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A phytosociological study of *Zygophyllum album* L. in the western Mediterranean coast of Egypt

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ABSTRACT

The distribution of *Zygophyllum album* as influenced by soil factors was evaluated in different habitats in the western Mediterranean coast of Egypt. Environmental differences between different habitats have less significant consequences on the abundance of *Z. album* than do microenvironmental variations within each.

Multiple correlations between the abundance of *Z. album* and microvariations in soil characters are higher than simple ones. The distribution of *Z. album* is controlled by a multitude of interacting factors. The analysis of correlation indicates that the role of individual ions especially Na^+, Ca^{++} and Cl^- may be more important than that of other factors.

Along the gradients of $CaCO_3$ and salinity, the abundance of *Z. album* increases at medium values and decreases towards low, as well as high ones. In relation to the percentage of sand gradient *Z. album* increases in abundance at higher values.

INTRODUCTION

The landscape of the western Mediterranean coastal region of Egypt is differentiated into a northern coastal plain and a southern inland plateau. The coastal plain is characterized by 6 prominent physiographic features: (i) coastal ridge, composed mainly of snow-white oolitic calcareous rocks, overlain by dunes; (ii) saline depressions, with brackish water and saline calcareous deposits; in other places, the depressions are less saline and the water table is relatively deep (>1 m); (iii) non-saline depressions, with a mixture of calcareous and siliceous deposits of deep loess; (iv) inland ridges, formed of limestone with a hard crystallized crust, and less calcareous than the coastal ridge; (v) inland plateau, characterized by an extensive flat rocky surface and shallow soil; (vi) inland siliceous deposits, sporadically distributed on the inland plateau and occasionally forming dunes, especially in more inland sites. These habitats are more or less arranged in sequence from the northern Mediterranean coast to the south.

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Phytosociological and ecological studies in this region reveal that many species (e.g. *Thymelaea hirsuta, Asphodelus microcarpus, Plantago albicans, Anabasis articulata, Gymnocarpos decandrum, Zygophyllum album, Pituranthos turtuosus, Helianthemum lippii* and *Noaea mucronta*) are of wide ecological amplitude; each attains a relatively high value of abundance in at least three habitats (Ayyad & Hilmy 1974; Ayyad & El-Ghonemy 1976; Ayyad & El-Ghareeb 1982; Shaltout 1983; Abdel-Razik *et al.* 1984). The distributional behaviour of *Zygophyllum album* as influenced by soil factors has been dealt with casually by many investigators in previous studies. The present study is an attempt to analyse the distribution of *Z. album* in order to: a) provide quantitative estimates of its abundance in different habitats in the western Mediterranean coastal region of Egypt and to assess the magnitude of variation of such abundance within each habitat; b) evaluate the correlations with different soil factors; and c) determine the mode of its behaviour along gradients of controlling factors.

REVIEW OF LITERATURE

Z. album is distributed throughout the north African Sahara to Arabia and tropical East Africa (Hosny 1978). Muschler (1912) recorded *Z. album* in Egypt, Algeria, Tunisia, Libya and Syria. It is recorded in floras of Syria, Palestine, and Sinai (Post & Dinsmore 1933), Lebanon and Syria (Mouterde 1966), Algeria (Quézel & Santa 1962), Tunisia (Cuenod 1954), and Egypt (Täkholm 1974). In other monographs, *Z. album* is recorded by Pampanini (1916) in Libya, by De Cosson (1935), Oliver (1938), and Montasir (1943) in Egypt, and Monteil & Sauvage (1949) in the Sahara.

Z. album has a wide geographical distribution in Egypt. It is common in the dry salt marshes in the coastal belts of the Mediterranean and the Red Sea. It is also abundant in certain inland desert wadis within the saline areas around the brackish water springs. Moreover, it is common in the area south of Lake Bardawil east of the Suez Canal. In the Western Desert, it is found in wadi El-Natrun depression and in saline dry patches along the Cairo–Alexandria desert road (Batanouny & Ezzat 1971). Montasir & Foda (1955) considered *Z. album* to be one of the most characteristic plants in deep sandy places with relatively high percentage of water-soluble salts.

The growth of *Z. album* in Egypt under widely different conditions of rainfall (158 mm/annum at Mersa Matruh to 3 mm/annum at Hurgada) shows that this species is not affected to a great extent by rainfall (Batanouny & Ezzat 1971). According to the same authors, the soils supporting this species have salt contents reaching 5·49% in the upper layer (0–25 cm). The carbonate content shows a wide range between 1·5 and 31·5%. The plant is a sand-binder and helps in stabilizing mobile sand and forming phytogenic hillocks. The hillocks formed by this species and others were studied by Batanouny & Batanouny (1968).

Tadros (1953) studied the halophytic communities in the western Mediterranean coast of Egypt and arranged the associations present starting from the more saline to the less saline. He found that *Z. album* follows *Halocnemetum strobilaceum, Salicornieto-Staticetum,* and *Arthrocnemeto-Limoniastretum* on elevated sandy, less saline soils. In the same region, Ayyad (1976) reported that it dominates the transition sites between saline and non-saline depressions. Ayyad & El-Ghareeb (1982)

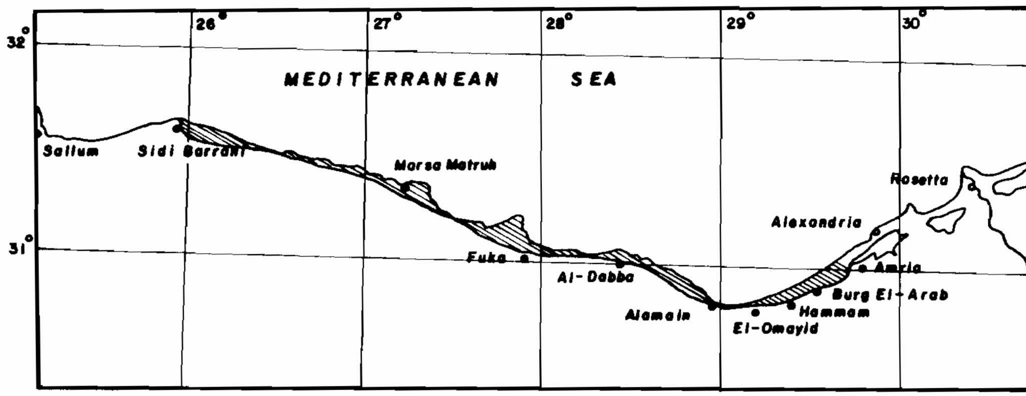

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Fig. 1. Map of the western Mediterranean coastal region of Egypt indicating the location of the study area (hatched area).

indicate that it attains high importance values in places of the saline depressions with a relatively deep water table (> 1 m) and intermediate levels of salinity.

THE STUDY AREA

Stands for field work were selected in an area along the northwestern coast of Egypt. This belt extends west approximately 500 km from Amria to Sidi Barrani (Fig. 1). It extends south for a mean distance of approximately 20 km inland. Topography, geomorphology, geology, soil, climate and vegetation of the study area are reported in detail in many studies (e.g. Ayyad & Hilmy 1974; Ayyad & El-Ghareeb 1982; Kamal 1988).

METHODS

Fifty-four stands (30 × 20 m) were marked in various major habitats and transitional sites between them. They were selected because they supported *Zygophyllum** in varying degrees of abundance. Each stand was characterized by a reasonable degree of visual physiographic and physiognomic homogeneity. In each stand, one hundred 1 × 2 m randomly distributed quadrats were sampled, and the number of individuals of each perennial species recorded. The records were then used to calculate the frequency and density of each perennial species. The sum of lengths of crown interception by each perennial, expressed as a percentage of the total length of five 30 m lines established in each stand was used as an estimation of crown cover. The density, frequency and cover were expressed for each species as a percentage of the total for all species in each stand. These three relative values were then summed up to provide an importance value (IV) for each species. Taxonomic nomenclature follows Täckholm (1974).

* *Zygophyllum* refers to *Zygophyllum album* L., unless otherwise noted.

Three soil samples (0–50 cm) were collected from each stand, air dried, thoroughly mixed, and passed through a 2 mm-sieve to remove gravel and debris. The portion finer than 2 mm was kept for physical and chemical determinations.

The procedures followed in estimating soil characters are according to the United States Salinity Laboratory Staff (1954) and Jackson (1960). Soil-water extracts at 1:5 were prepared for determinations of soil reaction, electric conductivity and concentration of water soluble Na^+, K^+, Ca^{++}, Mg^{++}, Cl^- and SO_4^{--}. A glass electrode pH meter was used to measure the soil reaction and a conductivity bridge to evaluate total soluble salts in meq/l (meq/l = electric conductivity in mhos/cm × 10^4). Na^+ and K^+ were estimated by a Perkin-Elmer model 52 flame photometer with propane burner. Ca^{++} and Mg^{++} were determined by EDTA. Determinations of Cl^- were carried out by titration against silver nitrate using potassium chromate as an indicator. Sulphates were gravimetrically estimated by precipitation as barium sulphate. Soil texture was determined by the Bouyoucos hydrometer method. Organic matter was estimated by the Walkley-Black titration method. A Collins' calcimeter was used to determine the $CaCO_3$ content, and a macro-Kjeldahl method employed to evaluate total nitrogen. Total phosphorus was extracted with conc. HCl and determined colorimetrically; colour intensities were measured by a photoelectric photometer set at 625 nm.

Stands were classified by means of a within-group dispersion method of agglomerative clustering (Orlóci 1967), using a computer program of Goldstein & Grigal (1972).

Association between the absolute density of *Zygophyllum* and different soil factors was evaluated by variance analysis. In applying this analysis, the range of variation in each factor was divided into an adequate number of equal categories and the significance of variation in the absolute density of *Zygophyllum* between these categories was tested. The least significant difference test (LSD) was applied as complementary to the analysis of variance in order to determine the significance of difference between the members of each pair of means.

The relationships between variations in soil factors and absolute density of *Zygophyllum* were evaluated by calculating simple linear correlation coefficients. The degree of significance of these coefficients was ascertained by the t-test. Multiple correlation coefficients were also calculated to assess the relationships between variations in the absolute density of *Zygophyllum* with binary combinations of soil factors.

All statistical procedures were carried out according to Steel & Torrie (1960).

Results

The most common species in the *Zygophyllum* communities are *Thymelaea hirsuta, Plantago albicans, Limoniastrum monopetalum* and *Asphodelus microcarpus*; each is recorded in 26 or more stands out of the 54 stands sampled in the present study (Table 1). However, none of these species can be considered as a leading dominant of the whole study area; instead, each exerts local dominance or is distinctly more important in a certain group of stands. This becomes evident if the average importance value of each species in the different vegetational groups resulting from the agglomerative classification is examined (Table 1). Stands of grouping "A" are dominated by *Thymelaea hirsuta* (IV = 44·26). Stands of grouping "B" are codominated

Table 1. Means of importance values of *Zygophyllum album* and common associated perennials (occurring in at least 13 stands) in different vegetational groupings resulting from the application of agglomerative classification

Species		Vegetational grouping					
		A	B	C	D	E	F
Zygophyllum album	(54)*	22·30	40·30	146·30	40·82	4·40	45·59
Anabasis articulata	(14)	—	21·12	12·52	—	104·19	39·76
Asphodelus microcarpus	(26)	17·00	29·64	49·59	1·29	59·36	64·66
Echinops spinosissimus	(17)	7·45	16·28	1·21	0·05	1·44	2·49
Echiochilon fruticosum	(13)	—	0·37	3·01	—	0·39	1.32
Frankenia revoluta	(13)	—	—	3·25	47·03	2·24	7·62
Gymnocarpos decandrum	(18)	0·16	1·98	3·78	—	4·66	3·10
Helianthemum lippii	(18)	—	0·11	1·05	—	0·55	1·47
Iris sisyrinchium	(19)	0·15	0·12	1·38	—	0·50	0·51
Limoniastrum monopetalum	(26)	7·64	81·07	21·89	189·22	25·75	23·77
Lycium europaeum	(17)	22·67	35·72	3·49	2·38	13·78	1·56
Noaea mucronata	(21)	—	8·45	6·38	—	5·62	2·75
Pituranthos turtuosus	(14)	0·25	—	1·71	—	3·29	1·72
Plantago albicans	(27)	1·42	1·48	33·40	—	11·32	15·96
Salsola longifolia	(15)	—	0·43	4·13	3·83	4·35	0·57
Salsola tetrandra	(24)	2·20	1·78	5·89	30·08	91·13	57·00
Scorzonera alexandrina	(14)	0.05	—	0·11	—	0·64	1·51
Suaeda vera	(14)	0·14	70·20	6·34	20·2	0·52	0·46
Thymelaea hirsuta	(27)	44·26	16·61	4·01	—	21·20	75·45

* The number between brackets indicates the number of occurrences.

by *Limoniastrum monopetalum* (IV = 81·07) and *Suaeda vera* (IV = 70·2). Stands of grouping "C" are overwhelmingly dominated by *Zygophyllum* (IV = 146·30), and stands of grouping "D" by *Limoniastrum monopetalum* (IV = 189·22). Stands of grouping "E" are codominated by *Anabasis articulata* (IV = 104·19) and *Salsola tetrandra* (IV = 91·13). The dominant species in the stands of grouping "F" are *Thymelaea hirsuta*, *Asphodelus microcarpus* and *Salsola tetrandra*, with importance values of 75·45, 64·66 and 57·0 respectively. Subordinate species are *Zygophyllum*, *Lycium europaeum* and *Asphodelus microcarpus* in groupings "A" and "B", *Asphodelus microcarpus* and *Plantago albicans* in grouping "C", *Frankenia revoluta*, *Zygophyllum* and *Salsola tetrandra* in grouping "D", *Asphodelus microcarpus* in grouping "E", and *Zygophyllum*, *Anabasis articulata* and *Limoniastrum monopetalum* in grouping "F".

The soils on which the different vegetational groupings are found, vary considerably both chemically and physically (Table 2). It is obvious that the soils of stands of grouping "C" dominated by *Zygophyllum* are characterized by intermediate contents of salinity (total soluble salts) and other nutrients.

The abundance of *Zygophyllum* as expressed by absolute density in each stand is indicated in Table 3, in which stands are grouped under the major types of habitats to which they belong. It is obvious that the minimum absolute density of *Zygophyllum* (0·1 individual m^{-2}) is attained in the transition sites between the saline depressions and the desert plain. Excluding this habitat, the mean absolute density of *Zygophyllum* varies between 0·56 individual m^{-2} in the coastal sand dunes and 3·10 individual m^{-2} in the transition sites between ridges and saline depressions; clearly

Table 2. The mean values of soil characteristics in different vegetational groupings resulting from the application of agglomerative classification. Each value is a mean of 3 samples

Soil factor		Vegetational grouping					
		A	B	C	D	E	F
Gravel (>2 mm)	(%)	0·06	0·39	2·00	2·97	1·16	2·36
Sand (2–0·02 mm)	(%)	95·56	90·36	74·59	62·78	64·76	54·86
Silt + Clay (<0·02 mm)	(%)	4·38	9·25	23·41	34·25	34·08	42·78
Oxidizable organic carbon	(%)	0·65	0·92	0·68	1·11	0·59	0·39
$CaCO_3$	(%)	76·18	39·91	45·48	43·11	55·17	50·10
Total nitrogen	(%)	0·08	0·06	0·03	0·10	0·08	0·01
Phosphorus (ppm)		2·69	7·36	9·62	9·65	10·56	3·40
pH		7·24	7·08	7·64	7·24	7·08	7·52
Total soluble salts	(meq/1)	39·34	67·30	47·33	87·11	12·14	11·07
Sodium	(meq/1)	16·18	29·89	15·66	42·11	2·14	1·98
Potassium	(meq/1)	1·52	1·08	0·75	1·84	0·68	0·36
Calcium	(meq/1)	2·61	6·46	11·14	8·29	3·11	2·28
Magnesium	(meq/1)	3·41	4·11	3·91	5·14	0·92	1·31
Chlorides	(meq/1)	8·94	19·45	8·81	21·62	1·93	2·39
Sulphates	(meq/1)	5·68	5·55	6·11	7·11	3·11	2·06

this range of variation is much narrower than that within any of these habitats. Thus environmental differences between these major habitats may have less significant consequences on the abundance of *Zygophyllum* than do microenvironmental variations within each.

The results of the analyses of variance of the absolute density of *Zygophyllum* in relation to different soil factors are summarized in Table 4. Values of "F" indicating the levels of significance of variation are included. *Zygophyllum* obviously varies significantly in density along gradients of sand, $CaCO_3$, total soluble salts and the concentration of Na^+, Ca^{++} and Cl^-. It is also obvious that the values of "F" in the case of individual ions are notably high, suggesting a close relationship between these ions and the phytosociological behaviour of *Zygophyllum*. In Table 5, means of absolute density of *Zygophyllum* at different categories of sand, $CaCO_3$, total soluble salts, Na^+, Ca^{++} and Cl^- are indicated; means followed by the same letter(s) in the same row are significantly different according to the LSD test; (this test was carried out for other soil factors but yielded no significant differences, and therefore were not included). In the case of sand percentage, it is obvious that all differences between the various categories are significant (Table 5). The highest mean (2·14 individual m^{-2}) is that of the fifth category, which has stands of the coarser soil texture; the lowest mean (0·13 individual m^{-2}) is that of the first category, with stands of the finer soil texture. This may indicate that performance of *Zygophyllum* is favoured by coarse soil texture.

Along the gradient of $CaCO_3$, the only significant difference is that between the means of the third and fourth categories (2·18 and 0·75 individual m^{-2}), which have calcium carbonate content more than 40% and less than 60% respectively). Along the total soluble salts gradient, the only mean that differs significantly from all others is that of the third category (the intermediate level of total soluble salts); it is due only to the notably high value of this mean (3·19 individual m^{-2}) that the

Table 3. Absolute densities (individual m^{-2}) of *Z. album* in major types of habitat. H_1 = coastal dunes, H_2 = transition between coastal dunes and saline depression, C = transition between ridges and saline depressions, D = saline depressions, E = transition between saline depressions and the inland desert plain, and F = the inland desert plain

Habitat											
H_1		H_2		H_3		H_4		H_5		H_6	
Stand	Density	Stand	Density	Stand	Density	Stand	Density	Stand	Density	Stand	Density
1	2·01	6	0·79	11	0·34	15	0·03	19	0·66	18	0·74
2	0·14	7	0·72	12	4·98	16	0·08	25	0·03	20	1·44
3	0·11	8	0·85	13	4·36	17	0·02	26	0·03	21	6·05
4	0·16	9	0·11	14	1·37	23	2·52	29	0·02	22	0·24
5	0·53	10	2·52	35	2·58	24	0·02	38	0·05	27	0·14
31	0·72	54	0·58	36	6·40	33	2·65	41	0·08	28	0·16
32	0·06			37	3·94	34	1·04	44	0·03	30	0·15
53	0·76	Mean = 0·93		40	6·03			49	0·05	39	0·24
				42	1·42	Mean = 0·91		50	0·09	45	0·30
Mean = 0·56				43	2·02			51	0·03		
				46	1·98			52	0·03	Mean = 1·05	
				47	3·20						
				48	1·72			Mean = 0·10			
				Mean = 3·10							

Table 4. F values resulting from the analyses of variance of the absolute density of *Z. album* along gradients of soil factors

Soil factor		F
Sand	(%)	3·88*
Oxidizable organic carbon	(%)	0·45
$CaCO_3$	(%)	4·80*
Total nitrogen	(%)	0·48
Phosphorus (ppm)		1·11
pH		0·44
Total soluble salts	(meq/l)	3·75*
Sodium	(meq/l)	16·71**
Potassium	(meq/l)	2·11
Calcium	(meq/l)	18·40**
Magnesium	(meq/l)	1·61
Chlorides	(meq/l)	14·40**
Sulphates	(meq/l)	1·34

* Significant $P \leqslant 0.05$.
** Highly significant $P \leqslant 0{\cdot}01$.

overall variation along this gradient is significant. The same also applies to the gradients of the concentration of Na^+, Ca^{++} and Cl^-.

The simple linear correlation coefficients (r) calculated between the absolute density of *Zygophyllum* and different soil factors are presented in Table 6. None of these coefficients is especially high, although correlation coefficients of 0·48 and 0·46 between the concentration of soluble Ca^{++} and Cl^- and the absolute density of *Zygophyllum* exist. However, it should be pointed out that the coefficient of determination (r^2), which represents the proportion of the total variation in absolute density of *Zygophyllum* significantly associated with the variation in the soil factor, is less than 0.23. It is also to be noted that the values of correlation coefficients in the case of individual ions are greater than those of other soil factors.

Table 5. Means of absolute density of *Z. album* (individual m^{-2}) at different categories of the important soil factors. Means followed by the same letter(s) in the same row are significantly different according to the LSD test. Categories of sand percentage: I = <55·0, II = 55·1–65, III = 65·1–75, IV = 75·1–85, V = >85. Categories of $CaCO_3$ (%): I = <30, II = 30·1–40, III = 40·1–50, IV = 50·1–60, V = >60. Categories of total soluble salts (meq/l): I = <13, II = 13·1–26, III = 26·1–39, IV = 39·1–52, V = >52. Categories of sodium (meq/l): I = <7, II = 7·1 – 14, III = 14·1–21, IV = 21·1–28, V = >28. Categories of calcium (meq/l): I = <1·3, II = 1·31–2·6, III = 2·61–3·9, IV = 3·91–5·2, V = >5·2. Categories of chlorides (meq/l): I = <7, II = 7·1–14, III = 14·1–21, IV = 21·1–28, V = >28

Soil factor		Categories				
		I	II	III	IV	V
Sand	(%)	0·13a	0·45a	0·77a	1·49a	2·14a
$CaCO_3$	(%)	1·46	1·93	2·18a	0·75a	1·56
T.S.S.	(meq/l)	0·58a	0·91b	3·19abcd	1·26c	1·16d
Na^+	(meq/l)	0·46a	0·51b	3·17abcd	0·86c	0·91d
Ca^{++}	(meq/l)	0·92a	0·56b	3·01abcd	1·01c	1.12d
Cl^-	(meq/l)	0·46a	0·90b	2·98ab	1·44	1·41

Table 6. Simple correlation coefficients (r) between the absolute density of *Z. album* and variations in soil characters. The asterisk denotes a significant correlation (at the 5·0% probability level)

Soil factor		r
Sand	(%)	+0·27
Silt + clay	(%)	+0·28
Oxidizable organic carbon	(%)	+0·11
$CaCO_3$	(%)	+0·29
Total nitrogen	(%)	+0·12
Phosphorus (ppm)		+0·17
pH		+0·15
Total soluble salts	(meq/1)	−0·29
Sodium	(meq/1)	−0·34*
Potassium	(meq/1)	+0·26
Calcium	(meq/1)	−0·48*
Magnesium	(meq/1)	+0·28
Chlorides	(meq/1)	−0·46*
Sulphates	(meq/1)	−0·31

Since simple correlations between the performance of *Zygophyllum* and single soil factors were found to be generally low, it was suspected that such performance might be more closely associated with combinations of interacting factors. Such possibility was explored by calculating multiple correlations between the absolute density of *Zygophyllum* and some binary combinations of soil factors. The results are included in Table 7. These results demonstrate clearly that multiple correlations are always higher than simple ones. For example, while simple correlations between the absolute density of *Zygophyllum* on one hand and sand, $CaCO_3$, T.S.S. on the other hand are 0·27, 0·29 and 0·29 respectively, corresponding multiple correlations are higher than 0·50. It may also be expected that still higher multiple correlations would be obtained if soil factors were taken in combinations of more than two.

Table 7. Multiple correlation coefficients (R) between the absolute density of *Z. album* and variations in binary combinations of soil characters. The asterisk denotes a significant correlation (at the 0·05 probability level). A: % sand, B: % $CaCO_3$, C: total soluble salts (meq/l), D: potassium (meq/l), E: magnesium (meq/l), F: sulphates (meq/l)

Factor combination	R
A, B	0·71*
A, C	0·56*
A, D	0·38*
A, E	0·37*
A, F	0·34*
B, C	0·53*
B, D	0·34*
B, E	0·31*
B, F	0·38*
C, D	0·48*
C, E	0·44*
C, F	0·47*
D, E	0·34*
D, F	0·38*
E, F	0·36*

DISCUSSION

The vegetation dealt with in the present study is classified by cluster analysis into six groupings named after their dominant species as follows: *Thymelaea hirsuta*, *Limoniastrum monopetalum—Suaeda monoica*, *Zygophyllum album*, *Limoniastrum monopetalum*, *Anabasis articulata—Salsola tetrandra*, and *Thymelaea hirsuta—Asphodelus microcarpus—Salsola tetrandra*. Most of these species have repeatedly been recorded as abundant in ecological studies of specific habitats in the western Mediterranean coastal region of Egypt (e.g. Tadros 1953; Tadros & Atta 1958; Ayyad 1976; Ayyad & El-Ghareeb 1982), and variations in their abundance have also been related to edaphic and topographic variations (Ayyad & El-Ghonemy 1976; Ayyad & El-Bayyoumy 1978; Ayyad & El-Ghareeb 1982; Abdel-Razik *et al.* 1984).

The vegetational groupings which resulted from the application of the cluster analysis in this study may be related to the *Salsolion tetrandrae* of habitats with soils derived from chalky rocks and marls and rich in gypsum and soluble salts (Zohary 1973) and the *Anabasion articulatae arenarium*, *Hammado-Anabasion articulatae* (Zohary 1973), and *Thymelaeion hirsutae* (Tadros & Atta 1958) of progressively less saline habitats. The associations belonging to these alliances with principal characteristic species which are also common in the northern coastal area of Egypt, have been described by Braun-Blanquet (1949), Maire & Weiller (1947), Killian & Lemée (1948), Simmoneau (1954a and b), Long (1954), Le Houérou (1959) and Novikoff (1958, 1961) in North Africa, and by Zohary (1944, 1947, 1972) in Sinai and Palestine. This may imply that the vegetation of the *Zygophyllum album* communities in the Mediterranean coastal region of Egypt represents a transition from the western communities in North Africa to those characteristic of the eastern Mediterranean. Ayyad & El-Ghareeb (1982) have arrived at a similar conclusion in their extensive study on the salt marsh vegetation of the western Mediterranean desert of Egypt.

Salinity has often been rated as the most prominent factor that has major consequences on plant life in arid regions. In many areas, the spatial distribution of species is related to salinity and plant communities are generally recognized in association with its pattern of variation (Shreve 1942; Vesey-Fitzgerald 1955; Kassas 1957; Tadros & Atta 1958; Flower & Evans 1966; Zahran 1967). Insofar as salinity adds an osmotic component to the matric potential of the soil solution, inducing "physiological dryness", it acts in the same direction as the paucity of rainfall or loss of moisture by run-off and/or excessive evaporation. In this way, salinity may be considered as one of the factors controlling the "moisture availability" and consequently the distribution of vegetation in arid regions (Ayyad & El-Ghareeb 1982). This, however, could be applicable only in explaining the macro-distribution of species. The present study provides evidence that the distribution behaviour of *Zygophyllum album* is not distinctly more related to salinity than to the concentration of individual ions. The analysis of correlation indicates that the concentration of different ions was probably more significant in determining the abundance of *Zygophyllum* in the study area. In fact, the osmotic pressure as such has not been found to be the most decisive factor in controlling the growth of plants (Boyko 1966; Heimann & Ratner 1966), and the local distribution of species is more likely related to the concentration of different ions (Gates *et al.* 1956; Chapman 1966; Ayyad & El-Ghareeb 1972, 1982). Of these ions, Na^+, Ca^{++}, and Cl^- are the most important. They do not only have a direct effect on the development and morphology of plants, but may be also responsible for changes in soil physical characters (Chapman 1964).

The spatial relations of species are evidently a product of their different needs and tolerances for physical and/or biotic factors (Ayyad & Hilmy 1974). Many studies in different habitats in the western Mediterranean desert of Egypt assert that few composite gradients are responsible for quantitative variations in the distribution of populations of species (e.g. Ayyad & Hilmy 1974; Shaltout 1983; Ayyad & El-Ghareeb 1974, 1982). In analysing the relationship between the distributional behaviour of *Zygophyllum* and soil factors taken into consideration by the present study, none of the simple linear correlations was found to be especially high. The percentage of variation in the absolute density of *Zygophyllum* which might be attributed to changes in any of these factors did not exceed 23%. This may be explained by the fact that this species may be so well adapted to the conditions in the study area that its behaviour is not noticeably affected by changes within the limits of one of the factors. When the absolute density of *Zygophyllum* was correlated with binary combinations of factors, higher values were obtained. Moreover, these factors may have an interacting effect, which means that any simple effect of a factor may depend upon the levels of other factors (Heimann & Ratner 1966; Osvald 1966; Ayyad & El-Ghareeb 1974, 1982). It may, therefore, be concluded that microvariations in the phytosociological behaviour of *Zygophyllum* in the western Mediterranean region of Egypt cannot be related to simple effects of individual factors, but rather to a complexity of interacting factors. Moreover, the relationships are not necessarily linear and analyses of curvilinear correlations may add more clarification to the subject.

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دراسة بيئية إجتماعية لنبات الرطريط
بالساحل الغربي للبحر الأبيض المتوسط بمصر

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خلاصة

في هذا البحث ، تمت دراسة توزيع نبات الرطريط (زيجوفيللم ألبم) في ست بيئات بالساحل الشمالي الغربي لمصر ، وعلاقة هذا التوزيع بالتباينات الدقيقة في بعض الصفات الطبيعية والكيمائية للتربة .

أثبتت الدراسة أن التباينات في غزارة نبات الرطريط في كل بيئة على حدة كانت أعلى من التباينات في غزارته بين البيئات المختلفة . وأوضحت التحليلات الإحصائية أن معامل الإرتباط بين غزارة النبات وأزواج من عوامل التربة كانت أعلى من معامل الإرتباط بين غزارته وعامل واحد فقط .

أظهرت النتائج أن تركيز أيونات الصوديوم والكالسيوم والكلوريدات كانت أكثر تأثيرا على توزيع النبات من عوامل التربة الأخرى . هـذا وقد تـزايدت غـزارة النبات في المـواقع ذات المستويات المتوسطة من كربونات الكالسيوم وملوحة التربة ، وفي المواقع ذات المستويات المرتفعة من نسبة الرمل .

العنوان الحالي : قسم العلوم ، كلية التربية الأساسية ، الشامية ٧١٥٠٩ ، دولة الكويت .