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Quantitative Phytosociological Study of Some Halophytes and Xerophytes in Egypt

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ABSTRACT

The present study was carried out on some halophytes and xerophytes in the Deltaic Mediterranean coastal salt marshes, desert of north and south Sinai and the northern part of the Red Sea coastal desert by studying their distribution and response to prevailing environmental factors. Vegetation and soil were sampled in 56 stands representing different saline and xeric habitat types. Relative values of frequency, density and cover were determined for each perennial species and were then added to provide an estimate of its importance value. Two Way Indicator Species Analysis (TWINSPAN) classified the stands into four defined vegetation groups using importance values of plant species. Detrended Correspondence Analysis (DCA) and Canonical Correspondence Analysis (CCA) were used to study species-environment relationships. The vegetation groups obtained by TWINSPAN classification were distinguishable and had a clear pattern of segregation on the ordination planes. Moisture content, porosity, sand fraction, sodium cation, electrical conductivity (EC) and chloride contents were the most important soil factors for the distribution of halophytic species. While the contents of calcium carbonate, magnesium and calcium cations, total nitrogen, silt and clay fractions and the soil reaction (pH) were the most effective soil factors affecting the distribution of xerophytic species.
Key words: Classification, edaphic factors, halophytes, ordination, xerophytes.

INTRODUCTION

The salt marsh vegetation is one of the most important types of vegetation in Egypt and is mainly formed of halophytes. It comprises littoral and inland salt marshes. The littoral salt marshes are the salt affected lands along the coasts of the Mediterranean Sea and the Red Sea. They are subjected to maritime influences. Beside the maritime influence of the Mediterranean Sea; the other water sources (northern lakes, drainage water, seepage water and rainfall) contribute to the creation of the Mediterranean coastal salt marshes (Zahran *et al*., 1990). The salt marshes in the middle (Deltaic) Mediterranean coast of Egypt are characterized by a shallow water table and/or high level of salinity. Some of these Deltaic salt marshes occur around edges of northern lakes and their dried bed. Others are found close to the Mediterranean Sea and are thus periodically inundated by sea water (Mashaly, 2002).

The desert vegetation is by far the most important and characteristic type of the natural plant life. It covers vast areas and is formed mainly of xerophytic shrubs and undershrubs. The Egyptian desert is among the most arid parts of the world characterized by arid and/or extreme arid climate. Vegetation is, thus, continuously exposed to extreme and drastic environmental conditions (Batanouny, 1979). In the desert, the appearance of the ephemerals and duration of their life cycles are dependent on the chance occurrence of rainy seasons. While, the xerophytes perennials are linked to the stands which they occupy, and are governed by the whole complex of physical and biotic conditions. The perennial plant cover forms the permanent framework of the desert vegetation and is the best indicator of habitat conditions (Kassas, 1952).

The salt marsh vegetation of the Deltaic Mediterranean coast has been studied by many authors (e.g. Montasir, 1937; El-Demerdash *et al*., 1990; Sharaf El-Din *et al*., 1993; Shaltout *et al*., 1995; Zahran *et al*., 1996; Mashaly, 2001 and 2002; El-Halawany 2003).

On the other hand, the desert vegetation in Egypt has been extensively studied by many authors e.g. Kassas (1952 and 1953), Kassas and Imam (1954), Kassas and El-Abyad (1962), Kassas and Girgis (1965), El-Ghonemy and Tadros (1970), Migahid *et al*. (1972), Batanouny and Abdel Wahab (1973), Batanouny and Abu Souod (1972), Ayyad and El-Ghonemy (1976), Batanouny (1979), El-Monayeri *et al*. (1981), El-Sharkawi *et al*. (1982), El-Sharkawi and Ramadan (1983 and 1984), Sharaf El-Din and Shaltout (1985), Bornkamm and Kehl (1990), Mashaly *et al*. (1995), and Mashaly (1996).

The present study aims to study the vegetation-environmental relationships by using multivariate analysis in the Deltaic Mediterranean coastal land of Egypt as well as in some areas of the Egyptian desert. Such analysis helps to emphasize the most effective and decisive soil variables that characterize the identified plant communities prevailing in the study area.

MATERIALS AND METHODS

The study area

The study area included two types of habitats: (1) Coastal saline habitat in the Deltaic Mediterranean coast, and (2) Desert or xeric habitat in North Sinai (represented by Wadi El-Arish), South Sinai (represented by St. Katherine area), and the northern part of the Red Sea coastal desert (represented by El-Galala desert) (Fig. 1).

The Deltaic Mediterranean coast of Egypt extends for a distance of about 180 km along the coast from Port Said in the east to Abu-Qir in the west with an average of 10 km in N-S direction from the coast (Mashaly, 2001). This Deltaic coast is built up by coarse and fine

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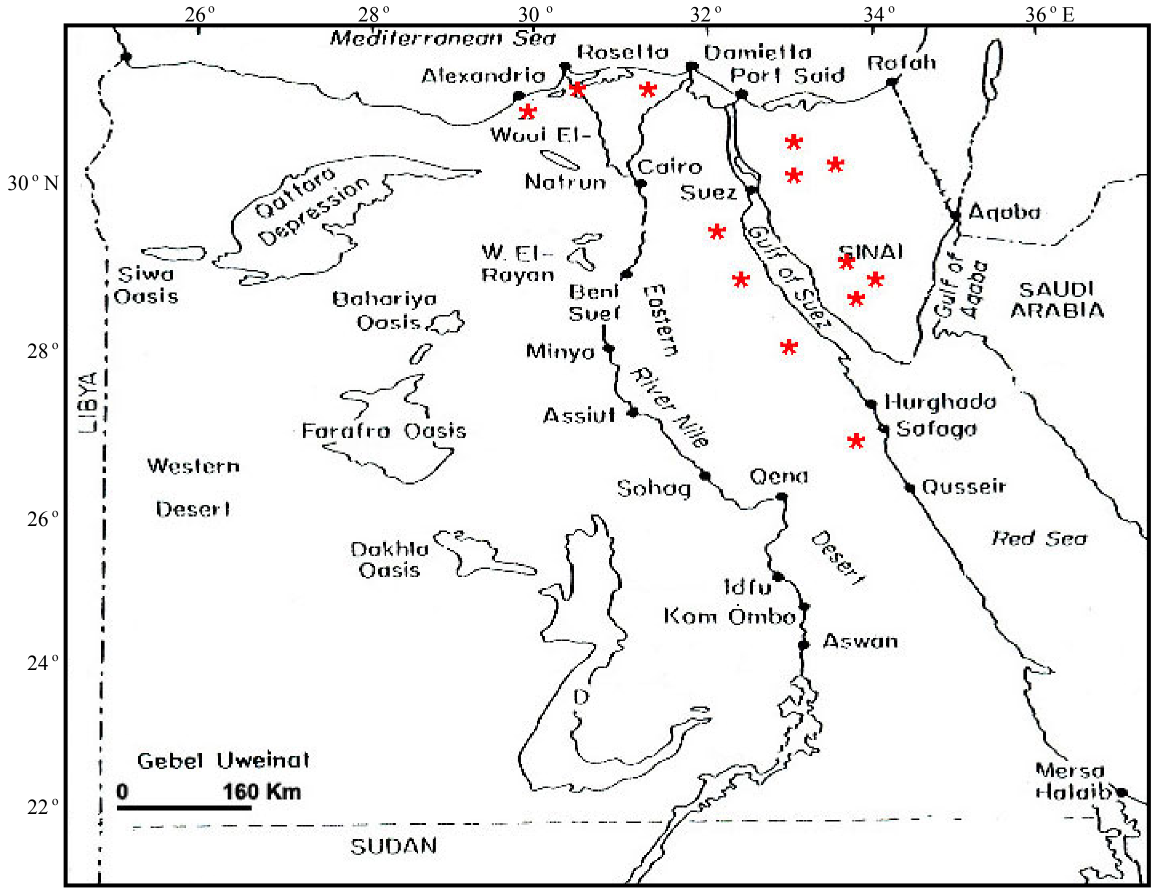

Figure (1): Map showing the locations of the study areas (*).

sand, silt and clay deposited by the River Nile (Abu Al-Izz (1971). According to Ayyad *et al.* (1983), the Deltaic coast belongs to the attenuated arid province characterized by a short dry period with warm summer, mild winter and annual rainfall from 100-160 mm.

The desert habitat was surveyed in the following three areas:

(a) North Sinai sub-region

It is represented by Wadi El-Arish. This wadi is one of the most important geographical features of northern Sinai. Its basin is about 2000 km^2 and its length is about 250 km. It narrows in its upper part through cutting the El-Tih plateau. This wadi is mainly joined by two tributaries (Wadi Al-Burak and Wadi Al-Aqaba). Along the wadi, alluvial deposit form three terraces having at the town of El-Arish, elevations of 35, 22 and 13 m above sea level (Zahran and Willis, 1992). According to Ayyad and Ghabbour (1986), North Sinai belongs to arid zone with hot summer, mild winter and rainfall of 20-100 mm.

(b) South Sinai sub-region

It is represented by St. Katherine area. This subregion has an area of one-third area of Sinai region (Shata, 1956). It was subjected to sever crustal disturbances during Tertiary and Quaternary times. St. Katherine area is traversed by several wadis; their soil is sand and covered in some parts with gravels. It belongs to hyperarid zone with cool winter, hot summer and rainfall up to 62 mm/year where precipitation may occur as snow that may last for four weeks (Migahid *et al.*, 1959).

(c) The northern part of the Red Sea coastal desert

It is represented by El-Galala desert which extends from Wadi Hagul at north to Hurghada at south. This sector extends between the littoral salt marsh belt and the coastal range of hills and mountains on the inland side. The climate is arid with mean annual rainfall ranges from 25 mm in Suez, 4 mm in Hurghada to 3.4 mm in Qussir (Zahran and Willis, 1992).

Stand selection

Fifty six stands (13 x 13 m each) were chosen along the study coastal and inland areas to represent the prevailing physiographic and physiognomic variations. The sampling process was carried out during April-October 2004. In each stand, relative density and relative frequency were estimated quantitatively using the point-centred quarter method (Cottam and Curtis, 1956; Ayyad, 1970). While, relative cover was estimated by applying the line intercept method (Canfield, 1941). Species abundance as expressed by the relative values of density, frequency and cover were calculated for each perennial species and summed up to give an estimate of its importance value (out of 300). The annual species were also recorded. Plant specimens were collected, identified and kept at the Herbarium of

Faculty of Science, Mansoura University. Species identification was according to Täckholm (1974) and Boulos (1999-2005).

RESULTS

TWINSPAN-classification

The application of TWINSPAN classification on the importance values of 89 perennial species recorded in 56 sampled stands led to recognition of four vegetation groups (Fig. 2). The vegetation structure of these groups is presented in (Table 1).

Group A comprises 8 stands codominated by *Phragmites australis* (IV = 51.09), *Zygophyllum aegyptium* (IV = 49.60) and *Arthrocnemum macrostachyum* (IV = 40.03). Other important species which attained relatively high importance values are *Cynanchum acutum* (IV=27.29), *Atriplex portulacoides* (IV=26.61) and *Halocnemum strobilaceum* (IV=24.14). *Inula crithmoides* (IV = 13.68) and indicator species *Tamarix nilotica* (IV = 10.74) are considered as common halophytic species in this group.

Group B consists of 4 stands dominated by *Sporobolus pungens* (IV = 183.03). *Alhagi graecorum* is the second important species in this group attaining a relatively high IV of about 77.08. The halophytic *Arthrocnemum macrostachyum* (IV = 21.33) and liana *Cyananchum acutum* (IV = 14.13) are also common associates in this group.

Group C comprises 34 stands codominated by *Zilla spinosa* (IV = 53.98), *Haloxylon salicornicum* (indicator species with IV = 41.54) and *Zygophyllum coccineum* (IV = 40.35). The most common species in this group is *Leptadenia pyrotechnica* (IV = 26.52). Other common species include *Panicum turgidum* (IV = 16.45), *Calotropis procera* (IV = 14.54) and *Fagonia mollis* (IV = 10.70) are also identified in this group.

Group D consists of 10 stands codominated by *Fagonia mollis* (indicator species with IV = 75.14) and *Achillea fragrantissima* (IV = 69.17). *Asclepias sinaica* (IV = 44.91) and *Fagonia bruguieri* (IV = 23.19) are considered as the most important species in this group. Other common species include *Stachys aegyptiaca* (IV = 18.52), *Zilla spinosa* (IV = 12.74) and *Artemisia judica* (IV = 11.96) are also recorded in this group.

The common associated annual species recorded in the present study include: *Senecio glaucus, Cakile maritima* subsp. *aegyptiaca, Mesembryanthemum crystillanum, M. nodiflorum, Sphenopus divaricatus, Paropholis incurva, Cotula cinerea, Zygophyllum simplex, Cleome amblyocarpa, Aizoon canariense, Asphodelus tenuifolius, Matthiola longipetala* subsp. *livida, Rumex vesicarius, Anastatica hierochuntica, Diplotaxis acris, Trigonella stellata,* etc.

Variations in soil factors

The soil variables of the four vegetation groups identified by TWINSPAN classification are presented in Table (2). It is clear that, most of soil characteristics showed remarkable variations between the different groups of stands. The soil texture in all groups is formed mainly of sand and partly of silt and clay. The moisture content, porosity and water holding capacity are higher in groups A and B than in groups C and D. Calcium carbonate content attained the highest mean value (43.07%) in group C and the lowest mean value (1.19%) in group B. The organic carbon content showed comparable mean values in group A (0.36%) and D (0.31%) as well as in group B (0.18%) and C (0.19%). The pH values indicated that, the soil reaction is slightly alkaline in all groups and it ranged between 8.21 in group A and 8.86 in group D. The electrical conductivity, chloride, sulphate, total phosphorus,

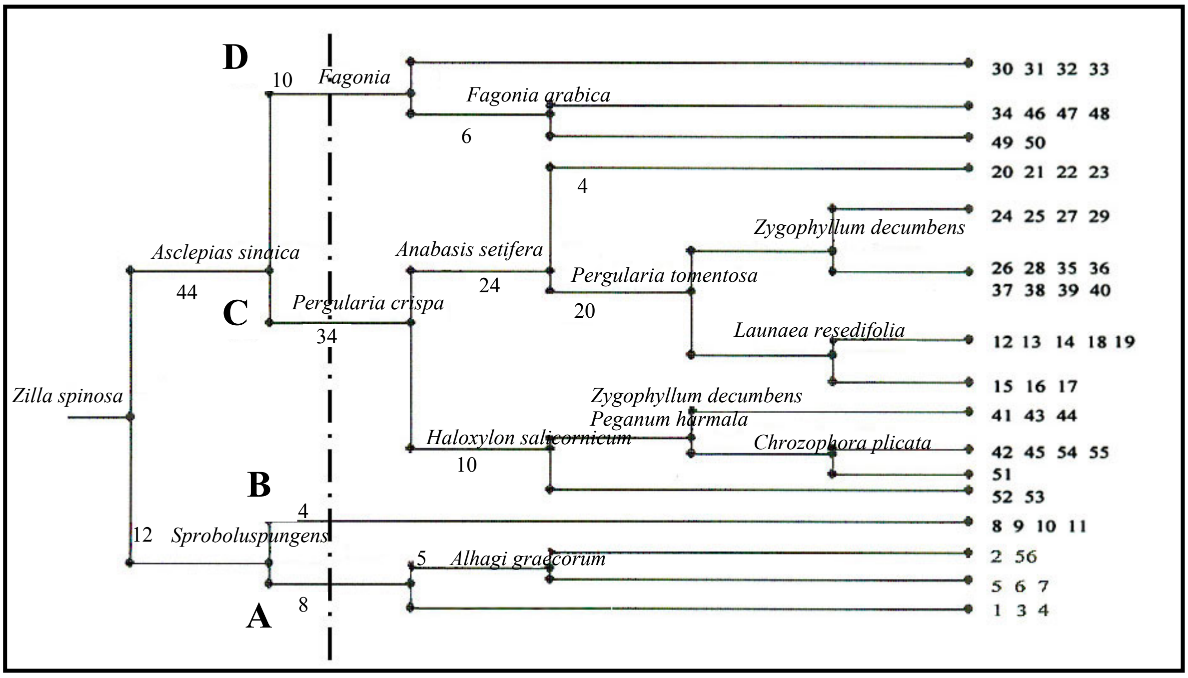

Figure (2): TWINSPAN dendrogram of the 56 stands based on importance values of 89 perennial species in the study area.

Table (1): Mean and coefficient of variation (between brackets) of the importance values of the perennial species in the different vegetation groups.

Species	Vegetation group			
	Group A	Group B	Group C	Group D
Achillea fragrantissima (Forssk) Sch. Bip.	-	-	7.66 (1.69)	69.17 (0.25)
Aerva javanica (Burm.) Juss. ex Schult.	-	-	0.02 (6.00)	-
Alhagi graecorum Boiss.	4.88 (1.73)	77.08 (0.57)	0.02 (6.00)	-
Alkanna orientalis (L.) Boiss.	-	-	-	9.89 (0.82)
Anabasis articulata (Forssk.) Moq.	-	-	0.04 (5.50)	-
Anabasis setifera Moq.	-	-	4.86 (3.19)	-
Artemisia judaica L.	-	-	1.45 (2.48)	11.96 (0.73)
Artemisia monosperma Delile	-	-	3.32 (3.24)	-
Arthrocnemum macrostachyum (Moric.) Koch	40.03 (1.17)	21.33 (1.02)	-	-
Asclepias sinaica (Boiss.) Muschl.	-	-	-	44.91 (0.42)
Aster squamatus (Spreng.) Hieron.	2.44 (1.85)	-	-	-
Astragalus spinosus (Forssk.) Muschl.	-	-	0.23 (4.61)	-
Atractylis carduus (Forssk.) Chr.	-	-	0.65 (3.89)	-
Atriplex halimus L.	-	-	5.65 (3.60)	-
Atriplex portulacoides L.	26.61 (1.49)	-	-	-
Atriplex semibaccatus R.Br.	3.31 (1.73)	-	-	-
Ballota undulate (Fresen.) Benth.	-	-	-	4.90 (2.11)
Calotropis procera (Aiton) W.T. Aiton	-	-	14.54 (1.86)	-
Capparis spinosa L.	-	-	0.07 (6.14)	-
Chrozophora plicata (Vahl) Spreng.	-	-	0.47 (5.55)	-
Citrullus colocynthis (L.) Schrad.	-	-	0.19 (3.32)	3.32 (2.84)
Convolvulus lanatus L.	-	-	0.36 (3.53)	-
Cressa cretica L.	0.81 (2.65)	-	-	-
Crotalaria aegyptiaca Benth.	-	-	1.01 (4.52)	-
Cynanchum acutum L.	27.29 (1.13)	14.13 (0.96)	0.11 (4.82)	-
Cynodon dactylon (L.) Pers.	6.89 (1.61)	-	0.73 (5.10)	-
Cyperus laevigatus L.	3.25 (1.73)	-	-	-
Deverra tortuosa (Desf.) DC.	-	-	8.40 (2.81)	3.71 (1.50)
Echinops spinosus L.	-	2.88 (1.44)	6.61 (1.70)	0.94 (2.77)
Echium angustifolium Mill. ssp. sericeum (Vuhl) Klotz	0.81 (2.66)	-	-	-
Euphorbia retusa Forssk.	-	-	1.49 (2.67)	1.54 (0.48)
Fagonia arabica L.	-	-	2.75 (1.84)	2.80 (1.04)
Fagonia bruguieri DC.	-	-	-	23.19 (1.27)
Fagonia mollis Delile	-	-	0.25 (3.56)	75.14 (0.48)
Farsetia aegyptia Turra	-	-	10.70 (1.51)	-
Forsskaolea tenacissima L.	-	-	0.10 (5.80)	-
Frankenia hirsute L.	-	1.56 (1.75)	-	-
Gypsophila capillaries (Forssk.) C. Chr.	-	-	4.11 (2.63)	-
Halocnemum strobilaceum (Pall.) M. Bieb.	24.14 (2.09)	-	-	-
Haloxylon salicornicum (Moq.) Bunge ex Boiss.	-	-	41.54 (0.97)	-
Heliotropium dignum (Forssk.) C. Chr.	-	-	0.39 (3.82)	-
Hyoscyamus muticus L.	-	-	1.53 (2.46)	-
Inula crithmoides L.	13.68 (1.61)	-	-	-
Iphiona mucronata (Forssk.) Asch. & Schweinf.	-	-	1.41 (4.26)	-
Juncus acutus L.	1.63 (1.72)	-	-	-
Juncus rigidus Desf.	0.81 (2.65)	-	-	-
Kickxia aegyptiaca (L.) Nabelek	-	-	2.35 (2.45)	0.68 (3.00)
Lasiurus scindicus Henrard	-	-	6.23 (2.73)	-
Launaea resedifolia (L.) Kuntze	-	-	0.60 (3.13)	-
Launaea spinosa (Forssk.) Sch. Bip. ex Kuntze	-	-	5.31 (3.18)	0.58 (2.28)
Lavandula coronopifolia Poir.	-	-	0.55 (4.53)	-
Leersia hexandra Sw.	0.81 (2.65)	-	-	-
Leptadenia pyrotechnica (Forssk.) Decne.	-	-	26.52 (1.65)	-
Limonium narbonense Mill.	1.63 (2.64)	-	-	-
Matthiola arabica Boiss.	-	-	-	2.78 (1.51)
Moltkiopsis ciliata (Forssk.) I.M. Johnst.	-	-	0.41 (3.29)	-
Nauplius graveolens (Forssk.) Wiklund	-	-	0.81 (2.91)	-
Ochradenus baccatus Delile	-	-	0.43 (5.81)	-
Origanum syriacum L.	-	-	-	0.54 (2.20)
Panicum repens L.	4.06 (1.78)	-	-	-
Panicum turgidum Forssk.	-	-	16.45 (1.98)	0.33 (3.00)
Paspalidium geminatum (Forssk.) Stapf	2.43 (1.86)	-	-	-
Peganum harmala L.	-	-	1.84 (2.74)	5.35 (1.86)
Pergularia tomentosa L.	-	-	9.52 (1.63)	0.46 (3.00)
Persicaria salicifolia (Willd.) Assenov	1.63 (1.72)	-	-	-
Phlomis aurea Decne	-	-	-	3.07 (2.57)
Phragmites australis (Cav.) Trin. ex. Steud.	51.09 (1.27)	-	-	-
Phyla nodiflora (L.) Greene	2.44 (1.85)	-	-	-
Pluchea dioscoridis (L.) DC.	2.50 (1.87)	-	-	-
Polycarpaea repens (Forssk.) Asch. & Schweinf.	-	-	0.28 (2.68)	-
Polygonum equisetiforme Sm.	3.25 (2.00)	-	-	-
Pulicaria crispa (Forssk.) Oliv.	-	-	7.97 (2.13)	-
Reaumuria hirtella Jaub and Spach	-	-	0.22 (4.59)	-
Retama raetam (Forssk.) Webb and Berthel.	-	-	0.64 (4.28)	-
Salvia deserti Decne.	-	-	0.59 (3.34)	-

Scrophularia deserti Delile	-	-	0.40 (5.88)	-
Senna italica Mill.	-	-	0.34 (5.85)	-
Solenostemma arghel (Delile) Hayne	-	-	-	0.07 (3.00)
Sphaerocoma kookeri T. Anderson	-	-	0.47 (4.23)	0.33 (3.00)
Sporobolus pungens (Schreb.) Kunth	4.06 (1.78)	183.03 (0.20)	-	-
Stachys aegyptiaca Pers.	-	-	0.61 (4.10)	18.52 (1.26)
Suaeda pruinosa Lange	9.20 (1.87)	-	-	-
Tamarix nilotica (Ehrenb.) Bunge	10.74 (2.04)	-	-	-
Trichodesma africanum (L.) R.Br.	-	-	0.72 (4.33)	-
Varthemia montana (Vahl) Boiss.	-	-	-	3.08 (2.01)
Zilla spinosa (L.) Prantl.	-	-	53.98 (0.54)	12.74 (1.30)
Zygophyllum aegyptium Hosny	49.60 (1.29)	-	-	-
Zygophyllum coccineum L.	-	-	40.35 (0.81)	-
Zygophyllum decumbens Delile	-	-	1.79 (2.52)	-

Table (2): Mean and standard error (StEr) of the different soil variables in the stands representing the different vegetation groups obtained by TWINSPAN classification of sampled stands in the study areas.

Soil variable	Group A		Group B		Group C		Group D	
	Mean	StEr	Mean	StEr	Mean	StEr	Mean	StEr
Sand (%)	92.41	1.20	96.98	0.66	80.07	2.60	82.78	2.73
Silt (%)	6.44	1.23	2.77	0.82	18.19	2.38	14.37	2.33
Clay (%)	1.15	0.55	0.24	0.01	1.74	0.25	2.85	0.53
Moisture content (%)	12.22	3.70	9.54	3.59	0.93	0.23	0.95	0.26
Porosity (%)	46.68	4.79	42.40	1.17	34.40	0.62	36.19	1.54
Water-holding capacity (%)	41.74	5.11	36.81	0.37	35.86	1.40	39.11	2.56
$CaCO_3$ (%)	4.17	2.07	1.19	0.39	43.07	3.49	6.52	0.94
Organic carbon (%)	0.36	0.10	0.18	0.01	0.19	0.03	0.31	0.02
pH	8.21	0.14	8.68	0.31	8.59	0.04	8.86	0.07
EC (mmhos/cm)	1.78	0.68	0.74	0.26	0.37	0.06	0.10	0.01
Cl^- (%)	0.64	0.26	0.16	0.06	0.05	0.01	0.01	0.00
$SO4^{-2}$ (%)	0.26	0.04	0.10	0.02	0.19	0.02	0.13	0.01
$HCO3^-$ (%)	0.08	0.02	0.13	0.03	0.09	0.01	0.08	0.00
Total Phosphorus (mg/100 g dry soil)	0.24	0.11	0.12	0.00	0.17	0.03	0.03	0.02
Total Nitrogen (mg/100 g dry soil)	2.16	0.44	0.90	0.10	2.25	0.18	3.45	0.46
Na^+ (mg/100 g dry soil)	153.83	52.88	108.4	22.60	3.62	0.39	1.15	0.23
K^+ (mg/100 g dry soil)	16.00	2.82	13.56	2.02	12.04	1.24	7.44	0.66
Ca^{++} (mg/100 g dry soil)	12.20	8.23	1.13	0.29	31.80	3.63	36.48	2.06
Mg^{++} (mg/100 g dry soil)	13.48	7.18	0.75	0.50	23.66	2.03	23.45	1.27
SAR	96.57	34.53	123.60	17.07	0.72	0.07	0.21	0.05
PAR	8.57	2.10	15.23	0.50	2.82	0.49	1.87	0.47

SAR = Sodium adsorption ratio, **PAR** = Potassium adsorption ratio

sodium and potassium cations attained their highest mean values in group A, and the lowest mean values in group D. The mean values of soluble bicarbonate are comparable in all groups with trace amount varied from 0.08% to 0.13%. On the other hand, the total nitrogen, calcium and magnesium cations attained their highest mean values in group D and the lowest mean values in group B.

The correlation coefficient (r) between the different soil variables in the sampled stands are shown in Table (3). It is clear that, all edaphic variables are significantly correlated with each other except bicarbonate, total phosphorus and potassium cation. It is also obvious that, there are four ranges of correlations between soil factors: (1) Wide range of significant correlations between sodium, magnesium, calcium, chloride, electrical conductivity and water-holding capacity, (2) Moderate range of significant correlations between calcium carbonate, organic carbon and sulphate contents, (3) Narrow range of correlations between fine fractions (silt and clay), total phosphorus, total nitrogen, porosity, soil reaction (pH) and potassium, and (4) No any correlations between soil moisture and bicarbonate contents.

Detrended correspondence analysis (DCA)

The ordination diagram resulting from DCA is shown in Figure (3). Group A codominated by *Phragmites australis, Zygophyllum aegyptium* and *Arthrocnemum macrostachyum* is segregated at the upper and mid-right side of the diagram. While, group B dominated by *Sporobolus pungens* is separated at the lower right side of the diagram. On the other hand, group C codominated by *Zilla spinosa, Haloxylon salicornicum* and *Zygophyllum coccineum* and group D codominated by *Fagonia mollis* and *Achillea fragrantissima* are clearly superimposed and segregated at the mid-left side of DCA diagram.

Canonical correspondence analysis (CCA)

The relationship between vegetation types and soil variables is indicated on the ordination diagram produced by CCA of the perennial species (Fig. 4). It is obvious that, sodium, chloride and electrical conductivity showed high significant correlation with the second axis of the diagram, where vegetation group A is segregated. However, moisture content, sodium and potassium adsorption ratios as well as soil porosity exhibited positive significant correlation with the same axis, where vegetation group B is separated.

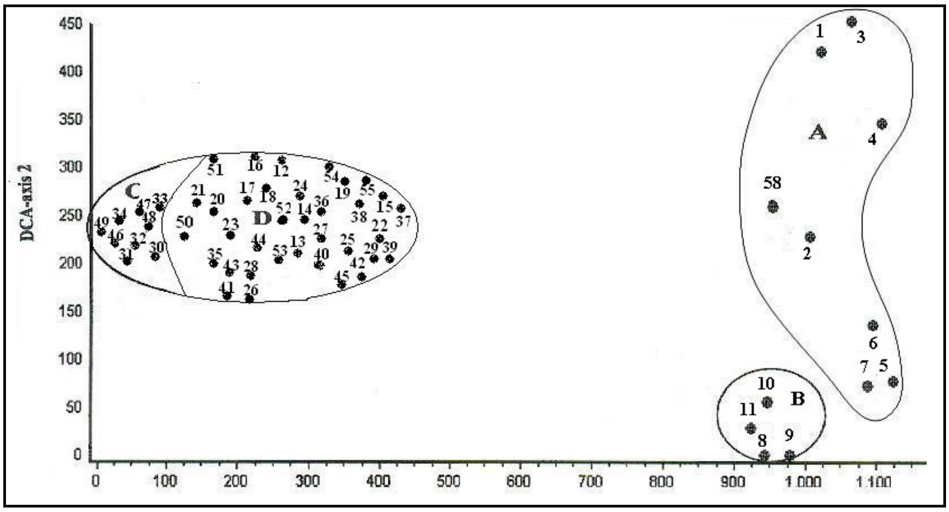

Figure (3): Detrended correspondence analysis (DCA) ordination diagram of the 56 sampled stands with TWINSPAN groups.

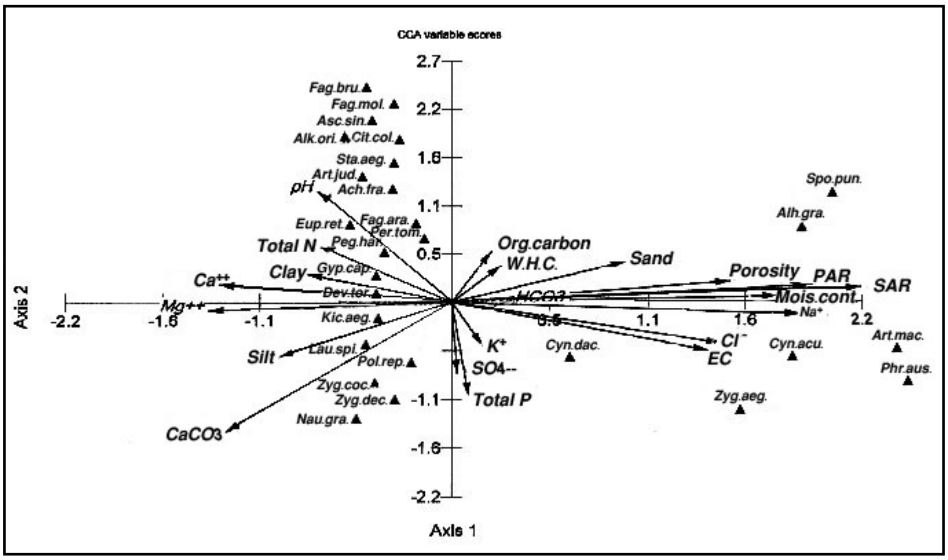

Figure (4): Canonical correspondence analysis (CCA) ordination diagram with different variables represented by arrows. The indicator and preferential species are abbreviated to the first three letters of each genus and species.

On the other hand, soil reaction (pH), calcium, total nitrogen and clay showed significant correlation with the first and second ordination axes, where vegetation group D is separated. While, calcium carbonate, magnesium and silt exhibited significant correlation with the same axes, where vegetation group C is segregated.

DISCUSSION

In recent times, the classification and ordination of the vegetation units has received serious attention, and a number of theoretical and practical treatises have been published on this subject. The purpose of measuring diversity and structure of a community is usually to judge its relationship to other community properties such as a productivity and stability or to the environmental conditions to which the community is exposed (Pielou, 1975). The community diversity increases as the number of species per sample increases and the abundance of species within a sample becomes even (Shafi and Yarranton, 1973).

In the present study, the vegetation was classified by TWINSPAN classification into four groups named after their dominant and/or codominant species as follows: *Phragmites australis - Zygophyllum aegyptium – Arthrocnemum macrostachyum* (group A), *Sporobolus pungens* (group B), *Zilla spinosa – Haloxylon salicornicum – Zygophyllum coccineum* (group C) and *Fagonia mollis – Achillea fragrantissima* (group D).

It is clear that; group A may represent the halophytic vegetation predominating the coastal saline habitat of the Deltaic Mediterranean coast. While, group B may

Table (3): Pearson-moment correlation (r) between the soil variables in the sampled stands in the study areas.

	Sand	Silt	Clay	M.c.	Por.	W.H.C.	CaCO3	O.c.	pH	EC	Cr	SO_4^{-2}	HCO_3^-	Tot. P	Tot. N	Na^+	K^+	Ca^{+2}	Mg^{+2}	SAR
Sand																				
Silt	-0.947																			
Clay	-0.763	0.706																		
M.c.	0.196	-0.211	0.039																	
Por.	0.045	-0.067	0.122	0.749																
W.H.C.	-0.326	0.335	0.384	0.573	0.748															
CaCO3	-0.253	0.301	0.01	-0.395	-0.342	-0.108														
O.c.	0.025	-0.076	0.208	0.424	0.533	0.522	-0.223													
pH	-0.058	0.042	0.166	-0.081	-0.312	-0.043	0.022	0.06												
EC	0.208	-0.243	0.033	0.833	0.665	0.46	-0.2	0.423	-0.286											
Cr	0.189	-0.227	0.097	0.846	0.734	0.511	-0.246	0.463	-0.292	0.967										
SO_4^{-2}	0.084	0.071	0.006	0.22	0.186	0.137	0.54	0.308	0.171	0.47	0.375									
HCO_3^-	0.043	0.002	0.017	0.228	0.125	0.144	0.217	0.003	0.094	0.174	0.182	0.033								
Tot. P	-0.287	0.374	0.186	0.101	0.144	0.239	0.128	0.221	0.03	0.085	0.041	0.047	0.083							
Tot. N	-0.25	0.24	0.276	0.051	0.137	0.283	-0.162	0.176	0.203	-0.033	0.027	0.113	0.055	-0.019						
Na^+	0.262	-0.292	-0.017	0.906	0.69	0.425	-0.3712	0.333	-0.227	0.908	0.925	0.245	0.218	-0.027	-0.106					
K^+	0.132	-0.12	-0.12	0.143	0.102	0.096	0.328	0.104	0.033	0.252	0.208	0.255	0.089	0.091	0.005	0.169				
Ca^{+2}	-0.198	0.178	0.204	-0.319	-0.28	-0.102	0.075	-0.092	0.167	-0.206	-0.277	0.296	-0.098	-0.205	0.419	-0.436	-0.049			
Mg^{+2}	-0.228	0.24	0.118	-0.31	-0.143	0.077	-0.006	0.188	0.031	-0.316	-0.322	-0.034	-0.199	0.195	0.294	-0.477	-0.097	0.472		
SAR	0.308	-0.335	-0.089	0.881	0.65	0.355	-0.411	0.252	-0.169	0.823	0.815	0.163	0.229	-0.056	-0.2	0.96	0.14	-0.488	-0.556	
PAR	0.274	-0.277	-0.212	0.654	0.492	0.219	-0.383	0.157	-0.255	0.61	0.559	0.086	0.145	-0.014	-0.192	0.726	0.18	-0.39	-0.498	0.826

M.c. = Moisture content, **Por.** = Porosity, **W.H.C** = Water holding capacity, **O.c.** = Organic carbon, **EC** = Electrical conductivity, **Tot. P.** = total phosphorus, **Tot. N** =Total nitrogen, **SAR** = Solution adsorption ratio, **PAR** = Potassium adsorption ratio, ***** Significant at $p < 0.05 = 0.273$, ****** Significant at $p < 0.01 = 0.354$, ******* Significant at $p < 0.001 = 0.443$.

represent the salt-tolerant vegetation predominating saline sand flats of the study areas. On the other hand, groups C and D may represent the xerophytic vegetation in the study desert habitat. Most of the species in both of groups A and B have analogues in the Mediterranean coastal land of Egypt, e.g. the studies of Tadros and Atta (1958), Ayyad and El-Ghareeb (1982), Zahran *et al*. (1990), El-Demerdash *et al*. (1990), Shaltout *et al*. (1995), Mashaly (2001 and 2002). However, the species in both of groups C and D have analogues in the Egyptian desert, e.g. the studies of Kassas (1952 and 1953), Kassas and Imam (1954), Kassas and El-Abyad (1962), Kassas and Zahran (1962), Kassas and Girgis (1965), Batanouny and Abu El-Souod (1972), Batanouny (1973 and 1979), El-Ghareeb and Abdel-Razik (1984), Sharaf El-Din and Shaltout (1985), El-Ghareeb and Shabana (1990), Zahran and Willis(1992), Mashaly *et al*. (1995), Mashaly (1996).

The identified vegetation groups in the present study may be related to alliances and associations described by Eig (1939), Zohary (1973) and Danin (1986).

In the present study, Detrended Correspondence Analysis showed that, the halophytic vegetation groups (A and B) are markedly segregated at the right side of DCA diagram. However, the xerophytic vegetation groups (C and D) are obviously separated at the left side of the diagram. This clear distinguished segregation between the recognized vegetation types are due to the differences in their floristic composition, nature of soils supporting their growth as well as due to the various macro and microclimatic conditions prevailing in their habitat and/or subhabitat types.

Ayyad (1981) claimed that, the classification of vegetation into communities is commonly related to soil physical characters, nature of surface and topographic peculiarities which all act through modifying the amounts of available moisture. Next to moisture availability, salinity is the most prominent factor having major consequences on plant life in arid and semi-arid lands. El-Sharkawi *et al*. (1982) and Sharaf El-Din and Shaltout (1985) recognized that, water and organic matter contents seem to be the most critical ecological factors in determining the studied type of vegetation. Also, the most important soil gradients which correlate with the abundance and distribution of vegetation as mentioned by Ayyad and El-Ghonemy (1976) and El-Kady (1993) are soil salinity, calcareous sedimentations, soil reaction, soil fertility (organic matter and phosphorus contents), moisture availability and soil texture. In the present investigation, the Canonical Correspondence Analysis indicated that, the distribution and abundance of the identified halophytic groups (A and B) are mainly controlled by the following edaphic factors: sodium, chloride, electrical conductivity (salinity), soil moisture and porosity. However, the xerophytic groups (C and D) are mainly governed by the following soil variables: soil reaction (pH), calcium, total nitrogen, fine fractions (silt and clay), calcium carbonate and magnesium content.

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دراسة بيئية اجتماعية كمية على بعض النباتات الملحية والجفافية في مصر

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الملخص العربـــي

استهدف هذا البحث دراسة تركيب ووفرة وتوزيع الغطاء النباتي لبعض المجتمعات النباتية الملحية الجفافية (الصحراوية) وذلك في بيئات المستنقعات الملحية بساحل البحر المتوسط لدلتا النيل وصحراء شمال وجنوب سيناء وصحراء الجلالة بساحل البحر الأحمر وعلاقة ذلك بالعوامل البيئية السائدة.

تم اختيار 56 موقعا وزعت توزيعا عشوائيا لتمثل جميع المتغيرات البيئية بمناطق نمو النباتات محل الدراسة وذلك لتحليل الكساء النباتي بطرق كمية لحساب الكثافة النسبية والتكرار النسبي والتغطية النسبية لكل نوع نباتي معمر لتقدير درجة الأهمية لكل نوع على حدة ، كذلك تم تقدير الخصائص الطبيعية والكيميائية للتربة بكل موقع من هذه المواقع.

باستخدام برامج التقسيم ثنائي الاتجاه (TWINSPAN) وتطبيقها على درجة الأهمية للنباتات المعمرة المسجلة (89 نوع نباتي) داخل المواقع المختارة (56 موقع) فقد أمكن تمييز أربع مجموعات نباتية بمناطق الدراسة ، وباستخدام برامج توزيع التطابق العكسي (DCA) فقد أمكن فصل وتوزيع المجموعات النباتية الأربعة بوضوح على طول محاور التسلسل ،أما باستخدام برامج التطابق (CCA) فقد أوضح أن أكثر عوامل التربة تأثيرا على وفرة وتوزيع النباتات قيد الدراسة كانت كما يلي:

أولا: محتوى الرطوبة ونفاذية التربة وقوام التربة (نسبة الرمل) وتركيز كاتيونات الصوديوم والتوصيل الكهربي (الملوحة) ونسبة الكلوريدات الذائبة كانت أهم عوامل التربة ارتباطا وتأثيرا على النباتات الملحية في بيئة المستنقعات الملحية (السبخات).
ثانيا: محتويات كربونات الكالسيوم وكاتيونات الماغنسيوم والكالسيوم والنيتروجين الكلى وتفاعل التربة (الرقم الهيدروجيني) وقوام التربة (نسبة الطمي والسلت) كانت أهم عوامل التربة ارتباطا وتأثيرا على وفرة وتوزيع النباتات الجفافية في الموائل الصحراوية بمناطق الدراسة.