

Ecological Relationships of Some Vegetation Units in the Jeddah-Makkah Region, Saudi Arabia

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ABSTRACT. *Hammada elegans*, *Suaeda monoica*, *Salsola tetrandra*, *Rhazya stricta* and *Dipterygium glaucum* form important communities in the Jeddah-Makkah region. Climatic aridity, altitudinal moisture gradients, extensive grazing and competition all contribute to the pattern of distribution, structure and composition of the vegetation.

Hammada elegans (Bunge) Botsch, *Suaeda monoica* Forssk., *Salsola tetrandra* Forssk., *Rhazya stricta* Decne and *Dipterygium glaucum* Decne form important distinct communities within the Jeddah-Makkah region in Saudi Arabia. Batanouny (1979) described the vegetation along the old Jeddah-Makkah road and recognized some of these community types. The present work reports an attempt to provide quantitative data and an examination of some of the ecological factors which might contribute to the structure, composition and pattern of these communities.

Climate

The climate is hot with temperature extremes and arid with low erratic rainfall. Batanouny (1979) gave an elaborate account of the climate of the Jeddah-Makkah region.

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Method

Transects in two sites which seemed to show definite topographic and consequently moisture gradients, and in which the plant communities were clearly zoned apparently according to these gradients, were selected for the study.

In the first site (along the Shimaysi-Taif Road 40 km from the second site), the ground rises gradually from the bed of a principal *wadi* to the foot of the hills. *Rhazya stricta* community type occupies the *wadi* bed (40-50 meters wide) and a zone of *Salsola tetrandra* community type extends from the raised *wadi* terrace across a distance of 640 m towards the hills; this is followed up to the foot of the hills and across a distance of 312 m by a zone of *Dipterygium glaucum* community type. In the second site (along the new Jeddah-Makkah Highway), a *Suaeda monoica* community type occupies the lowest part of the transect (1100 m wide) which is a part of a principal *wadi* (*Wadi Fatima*); as the ground rises gradually towards the hills a zone of an ecotone: *Suaeda monoica* - *Hammada elegans* community type (250 m wide) occurs. With increasing elevation up to the foot of the hills, this gives way to a *Hammada elegans* community type.

The vegetation characteristics were derived from the study of a representative sample plot in each zone. These were selected by subjective judgement. Here 10 quadrates, each measuring 10 × 10 m were sampled. The species within each quadrate were listed and the numbers of individuals (rooted living plants) recorded. From these data, frequency and density (number of individuals per 100 m²) for each species were assessed. Cover-abundance estimates for each species in each quadrate were made according to the Braun-Blanquet scale (see legend to Table 1). The data for density and cover-abundance estimates were statistically analysed; for this purpose the Braun-Blanquet scale was upgraded by one unit (e.g. + = 1). The vegetation was sampled during the rainy season of 1984.

Soil profiles in each zone were examined and samples were collected from each for the determination of moisture content, soil texture and chemical properties. Soil mechanical analysis was done by the Pipette method (Day 1965) and total water soluble salts were determined according to the procedure given by Richards (1954); the pH of soil extracts was measured by a pH-meter and soil moisture content was determined by weighing field and oven-dried samples.

Results

The vegetation characteristics of the different community types are summarised in Table 1.

Table 1. Analysis of the vegetation in the different community types in two transects within the study area in the Jeddah-Makkah region. Density = number of individuals per 100 m². Cover abundance estimates were made according to the Braun-Blanquet scale: +, very rare, less than 1%; 1, rare, 1-5%; 2, occasional, 6-25%; 3, frequent, 26-50%; 4, common, 51-75%; 5, abundant, 76-100%. The scale is upgraded by one unit (e.g., + = 1). 95% confidence limits (\pm values) are included.

Zone	Species	Mean density	Mean cover-abundance	Frequency %
SITE 1 (TRANSECT 1)	Perennials			
a) <i>Rhazya stricta</i>	<i>Rhazya stricta</i>	6.1 \pm 0.21	3.1 \pm 0.41	100
	<i>Dipterygium glaucum</i>	236.5 \pm 89.4	1.9 \pm 1.37	100
	<i>Panicum turgidum</i>	10 \pm 13.0	1.0 \pm 0	100
	<i>Salsola tetrandra</i>	2.4 \pm 1.53	1.0 \pm 0.34	90
	<i>Heliotropium digynum</i>		0.90 \pm 0.40	880
	<i>Aerva javanica</i>	0.2 \pm 0.46	0.1 \pm 0.23	10
	<i>Aerva lanata</i>	0.23 \pm 0.46	0.1 \pm 0.23	10
	<i>Acacia seyal</i>	0.1 \pm 0.23	0.3 \pm 0.60	10
	<i>Abutilon pannosum</i>	0.1 \pm 0.23	0.1 \pm 0.23	10
	<i>Leptadenia pyrotechnica</i>	0.1 \pm 0.23	0.1 \pm 0.23	10
	<i>Chrozophora obliqua</i>	0.2 \pm 0.46	0.1 \pm 0.34	10
	<i>Citrullus colocynthis</i>	0.3 \pm 0.68	0.1 \pm 0.23	10
	<i>Acacia ehrenbergiana</i>	0.1 \pm 0.23	0.2 \pm 0.46	10
	<i>Cucumis prophetarum</i>	0.1 \pm 0.23	0.1 \pm 0.23	10
	<i>Capparis decidua</i>	0.1 \pm 0.23	0.3 \pm 0.45	10
	Annuals			
	<i>Tribulus terrestris</i>		0.9 \pm 0.40	80
	<i>Glinus lotoides</i>		0.8 \pm 0.30	80
	<i>Cenchrus pennisetiformis</i>		0.4 \pm 0.37	40
	<i>Euphorbia granulata</i>		0.4 \pm 0.37	40
	<i>Gisekia pharnaceoides</i>		0.2 \pm 0.30	20
	<i>Launaea cassiniana</i>		0.1 \pm 0.23	10
	<i>Asphodelus fistulosus</i> v. <i>tenuifolius</i>		0.1 \pm 0.23	10
b) <i>Salsola tetrandra</i>	Perennials			
	<i>Salsola tetrandra</i>	10.9 \pm 2.91	3.4 \pm 0.37	100
	<i>Dipterygium glaucum</i>	319.7 \pm 63.0	2.4 \pm 0.37	100
	<i>Panicum turgidum</i>	85.8 \pm 27.8	1.1 \pm 0.23	100
	<i>Heliotropium digynum</i>		1.2 \pm 0.30	100
	<i>Rhazya stricta</i>	0.1 \pm 0.23	0.1 \pm 0.23	10
	<i>Farsetia aegyptia</i>	0.1 \pm 0.23	0.1 \pm 0.23	10
	<i>Convolvulus prostratus</i>	0.1 \pm 0.23	0.1 \pm 0.23	10

Table 1. contd.

Zone	Species	Mean density	Mean cover-abundance	Frequency %
c) <i>Dipterygium glaucum</i>	Annuals			
	<i>Tribulus terrestris</i>		1.0 ± 0.0	100
	<i>Launaea cassiniana</i>		0.4 ± 0.37	40
	<i>Cleome africana</i>		0.20 ± 0.30	20
	<i>Euphorbia granulata</i>		0.2 ± 0.30	20
	Perennials			
	<i>Dipterygium glaucum</i>	447.7 ± 102.7	3.6 ± 0.36	100
	<i>Panicum turgidum</i>	107.3 ± 21.7	2.0 ± 0.48	100
	<i>Heliotropium digynum</i>	—	0.9 ± 0.23	90
	<i>Salsola tetrandra</i>	0.2 ± 0.13	0.2 ± 0.30	20
	Annuals			
	<i>Glinus lotoides</i>		0.9 ± 0.23	70
	<i>Tragus racemosus</i>		0.5 ± 0.38	50
	<i>Tribulus terrestris</i>		0.2 ± 0.30	20
	<i>Euphorbia granulata</i>		0.2 ± 0.30	20
SITE 2 (TRANSECT 2)				
a) <i>Suaeda monoica</i>	Perennials			
	<i>Suaeda monoica</i>	8.6 ± 2.02	3.1 ± 0.41	100
	<i>Dipterygium glaucum</i>	56.2 ± 21.3	1.5 ± 0.38	100
	<i>Panicum turgidum</i>	22.2 ± 5.19	1.3 ± 0.35	100
	<i>Heliotropium digynum</i>		1.3 ± 0.35	100
	<i>Cyperus conglomeratus</i>	1.6 ± 1.55	0.4 ± 0.37	40
	<i>Citrullus colocynthis</i>	0.3 ± 0.35	0.3 ± 0.35	30
	<i>Farsetia aegyptia</i>	0.3 ± 0.35	0.3 ± 0.35	30
	<i>Hammada elegnas</i>	0.3 ± 0.35	0.3 ± 0.35	30
	<i>Rhazya stricta</i>	0.2 ± 0.30	0.2 ± 0.30	20
	Annuals			
	<i>Euphorbia granulata</i>		1.3 ± 0.35	100
	<i>Tragus racemosus</i>		1.0 ±	100
	<i>Tribulus terrestris</i>		1.0 ±	100
	<i>Launaea cassiniana</i>		0.4 ± 0.37	40
	<i>Glinus lotoides</i>		0.3 ± 0.35	30
	<i>Asphodelus fistulosus</i> v. <i>tenuifolius</i>		0.2 ± 0.30	20
	<i>Aristida adscensionis</i>		0.1 ± 0.23	10

Table 1. contd.

Zone	Species	Mean density	Mean cover-abundance	Frequency %	
b) <i>Hammada elegans</i> – <i>Suaeda monoica</i>	Perennials				
	<i>Hammada elegans</i>	8.1 ± 2.70	2.0 ± 0.48	100	
	<i>Suaeda monoica</i>	5.0 ± 0.58	1.8 ± 0.30	100	
	<i>Panicum trugidum</i>	171.4 ± 46.0	1.0 ± 0.00	100	
	<i>Heliotropium digynum</i>	–	1.0 ± 0.0	100	
	<i>Cyperus conglomeratus</i>	1.9 ± 1.4	0.8 ± 0.30	80	
	Annuals				
	<i>Glinus lotoides</i>		1.0 ± 0.00	100	
	<i>Tribulus terrestris</i>		1.0 ± 0.00	100	
	<i>Tragus racemosus</i>		1.0 ± 0.00	100	
	<i>Euphorbia granulata</i>		0.6 ± 0.37	60	
	<i>Aristida adscensionis</i>		0.5 ± 0.38	50	
	<i>Launaea cassiniana</i>		0.1 ± 0.23	10	
	c) <i>Hammada elegans</i>	Perennials			
		<i>Hammada elegans</i>	15.5 ± 3.59	3.5 ± 0.61	100
		<i>Panicum turgidum</i>	229.3 ± 100.2	2.2 ± 0.30	100
<i>Dipterygium glaucum</i>		37.0 ± 9.15	1.1 ± 0.23	100	
<i>Heliotropium digynum</i>			1.0 ± 0.00	100	
<i>Cyperus conglomeratus</i>		1.5 ± 1.18	0.5 ± 0.38	50	
Annuals					
<i>Tribulus terrestris</i>			1.0 ± 0.00	100	
<i>Tragus racemosus</i>			1.0 ± 0.00	100	
<i>Euphorbia granulata</i>			1.0 ± 0.00	100	
<i>Aristida adscensionis</i>			1.0 ± 0.00	100	
<i>Glinus lotoides</i>			0.5 ± 0.38	50	
<i>Launaea cassiniana</i>			0.2 ± 0.30	20	

Site 1 (Transect 1)

(a) *Rhazya stricta* Community Type (Plate 1)

The vegetation here is more elaborate than in the other community types and shows clear stratification. The tree layer is represented by *Acacia seyal* Del. and *Capparis decidua* (Forssk.) Edgew. (*C. aphylla* Roth.) (F = 10%); the shrub layer by *A. ehrenbergiana* Hayne (= *A. flava* (Forssk.) Schweinf.) *Leptadenia pyrotechnica* (Forssk.) Decne. The herbaceous layer includes the dominant – *R. stricta* (F = 100%) and several perennials: *Dipterygium glaucum*, the tussocky grass *Panicum turgidum* Forssk. (F = 100%), *Salsola tetrandra* (F = 90%), *Heliotropium digynum* (Forssk.) Asch. ex C. Christens. (= *H. luteum* Poir.) (F = 80%), *Aerva javanica* (Burm. f.) Spreng. (= *A. persica* (Burm. f.) Merrill, *A. tomentosa* Forssk.), *Aerva lanata* (L.) Juss. ex Schult., *Abuilton pannosum* (Forst. f.) Schlecht. (= *A. glaucum* Br & Mass., non Sweet, *A. muticum* (Del.) Webb.), *Chrozophora obliqua* (Vahl) A. Juss. ex Spreng. (= *C. oblongifolia* (Del.) A. Juss. ex Spreng.), *Citrullus colocynthis* (L.) Schrad. (= *Colocynthis vulgaris* Schrad.) and *Cucumis prophetarum* Jusl. ap. L. (F = 10%).

The field layer comprises several annuals:

Tribulus terrestris L., *Glinus lotoides* L. (= *Mollugo glinus* A. Rich.), (F = 80%), *Cenchrus pennisetiformis* Hochst. & Steud. (= *Pennisetum ciliare* (L.) Link), *Euphorbia granulata* Forssk. (F = 40%), *Gisekia pharnaceoides* L. (F = 20%), *Launaea cassiniana* (Jaub. & Sp.) Kuntze, and *Asphodelus fistulosus* L. v. *tenuifolius* Cav. (= *A. tenuifolius* Cav.) (F = 10%).

(b) *Salsola tetrandra* Community Type (Plate 2)

The herb layer includes the dominant – *Salsola tetrandra*, *Dipterygium glaucum*, *Panicum turgidum* and *Heliotropium digynum* (F = 100%), *Rhazya stricta*, *Farsetia aegyptia* Turra and *Convolvulus prostratus* Forssk. (*C. microphyllus* Sieb.) (F = 10%).

The field layer includes *Tribulus terrestris* (F = 100%), *Launaea cassiniana* (F = 40%), *Euphorbia granulata* and *Cleome africana* Botsch. (= *C. arabica* non L.) (F = 20%).

(c) *Dipterygium glaucum* Community Type (Plate 3)

The herb layer includes the dominant – *Dipterygium glaucum* (F = 100%) – *Panicum turgidum* (F = 100%), *Heliotropium digynum* (F = 90%) and *Salsola tetrandra* (20%).

The field layer comprises five annuals: *Glinus lotoides* (F = 70%), *Tragus racemosus* (L.), all (F = 50%), *Tribulus terrestris* and *Euphorbia granulata* (F = 20%).



Plate 1. The *Rhazya stricta* community type in the *wadi* bed along the Shimaysi-Taif road; the tall shrub *Leptadenia pyrotechnica*, the canopy of an *Acacia seyal* tree (background) and individuals of the herb *Dipterygium glaucum* (foreground) may be seen.



Plate 2. The *Salsola tetrandra* community type on the raised wadi terrace, showing the *Rhazya stricta* community type in the *wadi* bed and an *Acacia seyal* tree in the background.



Plate 3. *Dipterygium glaucum* extending to the foot of the hills. The coarse textured aeolian sand deposits are shown.



Plate 4. The *Suaeda monoica* community type along the new Jeddah-Makkah Highway.

Site 2 (Transect 2)

(a) *Suaeda monoica* Community Type (Plate 4).

The shrub layer is composed of the dominant species – *Suaeda monoica* (F = 100%); the herb layer comprises several perennials: *Dipterygium glaucum*, *Panicum turgidum* and *Heliotropium digynum*, (F = 100%), *Cyperus conglomeratus* (F = 40%), *Farsetia aegyptia*, *Hammada elegans* (F = 30%) and *Rhazya stricta* (F = 20%). The field layer comprises the prostrate perennial, *Citrullus colocynthis* (F = 30%) and several other annuals: *Euphorbia granulata*, *Tragus racemosus*, *Tribulus terrestris* (F = 100%), *Launaea cassiniana* (F = 40%), *Glinus lotoides* (F = 30%), *Asphodelus fistulosus* v. *tenuifolius* (F = 20%) and *Aristida adscensionis* L. (= *A. submucronatus* Schum.) F = 10%)

(b) *Hammada elegans-Suaeda monoica* Community Type (Plate 5)

This is a boundary (mixed) community between *Hammada elegans* and *Suaeda monoica* community types. It comprises the shrub *Suaeda monoica* (F = 100%) and the herbaceous perennials: *Hammada elegans*, *Panicum turgidum* (F = 100%), *Heliotropium digynum*, and *Cyperus conglomeratus* (F = 80%). The field layer comprises the annuals: *Glinus lotoides*, *Tribulus terrestris*, *Tragus racemosus* (F = 100%), *Euphorbia granulata* (F = 60%), *Aristida adscensionis* (F = 50%) and *Launaea cassiniana* (F = 10%).

(c) *Hammada elegans* Community Type (Plate 6)

The herb layer comprises the dominant – *H. elegans* and three other perennials: *Panicum turgidum*, *Dipterygium glaucum*, *Heliotropium digynum* (F = 100%), and the tussocky grass *Cyperus conglomeratus* Rottb. (*C. pungens* Boeck.) (F = 50%).

The field layer comprises several annuals: *Tribulus terrestris*, *Euphorbia granulata*, *Tragus racemosus*, *Aristida adscensionis*. (*A. submucronatus* Schum.) (F = 100%), *Glinus lotoides* (F = 50%) and *Launaea cassiniana* (F = 20%).

The edaphic characteristics are shown in Table 2. *Suaeda monoica* inhabits deep alluvial, fine-textured compact deposits overlain by aeolian sand. Mechanical analysis reveals that these deposits are sandy loam, while the soils in the habitats of the other communities are sandy. Data for soil moisture content reveal that *Suaeda monoica* soils are moister than those of *Rhazya stricta* > of *Salsola tetrandra* > of *Dipterygium glaucum* > of *Hammada elegans*. The pH values show that the soils in the habitats of the different communities are generally alkaline with no significant differences between the communities. The total water-soluble salts are generally low; however, the soils of *Suaeda monoica* and *Hammada elegans* are slightly saline and have the highest concentrations of salts while those of *Dipterygium glaucum* have the lowest.



Plate 5. *Hammada elegans* – *Suaeda monoica* community type. Mounds have been built by a plant of *H. elegans* (foreground) and by two plants of *S. monoica* (centre).



Plate 6. The *Hammada elegans* community type along the new Jeddah-Makkah Highway. Mounds built by the sandbinding *H. elegans* are shown.

Table 2. Analysis of soil samples from profiles within the habitats of the different community types in the study area in the Jeddah-Makkah region. The \pm values associated with the moisture content represent the 95% confidence limits.

Zone	Habitat	Profile	Depth (cm)	Coarse sand	Fine sand	Clay	Silt	Moisture content	pH	Total water-soluble salts (ppm)		
A) <i>Rhazya stricta</i>	Within the Wadi bed	1	0-5	39.5	60.0	0.3	0.2	1.51 \pm 0.17	8.8	189		
			5-25	40.5	58.5	0.4	0.0	2.88 \pm 0.06	9.1	154		
			25-50	40.0	59.0	1.0	0.0	3.02 \pm 0.16	9.1	163		
		2	0-5	55.0	44.5	0.4	0.1	1.52 \pm 0.05	8.8	106		
			5-25	36.5	62.5	1.0	0.0	2.24 \pm 0.16	8.6	102		
			25-50	29.0	70.5	0.4	0.0	2.84 \pm 0.18	8.7	90		
		B) <i>Salsola tetrandra</i>	Extreme hillward end of zone, on deep deposits	3	0-5	32.0	65.5	1.5	1.0	0.73 \pm 0.12	8.4	106
					5-25	30.5	67.0	1.0	1.5	1.46 \pm 0.06	8.2	64
					25-50	39.0	57.5	1.5	2.0	1.44 \pm 0.10	8.2	67
Wadi terrace	4		0-5	34.0	65.0	1.0	1.0	1.46 \pm 0.13	8.6	118		
			5-25	49.0	48.0	1.5	1.5	1.77 \pm 0.09	9.1	176		
			25-50	56.0	40.0	3.0	1.0	1.95 \pm 0.09	9.1	206		
	5		0-5	31.0	63.5	2.5	3.0	1.46 \pm 0.03	8.6	138		
			5-25	27.5	67.0	4.0	1.5	1.72 \pm 0.07	9.0	167		
			25-50	24.5	68.0	3.5	4.0	1.69 \pm 0.14	9.2	195		
C) <i>Dipterygium glaucum</i>	Extreme hillward end of zone, on deep sand deposits	6	0-5	38.0	61.0	0.1	0.4	0.62 \pm 0.09	8.8	76		
			5-25	45.5	54.0	0.1	0.4	1.04 \pm 0.06	8.7	77		
			25-50	24.5	75.0	0.1	0.4	1.06 \pm 0.10	9.0	75		
	Within the zone, on deep sand deposits	7	0-5	58.0	41.5	0.1	0.4	0.54 \pm 0.08	8.4	74		
			5-25	32.5	67.0	0.1	0.4	0.83 \pm 0.15	8.5	48		
			25-50	39.0	60.5	0.2	0.3	1.12 \pm 0.14	8.4	57		

Table 2. Contd.

Zone	Habitat	Profile	Depth (cm)	Coarse sand	Fine sand	Clay	Silt	Moisture content	pH	Total water-soluble salts (ppm)
A) <i>Suaeda monoica</i>	Within the zone	8	0-5	26.0	73.0	0.5	0.0	1.57 ± 0.25	9.3	288
			5-25	29.0	62.0	8.5	0.5	4.14 ± 0.07	9.6	384
			25-50	21.5	62.5	10.5	5.5	12.06 ± 0.25	9.8	416
		9	0-5	24.5	74.5	1.0	0.1	1.10 ± 0.04	9.4	240
			5-25	8.5	78.5	10.0	2.0	4.71 ± 0.34	9.6	275
			25-50	5.0	76.5	12.0	6.5	11.08 ± 0.99	9.7	256
B) <i>Hammada elegans</i>	Within the zone	10	0-5	42.0	57.5	0.0	0.1	0.62 ± 0.03	9.1	167
			5-25	47.0	52.0	0.0	0.1	0.66 ± 0.08	9.3	167
			25-50	45.0	53.0	0.0	0.1	0.71 ± 0.03	9.8	192
		12	0-5	20.5	79.0	0.1	0.0	0.64 ± 0.03	8.7	288
			5-25	15.0	84.0	0.0	0.0	0.75 ± 0.12	9.3	211
			25-50	17.0	82.0	0.0	0.0	0.69 ± 0.05	9.5	211
C) <i>Hammada elegans</i>	Extreme hillward end of the zone	13	0-5	21.0	79.0	0.1	0.0	0.63 ± 0.07	8.0	352
			5-25	25.5	73.5	0.1	0.1	0.65 ± 0.08	8.7	208
			25-50	33.5	65.0	0.1	0.1	0.61 ± 0.06	9.4	154
	Within the zone	0-5	27.5	71.5	0.1	0.1	0.57 ± 0.03	8.3	288	
		5-25	37.5	59.0	0.0	0.1	0.65 ± 0.08	9.6	205	
		25-50	43.0	55.0	0.1	0.0	0.78 ± 0.04	9.4	189	

Discussion and Conclusion

The vegetation, generally, is dominated by herbaceous vegetation; it is only when edaphic conditions are favourable (increased moisture and soil depth) in the *wadis* (habitats of *Rhazya stricta* and *Suaeda monoica*), that the vegetation becomes more complex and the growth forms of shrubs and trees are encountered. These *wadis* receive, during the rainy season, drainage water (and water-borne soil) from neighbouring hills and high ground and from other far distant catchment areas; thus their water resources may be greater than the actual local rainfall. Evenari *et al.* (1971) have observed that local run-off of mountain rain-water in the Negev desert may increase the rain-water received by low level sites by the equivalent of 100 to 200 mm per annum. Locally deep soils in the *wadis* may retain a high proportion of this, thus compounding the effect. Species density increased with increased potential for growth. *Rhazya stricta* (15 perennials and 7 annuals) and *Suaeda monoica* (9 perennials and 7 annuals) community types have higher species density as compared with *Hammada elegans* (6 perennials and 6 annuals) and *Dipterygium glaucum* (4 perennials and 4 annuals) community types which occupy the more xeric habitats at the highest elevations in the two sites studied. The vegetation in the two sites is subjected to substantial grazing pressure which might have eliminated the more palatable and desired species. Grime (1973), Mahmoud *et al.* (1982, 1985) and El-Sheikh *et al.* (1985) reported that environmental stresses reduce species density. Stresses due to the excessive grazing and the more xeric conditions within the habitats of *Dipterygium glaucum* and *Hammada elegans* may contribute to the low species density in these two communities. It is noteworthy that the sites of study are exposed to drifting sand and that the main components of the vegetation, e.g. *Rhazya stricta*, *Hammada elegans*, *Dipterygium glaucum*, *Salsola tetrandra*, *Suaeda monoica* and *Panicum turgidum* are adapted to tolerate sand burial and are effective sandbinders (Plates 5, 7 and 8). The perennial, tussocky and highly competitive grass, *P. turgidum*, which is normally successful and dominant in such sandy habitats was highly suppressed by repeated grazing a fact which contributes to the success and dominance of herbaceous unpalatable species such as *Rhazya stricta*, *Hammada elegans* and *Dipterygium glaucum*.

Since soil texture, pH and salinity (Table 2) are not very different in the habitats of the different communities, they do not seem to play a decisive role in the zonation of these communities. This zonation appears to follow an altitudinal moisture gradient. However, *Dipterygium glaucum* seems to have a wide ecological amplitude and is represented at various levels in the different community types. When environmental conditions allow individuals of *Rhazya stricta* to grow to maximum size and coalesce, *D. glaucum* is confined to the margin (Plate 1). However, in other parts of *Wadi Fatima*, e.g. along the old Jeddah-Makkah road, the thick growth of the highly competitive shrub *Suaeda monoica* excludes other species and forms distinct pure zones covering wide areas.



Plate 7. *Rhazya stricta* building mounds of considerable size.



Plate 8. *Hammada elegans* binding sand and building mounds.

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العلاقات البيئية لبعض الوحدات النباتية في منطقة جدة - مكة في المملكة العربية السعودية

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تكون نباتات *Suaeda monoica* ، *Hammada elegans* ،
Dipterygium glaucum ، *Rhazya stricta* ، *Salsola tetrandra*
عشائر هامة ومحددة في منطقة جدة - مكة. المناخ الجاف،
والتدرج في محتوى رطوبة التربة الناتج من التدرج في ارتفاع
الأرض، الرعى الجائر، والمنافسة كلها عوامل تتضافر فتؤثر
في تكوين هذه الوحدات النباتية وتركيبها وتوزيعها.