

Studies on the Vegetation and Soil Seed Bank in Western Saudi Arabia.

1. Wadi Fatima

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El Karemy Z.A.R. & Zayed K.M. 1999. Studies on the vegetation and soil seed bank in western Saudi Arabia. 1. Wadi Fatima. *Taekholmia* 19(1): 63-76

Vegetation and seed bank dynamics were undertaken in Wadi Fatima (western region of Saudi Arabia). 56 species representing 26 families of vascular plants are recorded in six community types dominated by *Acacia mellifera*, *Acacia tortilis* ssp. *tortilis*, *Rhazya stricta*, *Haloxylon salicornicum*, *Leptadenia pyrotechnica* and *Senna italica*, respectively. Assessment of soil seed bank was also undertaken.

Key words: Vegetation, Soil Seed Bank, Wadi Fatima, Saudi Arabia

Introduction

Studies on the vegetation and soils of western Saudi Arabia are scanty or descriptive. Vesey-Fitzgerald (1955) described the vegetation along the Red Sea coastal land, Batanouny and Baeshin (1978 & 1982) gave lists of species recorded along Jeddah-Mecca Road and along Medina-Badr Road respectively, while Baeshin and El-Sahhar (1983) scored a list of species along Jeddah-Badr road.

With the increasing demand for the conservation of natural resources and utilization of wild plants, quantitative investigations of the vegetation are urgently needed for the elucidation of the distributional behavior of species and seed bank dynamics in relation to phytosociological and environmental variations.

The present study provides information on the vegetation and seed bank dynamics of Wadi Fatima in the western region of Saudi Arabia.

The Study Area

Wadi Fatima is one of the main wadies crossing Hijaz mountains in the western region of Saudi Arabia. It lies between latitudes 21°11'-22°2' N and longitudes 39°10'-40°30' E, with a total area of about 4860 km².

The area bordering the wadi is composed of crystalline rock, belonging to the basement complex formed of granites, gneisses and schists (Organgi, 1982). Tertiary sedimentary rocks outcrop on the margins of its upstream part, while basement complex rocks outcrop in the lower part.

Received 6 February 1999. Revision accepted 3 May 1999.

The climate of the area lies within the subtropical dry zone of the deserts as defined by Walter *et al.* (1975). No humid period prevails in the area. The climatic data obtained from Jeddah Meteorological station shows that average annual precipitation is 71.3 mm, the air temperature is high with a mean maximum of 41.6 °C in July and a mean minimum of 14.5 °C in January.

Methods and Techniques

Vegetation pattern and structure were studied in four distinct habitats, namely, rocky slopes, terraces, runnels and mounds; using the modified Braun-Blanquet system (1964). Two scales are used: abundance-dominance (combining the abundance and cover of species) and the sociability (measure of grouping).

The collected plant specimens were identified according to Chaudhary (1989 & 1999), Collenette (1998) Migahid (1996) and Miller and Cope (1998). Herbarium specimens are deposited at the herbarium of Cairo University. Duplicate series of specimens were also deposited at the herbarium of Assiut University.

For estimation of seed bank, 32 soil samples were collected from each habitat. Each of which was taken from an area of 25 x 25 cm for a depth of 2 cm . Soil samples collected from each habitat were thoroughly mixed, sieved through 2 mm sieve and the weight of the soil per square meter was determined. Soil seed bank was estimated by cultivation and floating techniques according to Wang (1997) and Visser & Wentzel (1980), respectively.

Results

I. Vegetation:

1. *Acacia mellifera* community type (Fig. 1a).

This community type has a narrow ecological distribution in the surveyed area. It is confined to the west-facing rocky slopes. Plant cover ranges between 10-35% (Table 1), while the percentage of the fine sediments (silt & clay) ranges between 0.7 - 19.8% respectively (Table 2).

Associated perennials with presence values of 50% are:

Heliotropium arbainense (P=70%), *Lavandula pubescens* (P=60%), *Morettia parviflora* (P=60%), *Indigofera spinosa* (P=50%), *Grewia erythraea* (P=50%) , and *Abutilon muticum* (P=50%). Ephemerals with presence values of 50% or more are : *Zygophyllum simplex* (P=80%), *Farsetia ramosissima* (P=50%). The total number of recorded species of this community type includes 28 perennial and 10 ephemeral species (Fig. 1a).

2. *Acacia tortilis* ssp. *tortilis* community type

This community type abounds on terraces, shallow depressions and valleys. The soil is fine - textured,, compact and covered by rocks, with considerable amounts of silt and clay (9.7%).

The perennials constitute the permanent framework of the vegetation of this community: *Fagonia indica* (P=80%), *Boerhavia diffusa* and *Rhazya stricta* (P=60%) as well as *Centropodia forskalii* & *Panicum turgidum* (P=50%). The other recorded

perennials have lower presence values. The recorded ephemerals are: *Zygophyllum simplex* (P= 60%), *Tribulus terrestris* (P= 40%) and *Polygala irregularis* (P= 10%). Plant cover have a considerable value (10-25%).

3. *Rhazya stricta* community type

Vast areas of Wadi Fatima are sandy with coarse-textured deposits. Within these sandy areas, numerous mounds are found to be inhabited by *Rhazya stricta*.

Associated species of this community type are more or less similar to those of *Haloxylon salicornicum* community type, however the plant cover in *Rhazya stricta* community type is thinner (5-10 % , Fig. 1b).

4. *Haloxylon salicornicum* community type

The dominant plant is a platable succulent, grazed mainly by camels. *Haloxylon salicornicum* builds phytogenic mounds of fine materials around its body. This community type is recognized in the first instance by the dominant species which is the most abundant and the growth of which provides the homogeneity of the community.

The total number of associated species includes 9 perennials and 3 ephemerals. Perennials with presence values of 50% or more are: *Rhazya stricta* (P= 70%), *Stipagrostis plumosa* (P= 60%) and *Centropodia forskalii* (P= 50%) whereas the rest of the perennials have lower presence values. The ephemerals include *Zygophyllum simplex* and *Polygala irregularis* (P= 50%) as well as *Tribulus terrestris* (P= 20%). Plant cover ranges from 10 to 15% (Fig. 2a).

5. *Leptadenia pyrotechnica* community type

The dominant species is a leafless shrub, which is browsed by camels and cut for fuel. The community dominated by this plant occurs on deep, sandy soil, where the effect of wind is pronounced. Dunes formed by the deposition of wind-blown sand in Wadi Fatima support the growth of the vegetation dominated by *Leptadenia pyrotechnica*.

Associated perennials are: *Calotropis procera* (P= 80%), *Cenchrus ciliaris* (P=50%), *Citrullus colocynthis* (P = 30%) and *Cocculus pendulus* (P=20%). The recorded ephemerals are: *Zygophyllum simplex* (P=100%), *Euphorbia granulata* (P=30%), *Schouwia purpurea* (P=20%) as well as *Reichardia tingitana* and *Launaea capitata* (P = 10% each). Plant cover ranges from 5 to 15% and the dominant species contributes the major part of this cover.

6. *Senna italica* community type

The numerous runnels and water courses, are frequently inhabited by a vegetation dominated by *Senna italica*. The vegetation of this community is most luxuriant due to the dense growth of the dominant species. Plant cover is relatively high ranging between 30 and 45%.

Associated perennials are: *Fagonia indica* (P=80%), *Cynodon dactylon* (P= 60%), *Commicarpus helenae* (P= 40%) as well as *Cenchrus ciliaris* and *Pennisetum divisum* (P=30% each). The recorded ephemerals include: *Zygophyllum simplex* (P= 70%), *Tribulus terrestris* (P= 30%) and *Schouwia purpurea* (P= 20 % , Fig. 2b).

Table 2: Soil texture and seed bank of the different habitats of Wadi Fatima (A= upstream part, B = midstream part, C = downstream part)

Habitat	Community type		Soil texture			Soil seed bank (maximum number/m ²)	
			Coarse sand (%)	fine sand (%)	silt & clay (%)	emerged seedlings	Total seeds
Rocky slopes	<i>Acacia mellifera</i>	A	96.1	3.2	0.7	610	2728
		B	80.5	18.3	1.2	2412	40269
		C	59.6	20.6	19.8	8560	133192
Terraces	<i>Acacia tortilis</i>		82.3	17.7	9.7	1792	72540
Mounds	<i>Rhazya stricta</i>		90.7	5.9	4.3	1080	47384
	<i>Haloxylon salicornicum</i>		82.4	10.2	7.4	2180	69140
	<i>Leptadenia pyrotechnica</i>		89.6	3.6	6.5	1430	59342
Runnels	<i>Senna italica</i>		78.4	12.8	8.6	914	66026

II. Assessment of soil seed bank

A. Cultivation technique

Data of seed bank are given in Table 3. A glance to these data evince that the emergence of the seedlings started 5 days after sowing from the mounds inhabited by *Rhazya stricta* whereas the seedlings emerged 10 days later from the terraces inhabited by *Acacia tortilis*.

The number of emerged seedlings/m² increased remarkably reaching maximum values ranging between 914 and 8560 about 33 days after sowing. A considerable diminution in the seedlings reaching minimum values (30-15) were observed after 60 days.

B. Floating technique

Examination of data presented in Table (3) reveals that the uppermost 2 cm of the soil contains a tremendous numbers of buried seeds (seed bank). These amounted to 47384 (*Rhazya stricta*), 59342 (*Leptadenia pyrotechnica*), 66026 (*Senna italica*), 69140 (*Haloxylon salicornicum*), 72540 (*Acacia tortilis*) and 133192 (*Acacia mellifera* community type).

Discussion

The rugged topographical features of the surveyed area lead to the occurrence of different habitat types: rocky slopes, terraces, runnels and mounds. Each of these habitats has its particular soil attributes, water resources and microclimate as well. The vegetation is generally open and characterised by a permanent framework of perennial herbaceous species.

With the exception of *Acacia mellifera* community type, with species density attaining 28 perennials and 10 ephemerals, the other recognised community types have obviously low species density : *Acacia tortilis* (10 perennials & 3 ephemerals), *Rhazya stricta* (10 perennials & 1 ephemeral), *Haloxylon salicornicum* (9 perennials & 3 ephemerals), *Leptadenia pyrotechnica* (7 perennials & 5 ephemerals) and *Senna italica* (6 perennials & 3 ephemerals).

It is only when the edaphic conditions are more favourable to plant growth that the vegetation becomes more dense and numerous associates are encountered (Kassas, 1966). The recognised community types showed different ecological, geographical and sociological distribution : *Leptadenia pyrotechnica* occurs on deep sandy soil, where the effect of wind is pronounced, *Acacia mellifera* inhabits the rocky slopes, *Senna italica* abounds depressions and runnels whereas *Haloxylon salicornicum* and *Rhazya stricta* are the most wide spread on the mounds. *Acacia tortilis* community type is the most widespread in the study area especially on the terraces.

Soil seed bank can be a good predictor of vegetation that develops under certain environmental conditions (Brown, 1998).

The results obtained revealed that the uppermost 2cm of the soil, in the sandy area, contain tremendous number of germinable seeds (8520/m²). This was found higher than those recorded by Dalling *et al.* (1997) in tropical forest (1090/m²).

It was also observed that the neighbouring microhabitats play an important role in the distribution of the soil seed bank. In addition the results obtained showed that the total number of the buried seeds may have a value of 133192 seed/m²; however only 1.4-6.4% were found to be germinable, since some of the seeds are not viable or in a dormant stage.

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Habitat	Rocky slopes		Terraces		Mounds						Runnels	
Community dominated by:	<i>Acacia mellifera</i>		<i>Acacia tortilis</i>		<i>Rhazya stricta</i>		<i>Haloxylon Salicornicum</i>		<i>Leptadenia pyrotechnica</i>		<i>Senna italica</i>	
Plant cover %	10 - 35		10 - 25		5 - 10		10 - 15		5 - 15		30 - 45	
	AB	P (%)	AB	P (%)	AB	P (%)	AB	P (%)	AB	P (%)	AB	P (%)
<i>Ommicarpus helenae</i>	+1	20									+1	40
<i>Ochradenus baccatus</i>	+1	20										
<i>Andrachne aspera</i>	+1	20										
<i>Lycium shawii</i>	+1	20										
<i>Cadaba glandulosa</i>	+1	10										
<i>Tephrosia nubica</i>	+1	10										
<i>Fagonia indica</i>	+1	10	1.1	80	1.1	40	+1	30			1.1	80
<i>Trichodesma africanum</i>	+1	10										
<i>Euphorbia cuneata</i>	+1	10										
<i>Pergularia daemia</i>	+1	10										
<i>Pulicaria petiolaris</i>	+1	10										
<i>Acacia tortilis</i>			3.1	100	+1	20	+1	10				
<i>Boerhavia diffusa</i>			1.1	60			+1	20				
<i>Panicum turgidum</i>			1.2	50	+2	20	+2	40				
<i>Centropodia forskalii</i>			+1	50	+2	30	+2	50				
<i>Haloxylon salicornicum</i>			+2	20	+1	80	2.3	100				
<i>Acacia ehrenbergiana</i>			+1	20	+1	30			+1	40		
<i>Cenchrus ciliaris</i>					+1	20			1.1	50	+2	30
<i>Leptadenia pyrotechnica</i> (Fig. 4a)									2.2	100		
<i>Calotropis procera</i>									+1	80		

Table 1 (continued)

Habitat	Rocky slopes		Terraces		Mounds				Runnels			
Community dominated by:	<i>Acacia mellifera</i>		<i>Acacia tortilis</i>		<i>Rhazya stricta</i>		<i>Haloxylon Salicornicum</i>		<i>Leptadenia pyrotechnica</i>		<i>Senna italica</i>	
Plant cover %	10 - 35		10 - 25		5 - 10		10 - 15		5 - 15		30 - 45	
	AB	P (%)	AB	P (%)	AB	P (%)	AB	P (%)	AB	P (%)	AB	P (%)
<i>Senna italica</i>									1.1	40	3.2	100
<i>Citrullus colocynthis</i>									+1	30		
<i>Cocculus pendulus</i>									+1	20		
<i>Cynodon dactylon</i>											1.2	60
<i>Pennisetum divisum</i>											+1	30
EPHEMERALS												
<i>Zygopyllum simplex</i>	1.1	80	1.1	60			1.1	50	2.1	100	1.1	70
<i>Farsetia ramosissima</i>	+1	50										
<i>Caylusea hexagyna</i>	+1	40										
<i>Cometes abyssinica (Fig.4b)</i>	+1	30										
<i>Euphorbia granulata</i>	+1	30							+1	30		
<i>Polygala irregularis</i>	+1	30	+1	10			1.1	50				
<i>Kohautia caespitosa</i>	+1	30										
<i>Polygala erioptera</i>	+1	20										
<i>Senecio flavus</i>	+1	20										
<i>Schweinfurthia pterospermum</i>	+1	10										
<i>Tribulus terrestris</i>			+1	40	+1	20	+1	20			+1	30
<i>Schouwia purpurea</i>									+1	20	+1	20
<i>Reichardia tingitana</i>									+1	10		
<i>Launaea capitata</i>									+1	10		

Table 3 : Number of emerged seedlings/m2 from soils of the different habitats of Wadi Fatima (A=upstream part, B = midstream part, C = downstream part).

Habitat	Community type		Number of seedlings after:											
			5 days	10 days	15 days	20 days	25 days	30 days	35 days	40 days	45 days	50 days	55 days	60 days
Rocky slopes	<i>Acacia mellifera</i>	A	0	25	140	480	610	580	806	120	40	40	40	40
		B	50	356	1480	1860	2000	2412	2010	1540	690	200	100	80
		C	120	590	2600	4050	5200	7660	8560	6000	2400	1050	210	150
Terraces	<i>Acacia tortilis</i>		0	0	0	80	640	890	1350	1792	860	165	50	45
Mounds	<i>Rhazya stricta</i>		200	550	870	950	1080	1000	820	500	210	190	90	90
	<i>Haloxylon salicornicum</i>		0	0	20	900	2000	2180	2010	1050	620	220	120	90
	<i>Leptadenia pyrotechnica</i>		0	30	700	1000	1300	1360	1430	640	320	250	70	70
Runnels	<i>Senna italica</i>		0	0	320	540	680	914	240	120	80	50	40	30