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Ecology of the Inland Salt Marsh Vegetation at Al-Shiggah in Al-Qassim District, Saudi Arabia

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ABSTRACT. The vegetation in the inland salt marsh at Al-Shiggah, in Al-Qassim district, is characterized by its zonation. The different community types which characterize this vegetation are: *Seidlitzia rosmarinus, Suaeda pruinosa, S. pruinosa – Salsola baryosma – Zygophyllum decumbens, Z. decumbens, and Hammada elegans*. Differences in ground level, vertical elevation above the saline water table, moisture and salinity gradients and climatic aridity all contribute to the pattern of distribution, structure and composition of the vegetation.

Numerous distinct halophytic plant communities are associated with inland salt marshes in Saudi Arabia, especially in areas relatively little subjected to human interference. A good example is found at Al-Shiggah in Al-Qassim district 13° 5′ N, 26° 25′ E. The geological map of Saudi Arabia marks this salt marsh as Sabakha and Khabra deposits, in terminal basins, where the Quaternary commonly saline deposits are silt-clay and muddy sand. This salt marsh is a run-off collecting area (playa) where the water table is high (Dr. M.A. Mushrif, Geology Department, College of Science, King Saud University, Saudi Arabia, person. comm.); it extends about 2.5 Km E to W and about 1 Km N to S at its broadest point. Because of aeolian soil deposits, the salt marsh rises gradually from the lowlying flat ground, 'The Sabakha', landwards causing noticeable moisture and salinity gradients. The different vegetation units are arranged in successive zones running more or less parallel to one another (Plate 1). The vegetation of the inland salt marshes of Saudi Arabia, except for the reconnaissance survey of Vesey-Fitz Gerald (1955, 1957), has not been extensively investigated. This study describes the vegetation in the

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Plate 1. General view of Al-Shiggah salt marsh; note the zone of *Hammada elegans* (foreground) and the lowlying highly saline sterile Sabakha (white surface) in background.

different zones of the salt marsh at Al-Shiggah and various factors which influence the zonation pattern.

Climate

The data in Table 1 indicate a climate that is hot, with temperature extremes and arid with low erratic rainfall. The total annual rainfall is low (average 100.7 mm), seasonal (winter rainfall) and very variable. The rainfall in 1976 was 188.8 mm, and in 1979 it was 43.9 mm. Monthly rainfall is also variable: for January it varies from 6.0 mm in 1978 to 27.4 mm in 1977, for February it varies from 0 mm in 1977 to 26.8 mm in 1978; for March it varies from 0 mm in 1975 to 51.0 mm in 1976.

Similar variations may be noted in rainfall records of April, November and December. The summer period, June-October is practically rainless.

Average temperatures indicate a very hot summer: mean maximum temperature for June-September is 40°C or more, and a mild winter.

Table 1. Meteorological data at Unayza station 25 km from Al-Shiggah salt marsh.
(a) Monthly and annual rainfall (mm) (1975-1979).
(b) Mean daily maximum and minimum temperatures (°C). Data are based on averages for 10 years (1970-1979).

Year	J	F	M	A	M	J	J	A	S	O	N	D	Total
(a) Monthly and annual rainfall (mm) (1975-1979)													
1975	13.4	14.2	0	18.8	6.2	0	0	0	0	0	0	54.4	107.2
1976	20.6	21.4	51.0	19.4	0.8	0	0	0	0	0.2	57.8	17.6	188.8
1977	27.4	0	3.6	2.2	5.2	0	0	0	0	2.4	4.2	2.2	47.2
1978	6.0	26.8	12.2	1.2	0	0	0	0	0	0	36.2	5.2	87.6
1979	20.2	0	3.8	0	9.3	0	0	0	0	0	0	10.6	43.9
(b) Mean daily maximum and minimum temperatures													
Mean Max. °C	20.1	23	27	32	37	41	42	42	40	35	27	21	
Mean Min. °C	7	8	12	16	21	23	23	23	22	17	13	8	

Methods

The vegetation units across two transects (Fig. 1 a, b) which represent the different vegetation patterns (which were recognized subjectively by inspection of the site) were studied during the rainy season of 1973. The vegetation units are referred to here by the dominant species.

The vegetation characters were derived from the study of a representative sample plot (chosen on subjective criteria) in each zone. 10 quadrats, each measuring 10 × 10 m were sampled. The species within each quadrat were listed and the numbers of individuals recorded. From these data, frequency and density (number of individuals per sampled area) for each species were assessed. The cover-abundance estimates for each species in each quadrat were made according to the Braun-Blanquet scale (see legend to Table 2). The data for density and cover-abundance estimate were statistically analysed; for this purpose the Braun-Blanquet scale records were upgraded by one unit (*e.g.* + = 1). Full species list with authorities is given in the Appendix.

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 carried out by the Pipette Method (Day 1965) and total water soluble salts were determined by the procedure given by Richards (1954); pH of soil extracts was determined by a pH-meter. Moisture content was determined by weighing fresh and oven-dried soil samples. Moisture content values were determined in one day.

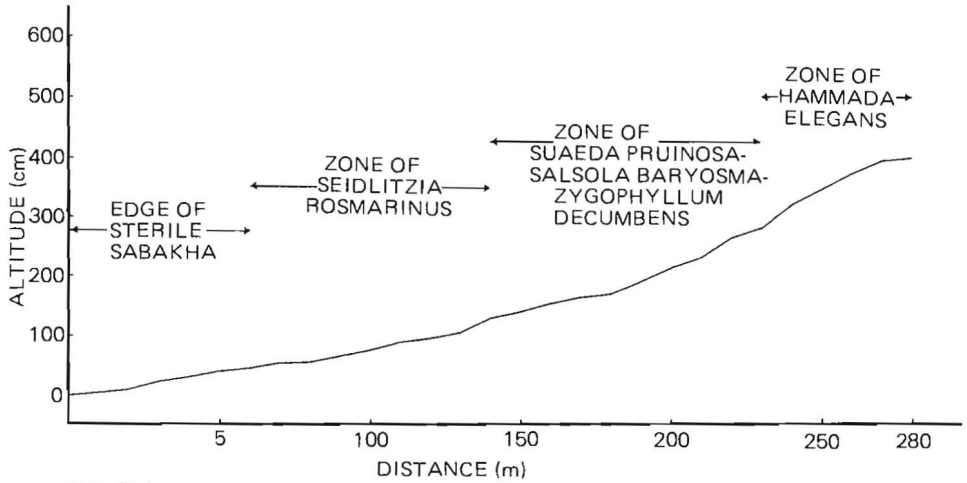

FIG. (1a)

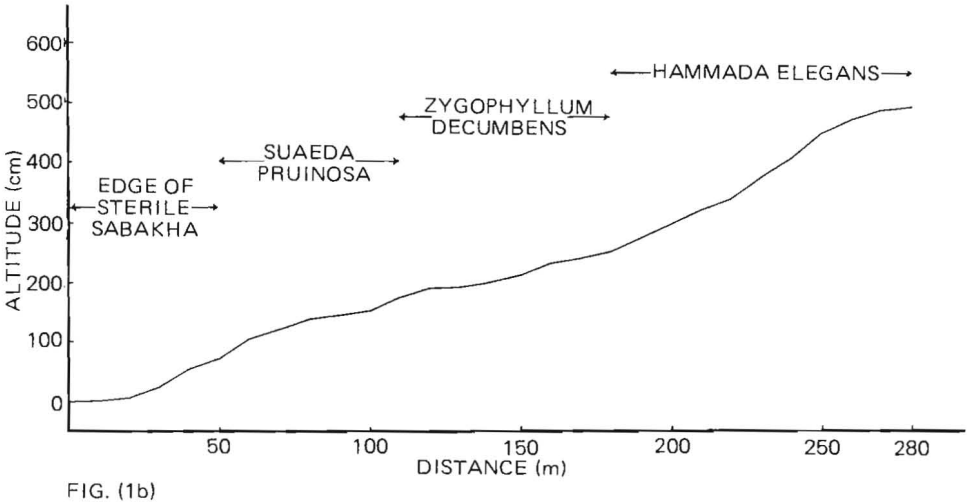

FIG. (1b)

Results

Transects in Fig. 1a and b show the pattern of distribution of the different community types across the marsh in relation to ground level. The vegetation characteristics of the different community types which compose the different zones of the salt marsh are shown in Table 2. The following community types were recognized.

Table 2. Analysis of the vegetation in the different zones of Al-Shiggah salt marsh. Cover-abundance estimates were made according to the Braun-Blanquet scale: +, < 5%; 1, 5-15%; 2, 16-25%; 3, 26-50%; 4, 51-75%; 5, 76-100%. The scale is upgraded by one unit (e.g. + = 1). Density-number of individuals per 100 m^2. 95% confidence limits are included.

Zone	Species	Mean density	Mean cover-abundance estimate	Frequency %
			Transect 1a	
Hammada elegans	**Perennials**	12.5 ± 2.08	3.20 ± 0.30	100
	Cornulaca monocantha	8.9 ± 2.76	1.80 ± 1.28	100
	Salsola baryosma	8.4 ± 4.07	1.40 ± 0.48	95
	Pituranthos triradiatus	6.3 ± 4.85	1.40 ± 0.90	70
	Panicum turgidum	1.8 ± 2.04	0.60 ± 0.49	50
	Seidlitzia rosmarinus	0.80 ± 0.34	0.30 ± 0.34	30
	Zygophyllum decumbens	0.80 ± 0.34	0.30 ± 0.34	30
	Salsola tetrandra	0.40 ± 0.50	0.30 ± 0.34	30
	Suaeda pruinosa	0.20 ± 0.29	0.20 ± 0.29	20
	Annuals			
	Schismus barbatus	– –	2.20 ± 0.45	100
	Plantago cylindrica	– –	1.90 ± 0.40	100
	Paronychia desertorum	– –	1.50 ± 0	100
	Erodium moschatum	– –	1.30 ± 0.34	100
	Eremobium diffusum	– –	1.00 ± 0	100
	Paronychia arabica	– –	0.90 ± 0.22	90
	Bassia muricata	– –	0.80 ± 0.32	80
	Neurada procumbens	– –	0.80 ± 0.32	80
	Tribulus terrestris	– –	0.80 ± 0.32	80
	Lotus halophilus	– –	0.70 ± 0.34	70
	Astragalus schimperi	– –	0.60 ± 0.36	60
	Koelpinia linearis	– –	0.60 ± 0.36	60
	Euphorbia granulata	– –	0.40 ± 0.30	40
	Moltkiopsis ciliata	– –	0.40 ± 0.30	40
	Emex spinosus	– –	0.30 ± 0.34	30
	Schimpera arabica	– –	0.20 ± 0.30	20
Suaeda pruinosa	**Perennials**			
Salsola baryosma	*Suaeda pruinosa*	36.1 ± 15.15	3.30 ± 0.71	100
Zygophyllum decumbens	*Zygophyllum decumbens*	28.8 ± 8.84	3.1 ± 0.67	100
	Salsola baryosma	28.5 ± 11.99	2.80 ± 0.56	100
	Seidlitzia rosmarinus	21.0 ± 0.36	1.60 ± 0.36	100
	Salsola tetrandra	3.6 ± 3.61	0.80 ± 0.45	90
	Hammada elegans	1.7 ± 0.90	0.90 ± 0.40	90
	Cornulaca monocantha	0.4 ± 0.22	0.30 ± 0.34	70
	Pituranthus triradiatus	0.4 ± 0.22	0.30 ± 0.34	50

Table 2. (*Cont., 1a*)

Zone	Species	Mean density	Mean cover-abundance estimate	Frequency %
	Aeluropus massauensis	0.2 ± 0.29	0.20 ± 0.13	20
	Annuals			
	Bassia muricata	– –	0.10 ± 0.22	10
	Plantago cylindrica	– –	0.10 ± 0.22	10
	Schismus barbatus	– –	0.10 ± 0.22	10
	Paronychia arabica	– –	0.10 ± 0.22	10
Seidlitzia rosmarinus	**Perennials**			
	Seidlitzia rosmarinus	15.5 ± 2.67	3.80 ± 0.45	100
	Suaeda pruinosa	4.9 ± 2.43	1.30 ± 0.92	80
	Limonium axillare	3.2 ± 2.01	1.0 ± 0.47	80
	Zygophyllum decumbens	1.1 ± 0.78	0.60 ± 0.36	60

			Transect 1b	
Hammada elegans	**Perennials**			
	Hammada elegans	18 ± 2.18	3.20 ± 0.30	100
	Cornulaca monocantha	2.8 ± 0.13	0.90 ± 0.22	90
	Panicum turgidum	2.7 ± 0.19	0.70 ± 0.34	70
	Pituranthos triradiatus	1.1 ± 0.85	0.80 ± 0.56	60
	Salsola baryosma	1.1 ± 1.52	0.30 ± 0.34	30
	Zygophyllum decumbens	1.1 ± 1.63	0.40 ± 0.49	30
	Salsola tetrandra	0.3 ± 0.34	0.30 ± 0.34	30
	Annuals			
	Schismus barbatus	– –	3.0 ± 0	100
	Plantago cylindrico	– –	1.8 ± 0.30	100
	Lotus halophilus	– –	1.7 ± 0.48	100
	Eremobium diffusum	– –	1.0 ± 0	100
	Neurada procumbens	– –	1.0 ± 0	100
	Launaea capitata	– –	1.0 ± 0	100
	Paronychia arabica	– –	1.0 ± 0	100
	Heliotropium digynum	– –	1.0 ± 0	100
	Astragalus schimperi	– –	1.0 ± 0	100
	Erodium moschatum	– –	1.0 ± 0	100
	Emex spinosus	– –	0.6 ± 0.36	60
	Tribulus terrestris	– –	0.6 ± 0.36	60
	Launaea cassiniana	– –	0.4 ± 0.36	40
	Aizoon canariense	– –	0.4 ± 0.36	30

Table 2. (*Cont., 1b*)

Zone	Species	Mean density	Mean cover-abundance estimate	Frequency %
Zygophyllum decumbens	**Perennials**			
	Zygophyllum decumbens	47.7 ± 13.01	3.6 ± 0.36	100
	Hammada elegans	14.0 ± 3.01	1.8 ± 0.30	100
	Suaeda pruinosa	9.6 ± 2.84	1.7 ± 0.34	100
	Salsola baryosma	7.0 ± 2.73	1.2 ± 0.30	100
	Seidlitzia rosmarinus	3.4 ± 1.85	1.1 ± 0.40	90
	Cornulaca monocantha	2.4 ± 1.07	0.9 ± 0.22	90
	Salsola tetrandra	1.2 ± 0.73	0.7 ± 0.34	70
	Pituranthos triradiatus	1.2 ± 0.73	0.7 ± 0.34	70
	Panicum turgidum	0.5 ± 0.30	0.3 ± 0.34	30
	Limonium lagopoides	0.3 ± 0.30	0.2 ± 0.30	20
	Annuals			
	Eremobium diffusum	– –	1.9 ± 0.40	100
	Lotus halophilus	– –	1.8 ± 0.45	100
	Schismus barbatus	– –	1.4 ± 0.36	100
	Plantago cylindrica	– –	1.4 ± 0.36	100
	Paronychia arabica	– –	1.0 ± 0	100
	Launaea capitata	– –	1.0 ± 0	100
	Erodium moschatum	– –	1.0 ± 0	100
	Launaea cassiniana	– –	1.0 ± 0	100
	Bassia muricata	– –	0.4 ± 0.36	40
	Aizoon canariense	– –	0.2 ± 0.30	20
	Emex spinosus	– –	0.2 ± 0.30	20
Suaeda pruinosa	**Perennials**			
	Suaeda pruinosa	64.6 ± 8.09	3.7 ± 0.34	100
	Zygophyllum decumbens	10.4 ± 3.18	1.4 ± 0.36	100
	Limonium lagopoides	8.7 ± 1.78	1.4 ± 0.36	100
	Seidlitzia rosmarinus	3.4 ± 0.93	1.3 ± 0.34	90
	Salsola baryosma	1.3 ± 0.49	0.6 ± 0.36	60
	Hammada elegans	0.7 ± 0.36	0.3 ± 0.34	30
	Salsola tetrandra	0.5 ± 0.40	0.2 ± 0.30	20

a) ***Seidlitzia rosmarinus*** *Community Type* (Transect 1a, Plate 2).

The community is characterized by perennial herbaceous plants which include the dominant: *Seidlitzia rosmarinus* (F = 100%), *Suaeda pruinosa, Limonium axillare* (F = 80%) and *Zygophyllum decumbens* (F = 60%).

b) ***Suaeda*** pruinosa-Salsola baryosma-Zygophyllum decumbens *Community Type* (Transect 1a, plate 3).

The herbaceous layer includes the dominant species *Suaeda pruinosa, Salsola baryosma-Zygophyllum decumbens* = (F = 100) and five other perennials: *Seidlitzia rosmarinus* (F = 100%), *Salsola tetrandra, Hammada elegans* (F = 90%), *Cornulaca monocantha* (F = 70%), *Pituranthos triradiatus* (F = 50%) and *Aeluropus massauensis* (F = 20%). The field layer is composed of four annuals: *Bassia muricata, Plantago cylindrica, Schismus barbatus, Paronychia arabica* (F = 10%).

Plate 2. Vegetation of the *Seidlitzia rosmarinus* community type.

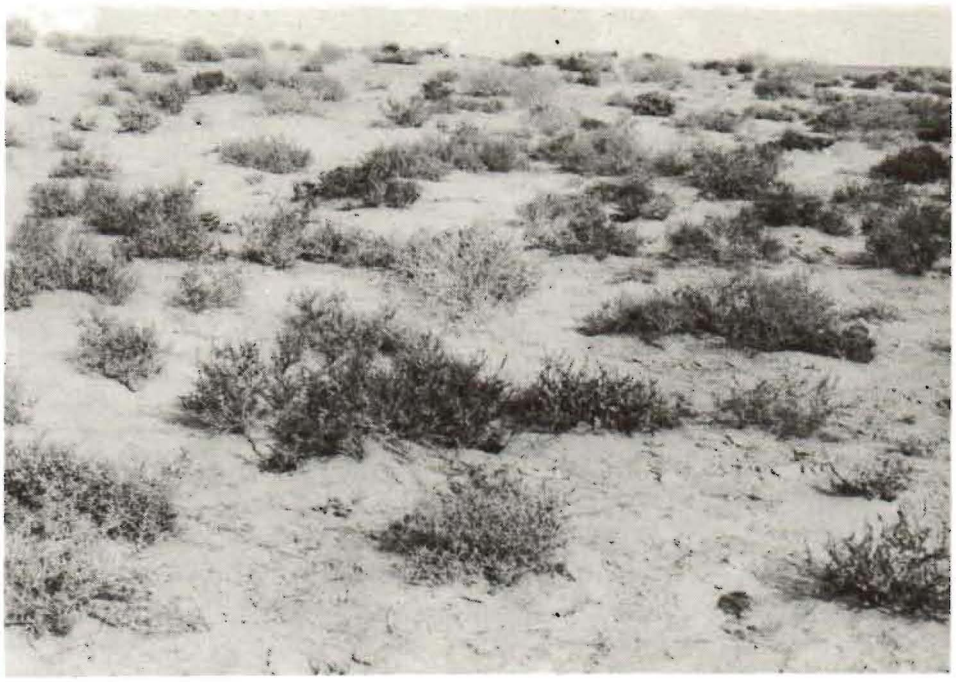

Plate 3. A stand of *Suaeda pruinosa-Salsola baryosma-Zygophyllum decumbens* community type.

c) ***Hammada elegans*** *Community Type* (Transects 1a and b, Plate 4).

The composition of this community is fairly similar in the two transects. The herbaceous layer includes the dominant species: *Hammada elegans* (F = 100%) and several other perennials (9 in Transect 1a and 7 in Transect 1b). Important species in this layer include *Cornulaca monocantha* (90-100%), *Salsola baryosma* (F = 30-95%), *Pituranthos triradiatus* (F = 60-70%) *Panicum turgidum* (F = 50-70%).

The field layer includes several annuals (16 in Transect 1a, and 14 in Transect 1b). Important components of this layer which were present in the two transects, include: *Schismus barbatus, Plantago cylindrica, Eremobium diffusum, Erodium moschatum* (F = 100%), *Paronychia arabica* (F = 90-100%), *Neurada procumbens* (F = 80-100%), *Lotus halophilus* (F = 70-100%), *Astragalus schimperi* (F = 60-100%), *Bassia mucronata* (F = 80%), *Koelpinia linearis* (F = 60%), *Moltkiopsis ciliata* (F = 40%), and *Schimpera arabica* were present in Transect 1a only, while *Launaea capitata, Heliotropium digynum* (F = 100%), *Launaea cassiniana* (F = 40%) and *Aizoon canariense* (F = 30%) were present in Transect 1b only.

Plate 4. Vegetation of *Hammada elegans* community type.

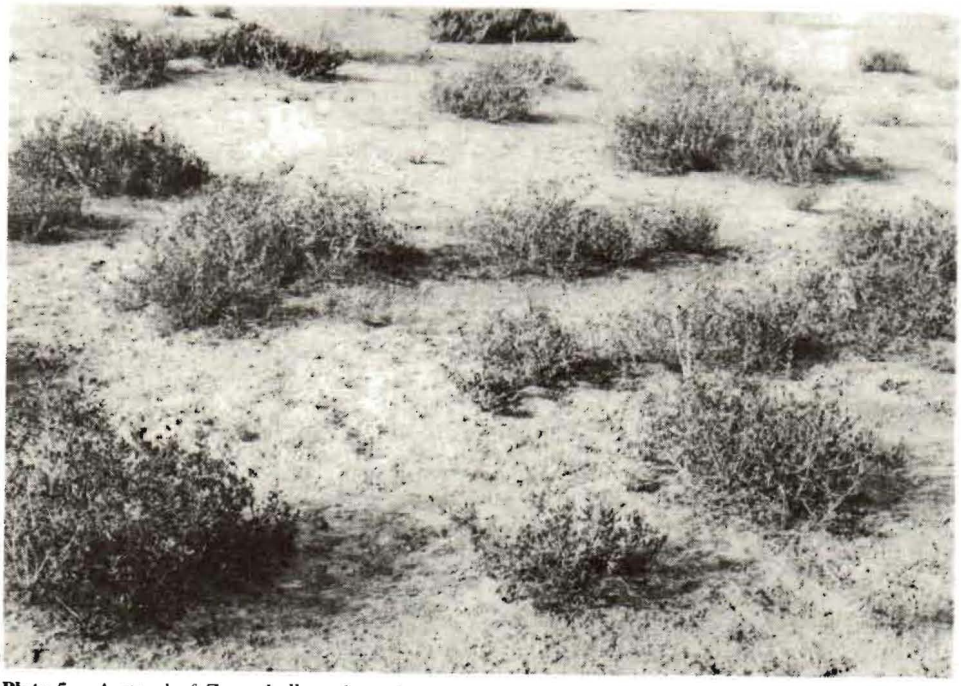

Plate 5. A stand of *Zygophyllum decumbens* community type.

d) ***Zygophyllum decumbens*** *Community Type* (Transect 1b, Plate 5).

The herbaceous layer includes the dominant species: *Zygophyllum decumbens* (F = 100%) and 9 other perennials: *Hammada elegans, Suaeda pruinosa, Salsola baryosma* (F = 100%), *Seidlitzia rosmarinus, Cornulaca monocantha* (F = 90%), *Salsola tetrandra, Pituranthos triradiatus* (F = 70%), *Panicum turgidum* (F = 30%) and *Limonium lagopoides* (F = 20%).

The field layer includes 11 annuals: *Eremobium diffusum, Lotus halophilus, Schismus barbatus, Plantago cylindrica, Paronychia arabica, Launaea capitata, Erodium moschatum, Launaea cassiniana* (F = 100%), *Bassia muricata,* (F = 40%), *Aizoon canariense* and *Emex spinosus* (F = 20%).

e) ***Suaeda pruinosa*** *Community Type* (Transect 1b, Plate 6).

This community is composed of herbaceous perennial species only. They include the dominant *Suaeda pruinosa* (F = 100%) and six other perennial species: *Zygophyllum decumbens, Limonium lagopoides* (F = 100%), *Seidlitzia rosmarinus* (F = 90%), *Salsola baryosma* (F = 60%), *Hammada elegans* (F = 30%) and *Salsola tetrandra* (F = 20%).

Plate 6. Vegetation of the *Suaeda pruinosa* community type.

Table 3. Edaphic characteristics in the different zones of vegetation in Al-Shiggah salt marsh.

Zone	Habitat	Profile	Ddepth (cm)	Coarse sand %	Fine sand %	Clay %	Silt %	Depth of water table (cm)	Moisture content %	pH	Total water-soluble salts ppm
Transect 1a											
	Lowlying flat saline ground 'Sabakha'	1	0-5	41.5	27.5	12.5	19.0	21	35.40 ± 1.29	8.7	44 800
			5-16	40.0	43.0	7.5	9.0		43.94 ± 4.45	8.6	19 200
		2	0-5	34.0	21.5	21.5	23.0	21	25.40 ± 4.19	8.9	76 640
			5-16	47.5	21.5	14.5	16.5		35.0 ± 4.48	8.9	39 040
Seidlitzia rosmarinus	End of zone towards the 'Sabakha'	3	0-5	55.5	36.0	3.5	5.0	35	27.73 ± 0.38	8.9	45 600
			5-21	60.5	16.5	11.0	12.0		28.69 ± 2.75	8.7	28 800
			21-25	35.0	47.5	8.0	9.0		30.05 ± 0.78	8.7	21 700
			25-35	43.0	34.0	8.0	15.0		30.25 ± 1.73	8.6	21 700
	Middle of the zone	4	0-5	45.5	35.5	5.0	14.0	57	15.93 ± 0.57	9.0	62 080
			5-25	56.0	28.0	3.0	13.0		26.13 ± 3.16	8.5	21 120
			25-50	45.5	42.5	5.0	7.0		30.18 ± 1.17	8.3	16 640
	landward end of zone, adjacent to *Suaeda pruinosa-Salsola baryosma-Zygophyllum decumbens* zone	5	0-5	45.0	32.5	9.0	13.0	76	7.49 ± 2.57	9.2	44 800
			5-25	40.5	44.5	6.0	9.0		17.65 ± 1.30	8.8	32 640
			25-50	42.5	47.0	7.0	3.0		20.00 ± 0.39	8.6	19 840
			50-75	72.5	22.5	2.0	2.5		23.08 ± 5.09	8.3	15 360

Suaeda pruinosa – Salsola baryosma – Zygophyllum decumbens	Within the zone	6	0-5	60.5	38.0	0.5	1.0	116	0.45 ± 0.26	9.2	11 520
			5-25	63.0	33.0	2.0	1.6		2.88 ± 0.21	9.2	11 520
			25-50	48.0	39.0	5.5	7.5		4.90 ± 0.19	9.3	5 760
		7	0-5	59.5	34.5	4.5	1.5	110	4.04 ± 0.54	8.9	4 480
			5-25	60.5	35.0	3.0	1.6		3.35 ± 0.69	9.4	5 760
			25-50	64.5	32.0	2.5	1.0		3.60 ± 1.33	9.0	6 400
	Landward end of zone adjacent to *Hammada elegans* zone	8	0-5	61.0	31.5	2.5	5.0	120	4.03 ± 0.54	8.2	2 688
			5-25	67.0	29.0	2.5	1.5		3.35 ± 0.69	8.9	7 040
			25-50	78.0	18.0	2.5	1.5		3.60 ± 1.33	8.7	5 440
Hammada elegans	Within the zone	9	0-5	56.5	39.5	2.5	1.5	No sign of water table at 2 metres depth	0.28 ± 0.21	9.0	512
			5-25	51.5	45.5	2.5	0.5		1.30 ± 0.12	9.1	339
			25-50	46.5	51.0	1.0	1.5		0.62 ± 0.01	9.4	345
Transect 1b											
Hammada elegans	Within the zone	10	0-5	54.5	39.5	2.5	3.5	No sign of water table at 2 metres depth	0.35 ± 0.09	9.2	416
			5-25	53.0	42.5	2.5	2.0		1.35 ± 0.43	9.5	435
			25-50	61.5	30.0	2.5	6.0		0.89 ± 0.17	9.3	890
	End of zone towards the 'Sabakha' and adjacent to *Zygophyllum decumbens* zone	11	0-5	51.0	40.5	2.5	6.0	162	0.59 ± 0.15	8.6	1 216
			5-25	51.5	45.0	2.5	1.0		1.52 ± 0.31	9.6	307
			25-50	54.5	43.5	1.0	1.0		1.69 ± 0.18	9.7	326

Table 3. (*Cont.*)

Zone	Habitat	Profile	Ddepth (cm)	Coarse sand %	Fine sand %	Clay %	Silt %	Depth of water table (cm)	Moisture content %	pH	Total water-soluble salts ppm
Zygophyllum decumbens	Within the zone	12	0-5	47.0	48.5	2.5	2.0	123	0.82 ± 030	9.2	7 040
			5-25	68.5	28.5	2.5	0.5		1.66 ± 0.18	9.4	3 840
			25-50	63.0	33.0	2.5	1.5		3.81 ± 0.57	8.9	6 400
		13	0-5	64.5	33.0	1.0	1.5	120	0.23 ± 0.09	9.2	8 960
			5-25	61.0	34.0	3.5	1.6		0.33 ± 0.09	9.4	11 280
			25-50	70.0	26.5	1.5	2.0		1.65 ± 0.14	8.9	7 040
Suaeda pruinosa	End of zone towards the 'Sabakha'	14	0-5	38.0	39.5	10.0	12.5	60	12.96 ± 0.67	9.2	189 440
			5-25	49.0	34.5	5.0	11.5		19.08 ± 0.60	9.0	27 520
			25-50	49.0	33.0	6.5	11.5		29.93 ± 0.94	9.0	12 800
	Within the zone	15	0-5	61.0	35.5	2.5	1.0	83	6.73 ± 0.20	8.7	26 240
			5-25	57.5	39.5	0.5	2.5		14.19 ± 0.62	8.8	14 080
			25-50	50.0	41.0	5.0	4.0		14.26 ± 0.89	8.7	10 880
		16	0-5	51.5	27.5	10.5	10.5	73	7.50 ± 0.28	9.3	158 720
			5-25	55.0	34.5	6.0	4.5		13.25 ± 0.92	9.1	17 920
			25-50	68.0	18.0	4.0	10.0		17.48 ± 2.07	8.9	10 240
	Landward end of zone adjacent to *Z. decumbens* zone	17	0-5	49.0	35.0	4.5	11.5	90	3.18 ± 0.56	9.2	25 600
			5-25	60.5	34.0	2.5	3.5		5.03 ± 0.21	9.1	7 040
			25-50	67.5	22.5	2.5	7.5		11.00 ± 1.34	8.7	7 680

Table 3 contains data concerning the edaphic characteristics in the different zones of the marsh. The soils in the different zones are, generally, sandy (but the Sabakha and the zone of *Seidlitzia rosmarinus* have comparatively high percentages of silt and clay) and alkaline (pH 8.2-9.6); moisture and salinity gradients which are due to differences in ground level, and depths of the saline water table are evident.

The lowlying flat ground 'The Sabakha' has the highest saline water table (21 cm depth), and the highest soil moisture content [25.4-35.4% at the surface (0.5 cm) and 35-43% at 5-16 cm depth]. In the zones of the different community types, the depth of the water table becomes lower and consequently the soil moisture content decreases as the land rises towards the landward end of the zone. In the *Seidlitzia rosmarinus* zone, the depth of the water table ranges between 35-76 cm and the soil moisture content between 7.5-27.7% at the surface and 17.7-28.7% at 5-25 cm depth. In the zone of *Suaeda pruinosa*, the depth of the water table ranges between 60-90 cm and the moisture content between 7.5-13% at the surface and 5-19.1% at 5-25 cm depth, while in that of *Suaeda pruinosa-Salsola baryosma-Zygophyllum decumbens* the depth of the water table ranges between 110-120 cm and moisture content between 0.38-0.45% at the surface and between 1.20-3.35% at 5-25 cm depth.

In *Zygophyllum decumbens* zone, the depth of the water table ranges between 120-123 cm, and the soil moisture content ranges between 0.23-0.83% at the surface and between 1.33-1.66% at 5-25 cm depth. The depth of the water table in the *Hammada elegans* zone is more than two metres and the moisture content ranges between 0.28-0.35% at the surface and 1.30-1.35% at 5-25 cm depth. The total soluble salts in the Sabakha range between 44800-76640 ppm in the surface samples and between 19200-39040 ppm in the samples at 5-16 cm depth. In the *Seidlitzia rosmarinus* zone, the total soluble salts range between 44800-62080 ppm at the surface and between 21120-32640 ppm at 5-25 cm depth. They range between 26240-89440 ppm in the surface samples, and between 14080-27520 ppm at 5-25 cm depth in the zone of *Suaeda pruinosa*. In the *Suaeda pruinosa-Salsola baryosma-Zygophyllum decumbens* zone the total soluble salts range, in the surface samples, between 2688-11520 ppm and between 5760-11520 ppm at 5-25 cm depth. In the *Zygophyllum decumbens* zone, the salts range between 7040-8960 ppm in the surface samples and between 3840-11280 ppm at 5-25 cm depth. In the surface samples of the zone of *Hammada elegans* they range between 416-512 ppm, and between 339-435 ppm at 5-25 cm depth.

Discussion and Conclusion

The zonation of the halophytic vegetation at Al-Shiggah salt marsh appears to be caused by a complex of factors: differences in ground level, vertical elevation above the saline water table, moisture and salinity gradients, and climatic aridity.

The level of the saline water table becomes lower and consequently soil moisture content decreases as the land rises from the central sterile lowlying flat ground, 'The Sabakha' (Plate 1), which has the highest water table and consequently the highest moisture conditions (Table 3). Here, the waterlogged conditions and the excessive salinity (Table 3) probably give a very hostile and consequently a sterile habitat (Plate 7). The depth of the water table (cm) in *Seidlitzia rosmarinus* zone < in *Suaeda pruinosa* zone < in *S. pruinosa-Salsola baryosma-Zygophyllum decumbens* zone < in *Zygophyllum decumbens* zone < in *Hammada elegans* zone (Table 3). Consequently, the soil moisture content in the different zones is in the order: *S. rosmarinus* > in *S. pruinosa* > in *S. pruinosa-S. baryosma-Z. decumbens* > in *H. elegans* zone (Table 3). It seems that the moisture requirements of the different community types are related to the soil moisture available within their habitats.

Because of the shallowly seated saline water table and very high evaporation, the habitat of *S. rosmarinus* is characterized by high soluble salts. Here salinity > in the zone of *S. pruinosa* > in the zone of *S. pruinosa-S. baryosma-Z. decumbens* > in *Z. decumbens* zone > in the zone of *H. elegans* (Table 3). The soils in the different zones of the marsh are generally sandy and alkaline (pH 8.2-9.6) (Table 3). Zonation of the vegetation seems to be mainly attributed to the salinity and

Plate 7. Sterile 'Sabakha'.

moisture gradients which result from the differences in ground level and vertical elevation above the saline water table. However, the limit of the zone of *Suaeda pruinosa* towards the zone of *Seidlitzia rosmarinus* may be due to the low water table (35-57 cm), which may create anaerobic conditions, and the increase in silt and clay ingredients.

The vegetation, generally, is characterized by a low species density (low diversity) (9 perennials + 16 annuals in the *Hammada elegans* zone, 10 perennials + 11 annuals in the *Zygophyllum decumbens* zone, 9 perennials + 4 annuals in the *Suaeda pruinosa-Salsola baryosma-Zygophyllum decumbens* zone, 7 perennials in the *Suaeda pruinosa* zone and 4 perennials in the *Seidlitzia rosmarinus* zone) (Table 2). Grime (1973) and Mahmoud *et al.* (1982) reported that environmental stress may reduce species density. The remarkable difference in species density in the zones of *S. rosmarinus* and *Suaeda pruinosa* on the one hand, and that in the other zones may be attributed to environmental stress. Only a few species within the zones of *Seidlitzia rosmarinus* and *Suaeda pruinosa* are adapted to withstand the severe conditions arising from both high salinity and high water table.

The marsh is dominated by herbaceous perennial vegetation which is supplemented (except in the zones of *S. rosmarinus* and *S. pruinosa*) during the rainy season by annual plants. However, it is not known whether the absence of annuals in the field layers of the zones of *S. rosmarinus* and *S. pruinosa* is due to the lack of seeds or to the failure of the seeds which reach these zones to germinate and/or to the failure of seedling establishment because of unfavourable edaphic conditions or a combination of these considerations.

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إيكولوجية الغطاء النباتى لسبخة ملحية داخلية فى الشِّقة بمنطقة القصيم بالمملكة العربية السعودية

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يتميز الغطاء النباتى فى السبخة الملحية الداخلية فى الشقة بمنطقة القصيم بتوزعه إلى مناطق. وقد كانت أنماط المجتمعات النباتية المختلفة التى تُميِّز الغطاء النباتى على النحو التالى:

- *Seidlitzia rosmarinus*
- *Suaeda pruinosa*
- *S. pruinosa-Salsola baryosma-Zygophyllum decumbens*
- *Z. decumbens*
- *Hammada elegans.*

كما أن الاختلافات في مستوى سطح الأرض والارتفاع العمودي فوق مستوى الماء الملحي الأرضي وتدرُّج مستويات رطوبة التربة وملوحتها وكذلك جفاف المناخ، كل ذلك ساهم في أنماط تَوزُّع الغطاء النباتي ومكوناته وتركيبه.

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