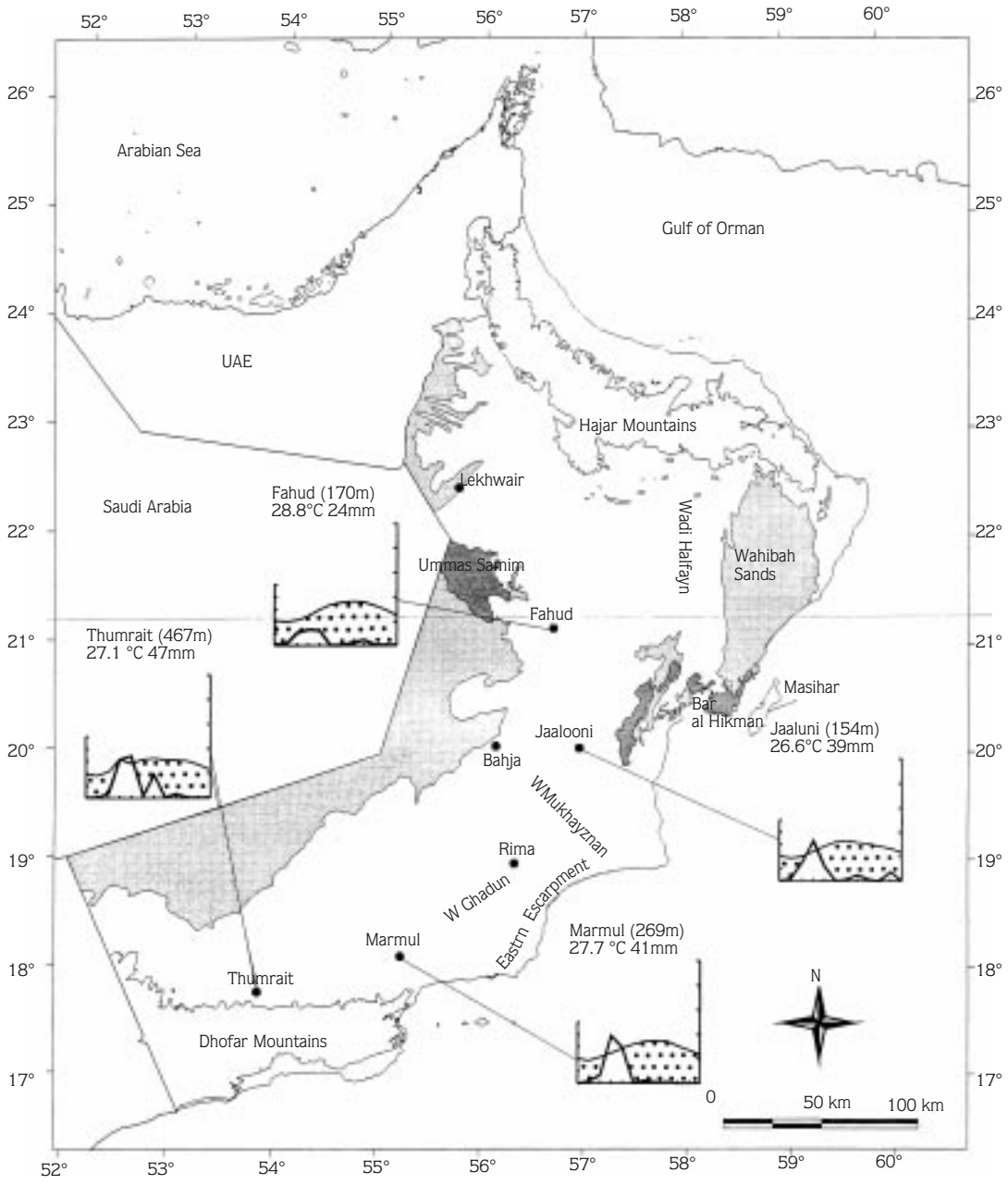

Figure 1. Map of Oman.

locations from where transects were made are given in Figure 1.

All animal and bird life seen was also recorded. Birds lists and their breeding status for the area were obtained from the Oman Birds Records Committee (1998) and from the Breeding Birds Atlas of Oman (1998). A list of mammals was made using published and unpublished sources (Harrison & Bates, 1991), and their endemism and Red List status was ascertained from Fisher (1999). Several species of reptiles were recorded and identified using Gardner (1999) and Leviton et al. (1992). For those interested in the fauna of the central Oman desert, I can supply, on request, lists of the mammals, reptiles and birds recorded there.

Results and Discussion

i. *Flora: vegetation classification and life-forms*

The central desert is sparsely vegetated with a low diversity of species. It is estimated that there are less than 25% of the total species present (Ghazanfar, 1991, 1992b). The main vegetation consists of scattered trees of *Acacia tortilis* (Forssk.) Hayne, large and small shrubs, and perennial grasses. The western edge of the desert adjoining the Rub' al-Khali sands is vegetated with dominantly psammophilic vegetation. This consists of stands of *Prosopis cineraria* and *Calligonum crinitum* Boiss. in areas where the dunes are stabilised and smaller shrubs such as *Zygophyllum qatarense* Hadidi, *Z. hamiense* Schweinf. and *Heliotropium kotschyi* (Ledeb.) Guerke at the base of dunes.

The vegetation of the central desert can be broadly classified as part of the *Acacia-Zygophyllum-Heliotropium* Vegetation Type, which is typical of the central plains of Oman, and *Prosopis-Calligonum* Vegetation Type, which is typical of the dune deserts in Oman (Ghazanfar, 1991, 1992, 1998a&b, 1999a). The influence of fog in the eastern parts of the desert area has increased the species richness, especially that of the drainage channels and shallow depressions. The open *Acacia* scrub, with *A. tortilis*, *A. ehrenbergiana* Hayne, *Ziziphus leucodermis* (Baker) O.Schwartz and *Prosopis cineraria* as the dominant woody components, and *Pulicaria glutinosa* (Boiss.) Jaub. & Spach *Rhazya stricta* Decne. and *Zygophyllum qatarense* as the main low shrubs form the major part of the vegetation. A ground cover of several species of grasses, of which *Stipagrostis sokotrana* (Vierh.) de Winter, a major food source for the reintroduced Arabian oryx (Stanley-Price 1989), is dominant on low gravel.

The vegetation of the western part of the desert is poorer with ± 100 species, most of which is restricted to wadi fans and runnels. *Acacia tortilis* is the only tree and *Cornulaca monacantha* Moq., *Heliotropium kotschyi*, *Zygophyllum qatarense* and *Z. hamiense* the main subshrubs.

Camels and goats browse on the *Acacia* and *Prosopis* trees, which show browse damage. *Acacia tortilis* frequently show a 2-tier growth and all trees of *Prosopis cineraria* show browse lines. Grazing has altered the natural low vegetation so that a dominance of unpalatable shrubs and subshrubs is evident in the vegetation of the entire central desert.

Ninety percent of the species of the central desert are hemicryptophytes and chamaephytes and the remaining phreatophytes and therophytes (Fig. 2, classification of life-forms after Raunkiaer, 1937). After rain, the seedlings of several annuals and perennials (mainly *Dipterygium glaucum* Decne. and *Heliotropium kotschyi* germinate, but only a few survive to the young seedling stage. *Zygophyllum simplex* L. is the most common annual seen after rain, especially in sandy depressions.

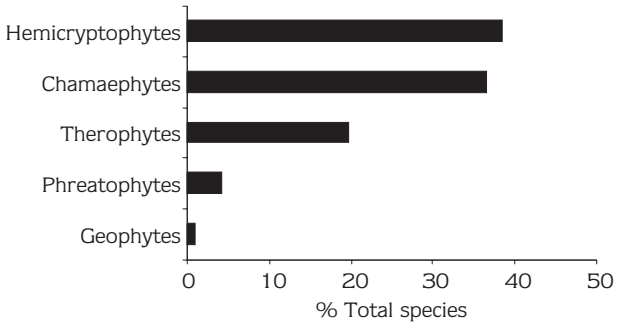

Figure 2. Life-forms in the central desert of Oman.

Vegetation Types

Further classification of the vegetation of the central plains shows 3 main vegetation types based on substrate and the dominance of species:

(1) *Acacia* communities

Acacia communities are the most widespread and dominant vegetation type of the central plains. (The Acacia-Zygophyllum-Heliotropium type, pro parte, Ghazanfar, 1992; Acacia Desert Parkland, pro parte Mandaville, 1975; Kürschner, 1999). *Acacia tortilis* is the dominant tree more or less throughout the central plains, distributed along the run-off channels and depressions. In the eastern desert (Jiddat al-Harasis) *Ziziphus leucodermis* and *Acacia ehrenbergiana* are the main associates, and in the larger wadis, *Ziziphus spina-christi* (L.) Desf. and *Prosopis cineraria* are often present with *Acacia tortilis*. In the western desert the distribution of *Acacia tortilis* is sparser as the flow channels do not reach there. Subshrubs include *Rhazya stricta* Decne., species of *Cleome* L., *Convolvulus oppositifolia* Al-Alawi, *Iphiona scabra* DC., species of *Ochradenus* Delile, *Launaea* Cass. *Tephrosia apollinia* (Del.) Link, the grasses *Panicum tugidum* Forssk., *Lasiurus scindicus* Henrad, *Ochthocloa compressa* (Forssk.) Hilu, species of *Stipagrostis* Nees,

and the sedge *Cyperus conglomeratus* Rottb. *Aristida adscensionis* L. is a common annual grass, and *Citrullus colocynthis* (L.) Schrad. and *Zygophyllum simplex* common annuals.

(2) *Zygophyllum* communities

(The Acacia-Zygophyllum-Heliotropium type, pro parte, Ghazanfar, 1992). This vegetation type typically lacks trees and is found mainly in the western part of the central desert. The plant density is sparse and species richness consists of a few species, with unpalatable species the most common. The dominant species are *Zygophyllum* spp. (*Z. hamiense* and *Z. qatarense*), associated with *Cornulaca aucheri* in gravelly and stony areas and areas with rocky outcrops, and with *Haloxylon salicornicum* (Moq.) Bunge ex Boiss. in sandy depressions. Other species include *Crotolaria persica* (Burm.f.) Merrill, *Dipterygium glaucum*, *Fagonia ovalifolia* Hadidi, *Heliotropium kotschyi*, *Pulicaria glutinosa*, *Rhazya stricta* and *Salsola rubescens* Franch. In sandy depressions where some moisture from dew may be available, other species such as *Tephrosia apollinia* may also occur.

(3) *Prosopis* woodlands

Open, relict woodlands of *Prosopis cineraria* are present in large sandy wadi channels at several locations in the central desert. Small woodlands are present at the outflows of Wadi Mukhayzanah and Wadi Muqshin. A small stand of very degraded trees is present at a small location at Wadi Tharawt. In most places *Prosopis* forms almost mono-specific stands, with *Acacia tortilis* as the co-dominant species at the edges of the woodlands. Subshrubs such as *Iphiona scabra* DC., *Pluchea arabica* (Boiss.) Qaiser & Lack, *Vernonia cinerea* (L.) Lees., *Indigofera oblongifolia* Forssk. and *Psoralea plicata* Del. plus a few other species are also present on the edges of these woodlands. Where there is evidence of subsurface water, such as in Wadi Muqshin, other species such as *Indigofera oblongifolia, Heliotropium kotschyi, Rhazya stricta*, *Dipterygium glaucum* and *Zygophyllum qatarense* are also present. *Calligonum crinitum* is present in areas with low to medium stabilised sand dunes, mainly on the western edges of the central plains. In past times, the *Prosopis* woodlands apparently covered larger areas in the central desert, but recent climatic changes (increased aridity over 3500 years BP, Sanlaville, 1992), have greatly reduced the water to sustain these woodlands. In addition, development and excessive use of subsurface water in the wadis has also led to the depletion of available water, thus furthering the degradation of these woodlands.

Plant species richness and endemism

Species richness of the central desert is poor with about 200 species (about 20% of the total plant species in Oman). The majority of the species are present in the eastern parts of the desert sustained by the regular fogs which supplement moisture for plant growth. In addition to flowering plants, several species of corticolous lichens (as well as a few species of saxicolous lichens and epilithic cyanobacteria) are also found in the central desert, again in the fog affected eastern parts (Ghazanfar, 1999b; Ghazanfar & Gallagher, 1998); on the Jiddat al-Harasis, corticolous lichens (*Ramalina*) form a part of the diet of the Arabian gazelle, *Gazella gazella* (Hawksworth et al. 1984).

Even though the species richness is poor in the central desert, the eastern desert forms a part of a local centre of endemism with 12 endemic species (Table 2).

Conservation and Concerns

A large part of the central desert of Oman is an oil asset area where oil drilling and pumping stations are located. The eastern part of the desert is designated as a World Heritage Site where the Arabian Oryx Sanctuary is located and is the largest protected area in the Arabian Peninsula. The Arabian Oryx Sanctuary is an important site for wildlife and biodiversity in general, including the Arabian oryx, houbara bustard, 2 species of gazelle, ibex and other threatened wildlife species. The area is also a local centre of plant endemism, and has important ecological, geological and wilderness areas. However, there are some concerns for the conservation of the fragile desert ecosystems such as this where man and his machines, and plants and animals coexist. As several areas of relatively high vegetation cover (such as wadis) within otherwise sparsely vegetated areas provide wildlife habitats, man-made activities can cause irreversible damage to such habitats. One such activity has been the removal of large quantities of topsoil (wadi soil and gravel) for the supply of soil for horticultural purposes. This has not only led to soil erosion through the removal of vegetation cover, but has also removed the seed reserves of the vegetation, thus making it difficult for natural re-vegetation to take place, and making such areas ideal places where weeds and exotic aliens can

Table 2. Plants species in the central desert which qualify under the IUCN Red List Categories, and the Endemic and Regionally Endemic Categories.

Taxon	Endemism	IUCN Red List Category	Regional (Oman) Red List Category	Comments
Convolvulus oppositifolia	Endemic	VU+D2	VU+D2	Endemic to Jiddat al-Harasis in central Oman; Vulnerable, with a small restricted population and prone to effects of human activities
Dipcadi biflora	Regionally endemic	LC	LC	Endemic to the central desert, Masirah and UAE; a small geophyte coming up after rain, restricted in distribution, at present placed in the Least Concern category, but may qualify to Near Threatened if development (road building and earth removal activities) are carried out in the areas where it grows.
Farsetia dhofarica	Regionally endemic	-	-	Endemic to Dhofar and eastern part of S Yemen. Low subshrub distributed in the central desert
Kickxia sp. nov.	endemic	-	-	Endemic to eastern part of central Oman
Ochradenus gifrii	Regionally Endemic	-	-	Regionally endemic to S Oman and E Yemen
Ochradenus harsusiticus	Endemic	-	-	Endemic to eastern part of the central desert
Pulicaria pulvinata	Endemic	NT	NT	Endemic to the central gravel desert. A low woody herb distributed in sandy wadis. Not common. Placed in the Near Threatened category, not threatened at present but close to qualifying for Vulnerable if overgrazing is not restricted
Rhus gallagheri	Endemic	-	-	Endemic to eastern part of the central desert
Schweinfurthia spinosa	Endemic	-	-	Endemic to Dhofar
Ziziphus leucodermis	Regionally endemic	-	NT	Endemic to Dhofar and eastern part of S Yemen. Intricately branched spiny shrub, placed in the Near Threatened category, not threatened at present but close to qualifying for Vulnerable if overgrazing is not restricted

invade. In most wadis, overgrazing by livestock has reduced the species richness considerably with the result that plant cover is dominated by thorny and unpalatable species such as *Fagonia indica* Burm. f., *Cornulaca monacantha* and *Tephrosia apollinea*. In certain wadis, such as Wadi Mukhayzahnah, pumping water from shallow aquifers and building in the wadis has caused drying of the outflows of wadis with the result that vegetation depending on this water has greatly suffered.

Summary and Conclusions

Deserts are extremely fragile ecosystems dependent on biotic and abiotic factors for their survival. The central desert of Oman is a hyper-arid area that has historically been subjected to changes of climate resulting in relict fragments of woodland and sparse vegetation cover. Man-made activities have led to changes in biodiversity and cover, and if left unchecked, will lead to irreversible damage and loss of species in this ecosystem.

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