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Ecological Study on some Grasses Growing Naturally in the Deltaic Mediterranean Coast of Egypt

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ABSTRACT

The present study aims to investigate the floristic composition and vegetation analysis of the flora associated with some grasses growing naturally on the sand formations in the Deltaic Mediterranean coast of Egypt. The total number of the recorded plant species was 79 species (44 annuals and 35 perennials) belonging to 70 genera and 26 families. The life –form spectra of the recorded species comprised 44 therophytes, 13 cryptophytes, eight hemicryptophytes, seven chamaephytes and phanerphytes for each. Chorologically, the Saharo-Sindian element was represented by relatively high number of species (34), followed by Irano-Turanian (32 species), then Euro-Siberian (10 species) and Sudano-Zambezian (9 species). Based on the importance alue of each species, the classification of the recorded species in 36 sampled stands led to recognition of four vegetation groups (A-D). The characteristics dominant and codominant species of vegetation groups were *Elymus farcatus* and *Calligonum polygonoides* (A), *Hordeum murinum* (B), *Stipagrostis lanata* and *Echinops spinosus* (C) and *Lycium schweinfurthii* and *Echinops spinosus* (D). DCA diagram showed overlapping between the identified groups. CCA-biplot exhibited that sulfates, calcium, potassium, magnesium and calcium carbonate were the most effective soil variables controlling the abundance of identified vegetation groups.
Keywords: Grasses, Mediterranean coast, classification, ordination, soil.

INTRODUCTION

The Mediterranean coastal region of Egypt can be divided into three sections: 1) the western section (Mareotis coast) between Abu Qir at east to Sallum at west for about 550 km long, 2) the middle section (Deltaic coast) between Port- Said at east to Abu Qir at west for about 220km long and 3) the eastern section (Sinai coast) between Rafah at east to Port-Said at west for about 200 km long. The vegetation of the coastal zone is considered the richest one among the phytogeographical regions of Egypt, where its flora represents more than 50% of the total flora of Egypt (Hassib,1951; Täckholm,1974).

The Deltaic Mediterranean coast can be distinguished into four main habitats:1) Sand formations (mounds, sheets and sand dunes), 2) Salt marshes (black barren, wet and dry), 3) Fertile sandy lands (cultivated and non-cultivated) and 4) Reed swamps. The sand formations are basically siliceous deposits mixed with clay and silt particles. The sand dunes are considered as the main geomorphic features especially in western part of this coast. These dunes can be classified into three types: mobile dunes, partial stabilized dunes and stabilized dunes (Mashaly, 2001&2002; Mashaly *et al*. (2008). Floristically, Poaceae is considered as the richest family in the Deltaic Mediterranean coast, where it dominates all habitats of this area, especially the sand formation habitat type.

Grasses (constitute the largest and most valuable family among the flowering plants, with about 10000 species in the flora of Egypt; it includes 277 species (Boulos, 2009). Grasses occupy wide tracts of land and they are evenly distributed in all parts of the world. They occur in every soil, in all kinds of situation and under all climatic conditions. Although several families of plants supply the wants of man, the grass family exceeds all the others in the amount and the value of its products. The grasses growing in pasture land and the cereals grown all over the world are of more value to man and his domestic animals than all the other plants taken together (Rangachari and Tadulingam, 2007). Therefore, the selection of some natural grasses in the present study is required and urgent. Therefore, the main objective of the present investigation aims to provide insight on the floristic compition and vegetation analysis of flora associated with some grasses growing naturally in sand formations in the Delta Nile Coast of Egypt.

The Study Area

The sampled stands were distributed in **t**he sand formations in the Deltaic Mediterranean coast of Egypt (Figure1).

The geologic and vegetation structures of the Nile Delta as a part of the northern Egypt has been subjected to the same geologic events that affected the whole region during its Pre-Miocene geological history. The major elements of geomorphology of Deltaic section were given by Sestini (1976)**.** These elements comprise two main geomorphological components: coastal and deltaic. Mashaly (1987) stated that the Deltaic coastal section is characterized by morphological structure basically different from that to the west of Abu-Qir Bay (Mareotis coast) and that to the east of Port-Said (Sinai coast). The rate of Deltaic growth varies from place to place along the Mediterranean coast. This is evidenced by three headlands penetrating into the sea, one at Ras El-Barr (Damietta), another at Baltim (Kafr El-Sheikh) and the third at Rosetta (El- Behira). The soils of the Nile Delta are heavy in texture, rather compact at the surface and rich in humus (El-Gabaly *et al*., 1969a)**.** According to the map of the world distribution of the arid regions

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(UNESCO, 1977), the soils of the study area are man variants of Gleysoils and Fluvisoils that belong to the Pliocene and Pleistocene (El-Gabaly *et al*., 1969b). Deposits covering the Delta reach about 10.9 m in thickness. These deposits are composed mainly of silt, clay, sandy clay with biotite, magnetite and limestone formations, these deposites are considered as the basis of Egypt's fertility (Abu Al-Izz, 1971). Ayyad and El-Gharbeeb (1984) mentioned that the Mediterranean coastal region of Egypt belongs to the dry arid climate zone of Koppen's classification system (1931), the arid mesothermal province of Thornthwaite (1948), and the Mediterranean coastal arid bioclimatic zone of Emberger (1955). The mean maximum air temperature ranged between 18.1 °C in January at Rosetta to 34 °C in July at Mansoura, and the mean minimum air temperature varied from 6.8 °C in January at Mansoura to 24.9 °C in August at Rosetta**.** The small amount of rainfall (100 – 150 mm) in the study area falls during winter season (November-March), while summer is practically dry and hot. The relative humidity varied from 69% in summer to 84% in winter.

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MATERIAL AND METHODS

During spring 2016, number of stands (36) was surveyed to represent five selected annual and perennial grasses namely. *Aegilops bicornis* (Forssk.) Jaub & Spach, *Bromus diandrus* Roth, *Elymus farctus* (Viv.) Runem.ex Melderis, *Hordeum murinum* L.and *Stipagrostis lanata* (Forssk.) De Winter. Thirty six stands (10m x 10m each) were chosen for sampling

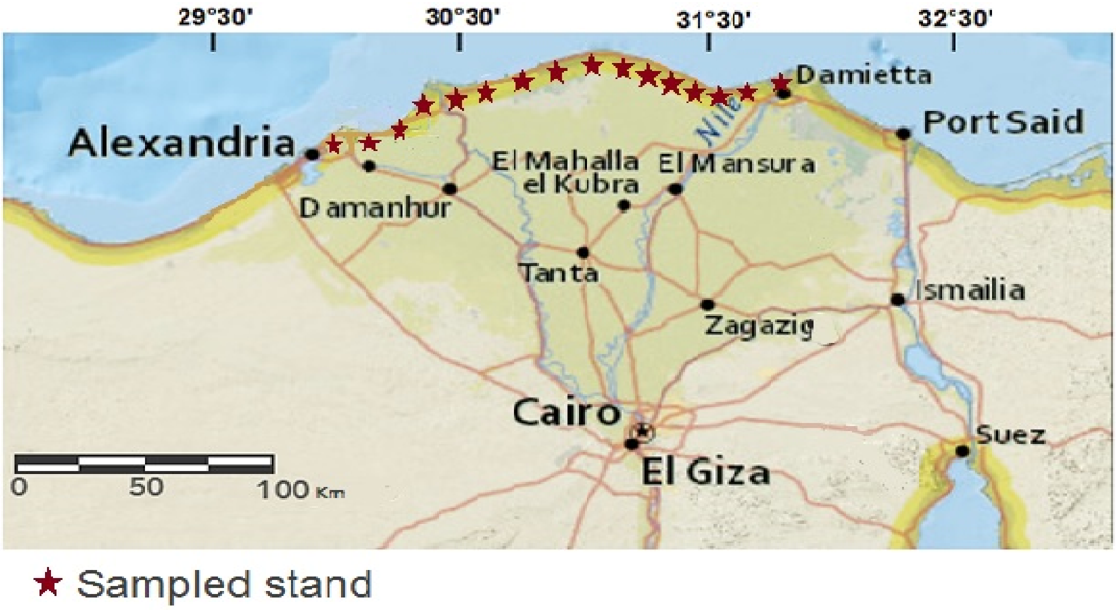

Figure (1). Map showing the location of the sampled stands in study area.

vegetation in the present study. These stands were selected to cover all physiographic variations to ensure sampling of wide range of vegetation diversity. The density and cover of each plant species were calculated in each stand. Density was obtained by counting the number of individuals of the species within a series of randomly distributed stands (Shukla and Candel, 1989). Cover was measured by application of line intercept method (Canfield, 1941). The importance value index (IV = out of 200) was calculated by the summation of relative values of density and cover for each species (Muller-Dombois and Ellenberg, 1974). From each sand three soil samples were collected from depth 0 – 50 cm, pooled together to from one composite sample, spread over sheets of paper, air dried, passed through 2 mm sieve, and packed in plastic bags ready for physical and chemical analyses. For the determination of particle sizes of soil samples (soil texture), drying sieves method (mechanical analysis) and the percentages of sand, silt and clay were calculated (Piper, 1947). Hilgard Pan Box was used for the estimation of maximum water holding capacity of the soil samples (Piper, 1947). The volumes of pores occupied by water and pores occupied by air (soil porosity) were determined by measuring flask method as described by Piper, 1947.The calcium carbonate was dissolved in excess of HCl (1 N) and then determined by titration against 1 N NaOH and expressed as percentage (Jackson, 1967), organic carbon was determined using Walkely and Black rapid titration method (Piper, 1947). Electrical-pH meter (Model Corning, NY 14831 USA) digital analyzer with glass electrode was used to determine the soil reaction of soil samples (Jackson, 1967) and electrical conductivity was measured by conductivity meter (Model Corning, NY 14831 USA) and expressed as mmhos/cm (Jackson, 1967). Chlorides in the soil extract were determined by titration with N/35.5 $AgNO_3$ in presence of K_2CrO_4 as an indicator (Jackson, 1967), sulphates were estimated gravimetrically using $BaCl_2$ solution. The sulphates were precipitated by barium chloride solution as barium sulphate and ignited in muffle furnace at 700-800 ^{o}C (Piper, 1947). Bicarbonates were determined by titration method using 0.1 N HCl using methyl orange as indicator (Pierce *et al.,* 1958). Total soluble phosphorus was determined by digestion and followed by direct stannous chloride method as described in American Public Health Association (APHA, 1998). The total nitrogen was determined by the conventional semi-micromodification of Kjeldahl method (Pirie, 1955). Na and K cations were determined in soil samples by Flame Photometer (Model PHF 80 P Biologie Spectrophotometer), while Ca, Mg, Fe, Mn, Zn, Cu, Co, Cd and Pb were estimated using Atomic Absorption Spectrometer (A Perkin-Elmer, Model 2380.USA) (Allen *et al.,* 1974).Two multivariate analysis techniques (classification and ordination) were applied. The classification technique applied here was the two way indicator species analysis (TWINSPAN) using the CAP software for windows version 1.2 (Henderson and Seaby,1999) The performed ordination techniques were the Detrended Correspondence Analysis (DCA) and the Canonical Correspondence Analysis (CCA) using computer program MVSP, version 3.1 (Ter Braak, 2003). The identification, nomenclature and chorotypes of the recorded plant species were according to (Täckholm, 1974), (Zahary, 1966 &1972); Feinbrun-Dothen (1978 &1986) and (Boulos, 1999-2005 & 2009).

RESULTS

Floristic Features

The floristic features of Deltaic Mediterranean coast of Egypt in the present study is listed in Table (1). In total, 79 plant species belonging to 70 genera and 26 families were recorded in 36 sampled stands on the sand formations in the Deltaic Mediterranean coast of Egypt. Asteraceae included 15 species, followed by Poaceae (12 species), then Chenopodiaceae (7 species). Brassicaceae and Fabaceae (5 species each) and Polygonaceae (4 species). These six families were the species rich families where they constituted the main bulk of the flora in the present study (48 species = 60.76%).

Life span

The life-span of the recorded species (79) includes 44 annuals (56.69%) and 33 perennials (44.30%).

Life form

The life–form spectra of the recorded species include 44 species as therophytes (55.69%), followed by 13 species as cryptophytes (16.45%), then eight species hemicryptophytes (10.12%) and seven species as chamaephytes and phanerphytes for each (8.86%).

Chorological analysis

The chorological affinity was presented in Table (2). The Saharo-Sindian element was represented by 34 species which can be distinguished into 15 Biregional, 11Pluriregional and eight Monoregional elements. Irano-Turanian element was represented by 21 species which can be also distinguished into 11 Pluriregional and ten Biregional elements . Euro-Siberian element was represented by ten species which may be distinguished into eight Pluriregional and two Biregional elements. Sudano-Zambezian element was represented by nine species which distinguished into seven Biregional and two Pluriregional elements. Cosmopoliton element was represented by six species, three species as Pantropical and one species for each Palaetropical ,Neotropical and Cultivated and Naturalized elements. In general as shown in Table (2), the Biregional elements were represented by 29 species (36.72%), followed by the Monoregional elements 22 species (27.85%), then the Pluriregional elements 16 species (20.25%), and the world wide elements by 11 species (13.92%).

Vegetation Structure

Classification of sampled stands

The application of TWINSPAN classification based on the importance values (out of 200) of 79 plant species recorded in 36 sampled stands in the present study, led to the identification of four vegetation groups (A, B, C and D; Figure 2). The vegetation composition of these groups was presented in Table (3). The vegetation groups were named according to the 1st and 2nd dominant species with the highest importance value in each group.

Vegetation group A included 21 species distributed in 4 stands. The codominant species were *Elymus farctus* (IV=35.83) and *Calligonum polygonoides* (IV=31.84). The most important associated species in this group include *Zygophyllum aegyptium* (IV=21.29) *and Rumex pictus* (IV=16.22), but the indicator species has not been detected. Group B comprised 13 stands with 50 species.

Hordeum murinum (IV=20.95) was the dominant species. *Bromus diandrus* (IV=10.73) and *Senecio glaucus* (IV=10.47) were recorded as the most important associated species in this community. The indicator species of this group included *Lactuca serriola* (IV=1.90), *Tamarix tetragyna* (IV=6.86), *Lotus halophilus* (IV=1.30), *Melilotus indicus* (IV=2.75) and *Rumex pictus* (IV=6.26).

Group C comprised 11 stands with 38 species, and it was codominated by *Stipagrostis lanata* (IV=24.83) and *Echinops spinosus* (IV=22.85). *Rumex pictus* (IV=15.33) and *Moltkiopsis ciliata* (IV=12.79) were the most important associated species in this community. The indicator species in this group comprise *Plantago squarrosa* (IV=7.33) and *Senecio glaucus* (IV=7.39).

Group D included 43 species in 8 stands, and it was codominated by *Lycium schweinfurthii* (IV=25.03) and *Echinops spinosus* (IV=23.80). The indicator species in this group comprise *Atriplex halimus* (IV=2.13) and *Rumex pictus* (IV=5.16). The most important associated species in this community included *Stipagrostis lanata* (IV=11.61), *Erodium laciniatum* (IV=11.44) and *Moltkiopsis ciliata* (IV=10.80).

Ordination of sampled stands

The Detrended Correspondence Analysis (DCA) ordination plot of the 36 sampled stands on axes 1 and 2 is shown in Figure (3). Group A codominted by *Elymus farctus* and *Calligonum polygonoides* was separated at the uppermost part of DCA diagram. On the other hand, group B dominated by *Hordeum murinum* was segregated at the lower part of DCA diagram. Both groups A and B were superimposed. Group C codominated by *Stipagrostis lanata and Echinops spinosus* was segregated at lower part of the left side of the DCA diagram, while group D codominated by *Lycium schweinfurthii* and *Echinops spinosus* was separated at the lower part of the right side of the DCA. It is clear that the identified four vegetation groups (A-D) were obviously superimposed with unclear pattern of segregation on the ordination (DCA) plane.

Vegetation- Soil Relationships

Relationship between soil parameters and vegetation groups

The variation of soil variables between four vegetation groups recognized by the TWINSPAN classification was shown in Table (4).

The highest percentage of sand was attained in group (D), while the lowest percentage was estimated in group (C). The highest percentage of silt fraction was attained in group (C), while the lowest percentage was determined in group (D). The highest percentage of clay fraction was attained in group (B), while the lowest percentage was estimated in group (D). Soil porosity attained the highest value in group (C), while the lowest value in group (A). Maximum water - holding capacity showed the highest value in group (B), while it showed the lowest value in group (D).

The chemical soil variables showed variations from

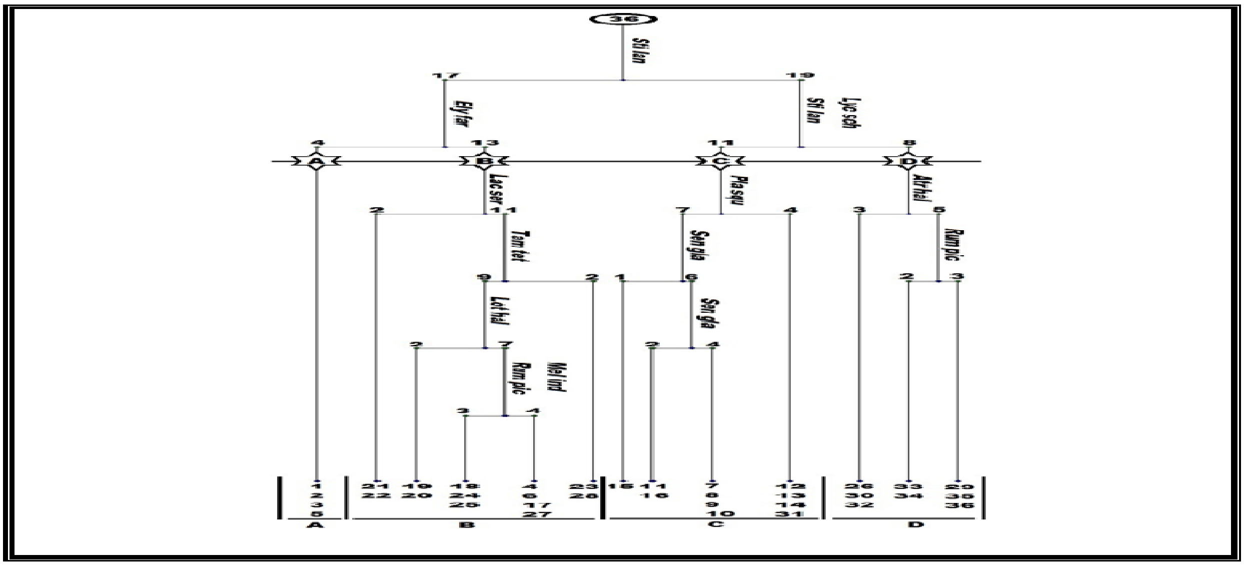

Figure (2):TWINSPAN dendrogram recognizing four groups (A, B, C and D) at the third level. The indicator species are abbreviated by the first three letters of genus and species, respectively. The indicator species are coded as follow: *Sti lan = Stipagrostis lanata; Ely far = Elymus farctus; Lyc sch = Lycium schweinfurthii; Lac ser = Lactuca serriola; Pla squ = Plantago squarraso; Atr hal = Atriplex halimus; Tam tet = Tamarix tetragyna; Sen gla = Senecio glaucus; Rum pic = Rumex pictus; Lot hal = Lotus halophilus; Mel ind = Melilotus indicus.*

Table (1): Species composition of the selected grass species in the study area, with their families, life span, life-forms and chorotypes. Ann: Annuals; Per: Perennials; Th: Therophytes; Ch: Chamaephytes; H: Hemicryptophytes; Ph: Phanerophytes; Cr: Cryptophytes; ME: Mediterranean; SA-SI: Saharo-Sindian; IR-TR: Irano-T uranian; S-Z: Sudano-Zambezian; ER-SR: Euro-Siberian; PAL: Palaeotropical, COSM: Cosmopolitan; PAN: Pantropical; NEO: Neotropical; , CULT and NAT: Cultivated and Naturalized.

Family and Species	Life span	Life form	Chorotype
Aizocaceae			
Mesembryanthemum crystallinum L.	Ann.	Th	ME+ER-SR
M. nodiflorum L.	Ann.	Th	ME+ER-SR+SA-SI
Amaryllidaceae			
Pancratium maritimum L.	Per.	Cr	ME
Apiaceae			
Bupleurum semicompositum L.	Ann.	Th	ME+IR-TR+SA-SI
Daucus litoralis Sm.	Ann.	Th	ME
Pseudorlaya pumila (L.) Grande	Ann.	Th	ME
Asclepiadaceae			
Cynanchum acutum L.	Per.	H	ME+IR-TR
Asparagaceae			
Asparagus stipularis Forssk.	Per.	Cr	ME+SA-SI
Asteraceae			
*Atractylis carduus (*Forssk.) C.Chr.	Per.	H	ME+SA-SI
Carduus getulus Pomel	Ann.	Th	SA-SI
C. pycnocephalus L.	Ann.	Th	ME+IR-TR
Carthamus tenuis (Boiss & Blanche) Bornm.	Ann.	Th	ME
Centaurea glomerata Vahl	Ann.	Th	ME
Echinops spinosus L.	Per.	H	ME+SA-SI
Ifloga spicata (Forssk.) Sch.Bip.	Ann.	Th	SA-SI
Lactuca serriola L.	Ann.	Th	ME+IR-TR+ER-SR
Launaea mucronata (Forssk.) Muschl.	Per.	H	ME+SA-SI
Limbardia crithmoides (L.) Dumort.	Per.	Ch	ME+ER-SR+SA-SI
Reichardia tingitana (L.) Roth	Ann.	Th	ME+SA-SI+IR-TR
Senecio glaucus L.	Ann.	Th	ME+SA-SI+IR-TR
Sonchus bulbous (L.) N.Kilian &Greuter	Per.	Cr	ME
S. oleraceus L.	Ann.	Th	COSM
Urospermum picroides (L.) F.W. Schmidt	Ann.	Th	ME+IR-TR
Boraginaceae			
Anchusa humilis (Desf.) I.M. Johnst.	Ann.	Th	ME+SA-SI
Heliotropium curassavicum L.	Per.	Ch	NEO
Moltkiopsis ciliata (Forssk.) I.M. Johnst.	Per.	Ch	SA-SI+S-Z+ME
Brassicaceae			
Brassica tournefortii Gouan	Ann.	Th	ME+IR-TR+SA-SI
Cakile maritima Scop. subsp. *aegyptiaca* (Willd.) Nyman	Ann.	Th	ME+ER-SR

Table (1) continue

Family and Species	Life span	Life form	Chorotype
Lobularia arabica (Boiss.) Muschl.	Ann.	Th	SA-SI
L. libyca (Viv.) C.F.W.Meissn.	Ann.	Th	SA-SI
Maresia pygmaea (DC.) O.E.Schulz	Ann.	Th	SA-SI
Caryophyllaceae			
Paronychia arabica (L.) DC.	Ann.	Th	SA-SI+ME+S-Z
Silene succulenta Forssk.	Per.	H	ME
S. viviani Steud.	Ann.	Th	ME+SA-SI
Chenopodiaceae			
Atriplex halimus L.	Per.	Ph	ME+SA-SI
Bassia indica (Wight) A.J.Scott	Ann.	Th	S-Z+IR-TR
Chenopodium album L.	Ann.	Th	COSM
C. murale L.	Ann.	Th	COSM
Halocnemum strobilaceum (Pall.) M.Bieb.	Per.	Ch	SA-SI
Salsola kali L.	Ann.	Th	COSM
Suaeda vera Forssk.ex.J.F.Gmel.	Per.	Ch	ME+SA-SI+ER-SR
Convolvulaceae			
Cressa cretica L.	Per.	H	ME+PAL
Cyperaceae			
Cyperus capitatus Vand.	Per.	Cr	ME
C. conglomeratus Rottb.	Per.	Cr	SA-SI+S-Z
C. rotundus L.	Per.	Cr	PAN
Euphorbiacea			
Ricinus communis L.	Per.	Ph	CULT and NAT
Fabaceae			
Alhagi graecorum Boiss.	Per.	H	PAL
Lotus halophilus Boiss. & Spruner	Ann.	Th	ME+SA-SI
Melilotus indicus (L.) All.	Ann.	Th	ME+IR-TR+SA-SI
Ononis serrata Forssk.	Ann.	Th	ME+SA-SI
Retama raetam (Forssk.) Webb & Berthel.	Per.	Ph	SA-SI+IR-TR
Geraniaceae			
Erodium laciniatum (Cav.) Willd.	Ann.	Th	ME
Juncaceae			
Juncus acutus L.	Per.	Cr	ME+IR-TR+ER-SR
Malvaceae			
Malva parviflora L.	Ann.	Th	ME+IR-TR
Neuradaceae			
Neurada procumbens L.	Ann.	Th	SA-SI+IR-TR
Plantaginaceae			
Plantago squarrosa Murray	Ann.	Th	ME
Plumbaginaceae			
Limoniastrum monopetalum (L.) Boiss.	Per.	Ch	SA-SI
Poaceae			
Aegilops bicornis (Forssk.) Jaub & Spach	Ann.	Th	ME+SA-SI
Cutandia memphitica (Spreng.) Benth.	Ann.	Th	ME+IR-TR+SA-SI
Cynodon dactylon (L.) Pers.	Per.	Cr	PAN
Elymus farctus (Viv.) Runem.ex Melderis	Per.	Cr	ME
Hordeum murinum L.	Ann.	Th	ME+IR-TR+ER-SR
Imperata cylindrica (L.) Raeusch.	Per.	H	PAL+ME
Lolium multiflorum Lam.	Ann.	Th	ME+IR-TR+ER-SR
Parapholis incurva (L.) C.E.Hubb	Ann.	Th	ME+IR-TR+ER-SR
Phalaris minor Retz.	Ann.	Th	ME+IR-TR
Phragmites australis (Cav.) Trin. ex Steud.	Per.	Cr	COSM
Stipagrostis lanata (Forssk.) De Winter	Per.	Cr	SA-SI
Polygonaceae			
Calligonum polygonoides L. subsp. *comosum* (L' Her.) Soskov	Per.	Ph	SA-SI+IR-TR
Emex spinosa (L.) Campd.	Ann.	Th	ME+SA-SI
Polygnum equisetiforme Sm.	Per.	Cr	ME+IR-TR
Rumex pictus Forssk.	Ann.	Th	ME+SA-SI
Solanaceae			
Solanum nigrum L.	Ann.	Th	COSM
Lycium schweinfurthii Dammer	Per.	Ph	ME
Tamaricaceae			
Tamarix nilotica (Ehrenb). Bunge	Per.	Ph	SA-SI+S-Z
T. tetragyna Ehrenb.	Per.	Ph	SA-SI+S-Z

Family and Species	Life span	Life form	Chorotype
Typhaceae			
Typha domingensis (Pers.) Poir.ex Steud.	Per.	Cr	PAN
Zygophyllaceae			
Zygophyllum aegyptium Hosny	Per.	Ch	ME

Table (2): Summarized chorological analysis of the recorded flora in the study area.

Chorotype	No	%	Geographical distribution
ME	14	17.72	
SA-SI	8	10.126	**Mono-regional elements**
Sub Total	**22**	**27.85**	
ME+SA-SI	12	15.189	
ME+IR-TR	6	7.59	
IR-TR+S-Z	4	5.06	
SA-SI+S-Z	3	3.79	**Bi-regional elements**
ME+ER-SR	2	2.53	
ME+PAL	2	2.53	
Sub Total	**29**	**36.72**	
ME+IR-TR+SA-SI	6	7.59	
ME+IR-TR+ER-SR	5	6.32	
ME+ER-SR+SA-SI	3	3.79	**Pluri-regional elements**
ME+SA-SI+S-Z	2	2.53	
Sub Total	**16**	**20.25**	
COSM	6	7.59	
PAN	3	3.79	
PAL	1	1.26	**World-wide elements**
NEO	1	1.26	
Sub Total	**11**	**13.92**	
CULT & NAT	**1**	**1.26**	**CULT &NAT**
Total	**79**	**100**	

Table (3) Mean importance values (out of 200) and coefficient of variation (between brackets) of recorded species in the different vegetation groups resulting from the TWINSPAN. classification.

No.	Species	Group A	Group B	Group C	Group D
	Total number of stands	**4**	**13**	**11**	**8**
1	*Aegilops bicornis*	-	9.38 (0.093)	0.84 (3.31)	4.30 (1.58)
2	*Alhagi graecorum*	-	0.85 (3.60)	5.125 (1.76)	-
3	*Anchusa humilis*	-	4.63 (1.69)	-	2.13(1.39)
4	*Asparagus stipularis*	-	-	0.95 (3.31)	7.80 (0.65)
5	*Atractylis carduus*	3.26 (2)	-	0.36 (3.31)	2.33 (1.38)
6	*Atriplex halimus*	-	0.66 (3.60)	-	14.92 (0.88)
7	*Bassia indica*	-	0.57 (3.60)	-	-
8	*Brassica tourmefortii*	3.70 (2)	7.31 (1.46)	1.33 (3.317)	1.63 (1.89)
9	*Bromus diandrus*	5.87 (2)	10.73 (1.257)	1.23 (3.31)	0.55 (2.82)
10	*Bupleurum semicompositum*	-	-	-	0.99 (2.82)
11	*Cakile maritima*	15.24 (0.533)	9.01 (0.707)	2.66 (2.28)	0.43 (2.82)
12	*Calligonum polygonoides*	31.84 (0.852)	-	-	4.43 (2.19)
13	*Carduus getulus*	-	-	0.63 (3.31)	3.60 (1.13)
14	*Carduus pycnocephalus*	-	4.13 (2.126)	-	0.78 (2.82)
15	*Carthames tenuis*	2.09 (2)	5.75 (1.64)	-	2.80 (1.49)
16	*Centaurea glomerata*	-	0.86 (3.60)	-	9.05 (0.64)
17	*Chenopodium album*	-	0.77 (2.44)	-	-
18	*Chenopodium murale*	-	6.06 (0.933)	-	-
19	*Cressa cretica*	-	-	-	0.78 (2.82)
20	*Cutandia memphitica*	8.89 (1.30)	-	0.38 (3.31)	-
21	*Cynanchum acutum*	-	0.616(3.60)	-	0.65 (2.82)
22	*Cynodon dactylon*	-	1.44 (2.63)	-	1.57 (1.88)
23	*Cyperus capitatus*	-	-	3.73 (1.95)	3.54 (1.12)
24	*Cypers conglomeratus*	-	0.19 (3.60)	0.84 (3.31)	8.57 (0.52)
25	*Daucus litoralis*	-	-	7.22 (0.99)	3.44 (1.12)
26	*Echinops spinosus*	-	2.55 (2.81)	22.85 (0.70)	23.8 (0.738)
27	*Elymus farctus*	35.83 (0.456)	-	8.48 (1.58)	-
28	*Emex spinosa*	-	3.18 (1.61)	-	1.13 (2.82)
29	*Erodium laciniatum*	1.99 (2)	5.92 (1.174)	8.58 (1.012)	11.44 (0.414)
30	*Halocnemum strobilaceum*	10.12 (2)	-	-	-
31	*Heliotropium curassavicum*	-	1.85 (2.45)	-	-
32	*Hordeum marinum*	2.42 (2)	20.95 (0.488)	3.79 (2.27)	-
34	*Ifloga spicata*	4.08 (2)	-	2.58 (1.43)	-
35	*Imperata cylindrica*	-	-	7.58 (1.21)	-

Table (3) continue

No.	Species	Group A	Group B	Group C	Group D
36	*Juncus acutus*	-	1.35 (3.60)	-	-
37	*Lactuca serriola*	-	1.90 (1.81)	-	-
38	*Launaea mucronata*	5.18 (1.258)	5.24 (1.73)	4.12 (1.55)	2.53 (1.43)
39	*Limbarda crithmoides*	-	4.15 (2.5)	-	-
40	*Limoniastrum monopetalum*	-	2.83 (3.60)	-	1.84 (2.82)
41	*Lobularia arabica*	-	-	0.62 (3.31)	0.74 (1.88)
42	*Lobularia libyca*	-	-	0.26 (3.31)	-
43	*Lolium multiflorum*	-	1.425 (1.93)	-	-
44	*Lotus halophilus*	-	1.30 (2.45)	12 (0.716)	1.28 (2.37)
45	*Lycium schweinfurthii*	-	2.77 (3.60)	-	25.03 (0.62)
46	*Malva parviflora*	-	9.40 (0.845)	-	-
47	*Maresia pygmaea*	-	-	0.45 (3.31)	-
48	*Melilotus indicus*	-	2.75 (1.62)	-	-
49	*Mesembryanthemum crystallinum*	-	9.67 (0.76)	0.87 (3.31)	2.61 (1.38)
50	*Mesembryanthemum nodiflorum*	-	2.04 (2.44)	-	-
51	*Neurada procumbens*	-	-	6.09 (1.67)	3.24 (1.30)
52	*Ononis serrata*	-	-	6.05 (1.24)	1.70 (1.85)
53	*Pancratium maritimum*	-	0.72 (3.60)	3.97 (2.23)	-
54	*Parapholis incurva*	-	1.17 (3.60)	-	-
55	*Paronchyia arabica*	0.91 (2)	-	0.61 (3.31)	2.21 (2.13)
56	*Phargmites australis*	-	4.10 (1.45)	-	-
57	*Phalaris minor*	-	0.91 (3.60)	-	-
58	*Plantago squarrosa*	-	-	7.33 (1.59)	2.73 (1.42)
59	*Polygnum equisetiforme*	-	3.38 (1.99)	-	0.45 (2.82)
60	*Pseudorlaya pumila*	-	-	-	0.43 (2.82)
61	*Raphanus raphanistrum*	-	1.14 (3.60)	-	-
62	*Reichardia tingitana*	1.715 (2)	7.82 (0.87)	1.88 (2.25)	1.88 (1.49)
63	*Retama reatam*	-	-	5.95 (3.31)	2.30 (2.82)
64	*Ricinus communis*	-	1.71 (3.60)	-	-
65	*Rumex pictus*	16.22 (0.728)	6.26 (1.16)	15.33 (0.426)	5.16 (0.84)
66	*Salsola kali*	4.79 (2)	0.36 (3.60)	-	-
67	*Senecio glaucus*	9.17 (0.712)	10.47 (0.55)	7.39 (0.79)	1.17 (1.92)
68	*Silene succulenta*	-	-	4.42 (1.71)	-

Table (3) continue

No.	Species	Group A	Group B	Group C	Group D
69	*Silene vivianii*	-	-	1.13 (2.48)	-
70	*Solanum nigrum*	-	0.59 (3.60)	-	-
71	*Sonchus bulbusa*	-	-	-	-
72	*Sonchus oleraceus*	-	2.12 (2.04)	-	-
73	*Stipagrostis lanata*	4.45 (2)	-	24.83 (0.212)	11.61 (0.271)
74	*Suaeda vera*		-	-	5.09 (1.13)
75	*Tamarix nilotica*	10.92 (2)	-	-	5.34 (1.89)
76	*Tamarix tetragyna*	-	6.86 (2.44)	-	-
77	*Typha domingensis*	-	1.22 (3.60)	-	-
78	*Urospermum picroides*	-	2.96 (2.44)	-	-
79	*Zygophyllum aegyptium*	21.29 (0.955)	4.89 (2.52)	2.03 (3.31)	-

one group to another. The highest values of organic carbon and pH were attained in group (C), while the lowest value of these variables was estimated in group (D). The highest value of electrical conductivity was attained in group (C), while the lowest value was estimated in group (B). Calcium carbonate content recorded the highest value in group (A), and the lowest value in group (D). The highest values of chlorides and bicarbonates were recorded in group (C), while the lowest values of these variables were estimated in group (A). Sulphates recorded the highest value in group (D), while the lowest value in group (B).The highest values of total dissolved phosphorus and total nitrogen were determined in group (C), while the lowest values of these variables were estimated in group (A).

On the other hand, the highest concentrations of the extractable sodium and calcium were determined in group (C), while the lowest values of these variables were estimated in group (A). Group (C) also attained the highest concentrations of potassium and magnesium, while the lowest values of these variables were estimated in group (B).

In addition, the highest concentrations of the micro elements such as ferrous and copper were determined in group (B), while the lowest values of these variables were estimated in group (A). Group (C) attained the highest concentrations of the manganese and zinc, while the lowest values of these variables were estimated in group (A). Group (B) attained the highest concentrations of the cobalt and cadmium, while the lowest values of these variables were estimated in group (D). Lead showed the highest concentration in group (B), and the lowest concentration in group (C).

Correlation between soil variables and vegetation gradients

The correlation between vegetation and soil characteristics is indicated on the ordination diagram produced by Canonical Correspondence Analysis (CCA) of the biplot of the recorded species and soil variables (Figure 4). It is obvious that sulphates, calcium, magnesium, potassium, cobalt, calcium carbonates, cadmium and copper were the most effective soil variables controlling the distribution and abundance of the vegetation groups in the study area.

The characteristics codominat and the most important species of vegetation group C namely, *Stipagrostis lanata, Echinops spinosus* and *Moltkiopsis ciliata* were separated at the middle left quarter of CCA, where this group was closely related with calcium,sulphates,potassium,magnesium manganese,zinc and pH. Codominat and leading species of vegetation group D namely, *Lycium schweinfurthii, Echinops spinosus, Elymus farctus, Atriplex halimus and Erodium laciniatum* were segregated at the lower-left quarter of CCA-diagram, where this group was obviously related with zinc, sand particle and porosity. On the other hand, the dominant and the most important species in group A namely, *Elymus farctus,Calligonum polygonoides* and *Zygophyllum aegyptium* were separated at the upper-right quarter of CCA, where this group was correlated with calcium carbonates. On the other hand, the dominant and leading species in group B namely, *Hordeum murinum* ,*Bromus diandrus* and *Senecio glaucus* were separated at the lower-right quarter of CCA, where this group was correlated with cobalt, cadmium, copper, clay particle, maximum water holding capacity ,silt fraction and total nitrogen.

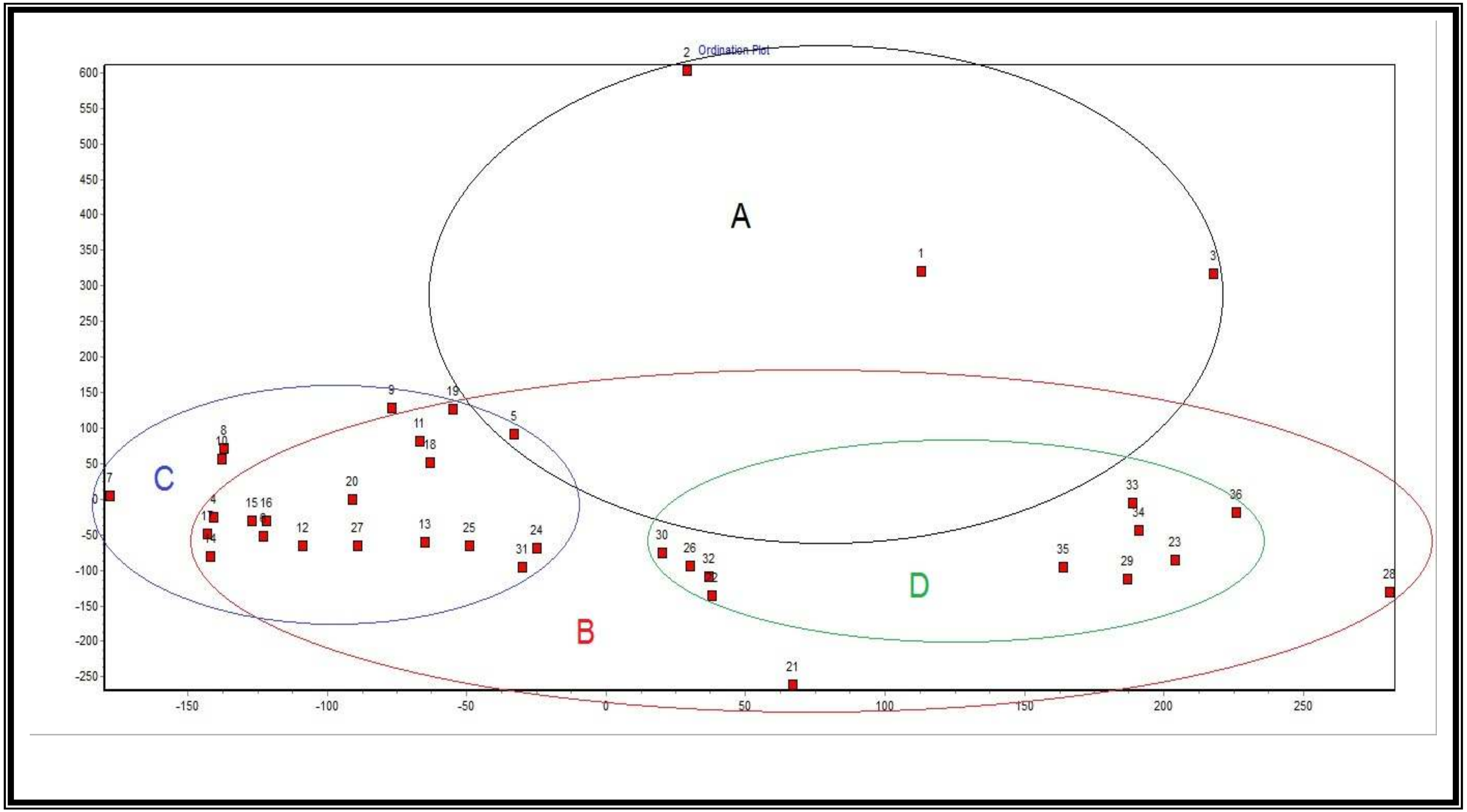

Figure (3): DCA ordination diagram of the four vegetation groups identified by TWINSPAN classification**.**

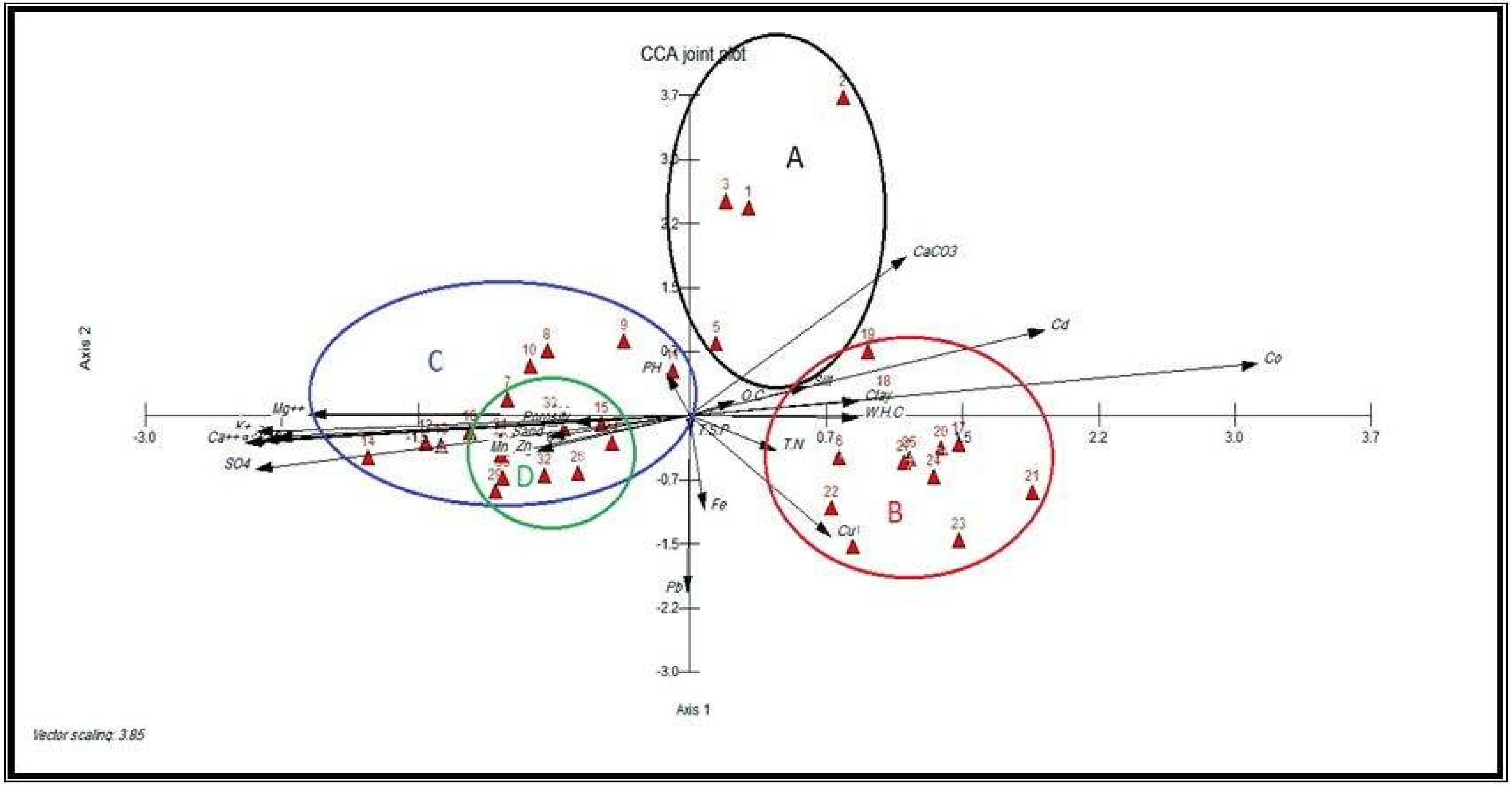

Figure (4): CCA-ordination biplot of the sampled stands and soil variables in the study area.

Table (4): Mean values± standard errors of the soil variables representing the four vegetation groups obtained by TWINSPAN. MWHC: maximum water-holding capacity; MC: moisture content; OC: organic carbon; EC: electrical conductivity; TN: total nitrogen; TDP:total dissolved phosphorus**.**

Soil variable	Vegetation group A	B	C	D
Sand	74.41± 0.487	71.48 ± 2.19	71.44 ± 2.042	76.46 ± 1.040
Silt	13.78 ± 0.148	15.8 ± 1.137	16.38 ± 1.390	12.96 ± 0.678
Clay (%)	10.97 ±0.344	12.72 ± 1.075	12.2 ± 0.760	10.56 ± 0.383
M.W.H.C	34.62 ± 0.730	38.42 ± 1.906	37.9 ± 1.366	34.06 ± 1.079
Porosity	37.79 ± 1.566	39.77 ± 1.306	43.2 ± 1.700	39.40 ± 1.370
O.C	0.275 ± 0.0332	0.36 ± 0.0419	0.43 ± 0.0549	0.23 ± 0.0295
PH	8.2 ± 0.080	8.13 ± 0.0459	8.22 ± 0.0378	8.1 ± 0.051
EC (mmhos cm^{-1})	1.61 ± 0.252	1.60 ± 0.127	2.162 ± 0.077	2.085 ± 0.173
$CaCO_3$	4.46 ± 0.285	3.422 ± 0.3108	2.9 ± 0.219	2.75 ± 0.310
(%) Cl^-	5.1 ± 0.772	5.17 ± 0.396	6.70 ± 0.193	6.29 ± 0.515
SO_4^{--}	1.47 ± 0.278	1.45 ± 0.1570	2.08 ± 0.135	2.18 ± 0.213
HCO_3^-	1.67 ± 0.240	1.7 ± 0.1342	2.28 ± 0.080	2.19 ± 0.203
T.D.P	6.31 ± 0.145	7.08 ± 0.3210	7.5 ± 0.405	6.70 ± 0.236
T.N	33.28 ± 0.306	44.4 ± 3.051	46.56 ± 3.229	36.61 ± 0.798
Na^+ (mg /100 g dry soil)	5.24 ± 0.77	5.32 ± 0.4002	6.9 ± 0.192	6.59 ± 0.491
K^+	0.37 ± 0.066	0.36 ± 0.0327	0.52 ± 0.020	0.47 ± 0.0431
Ca^{++}	1.56 ± 0.243	1.58 ± 0.1327	2.15 ± 0.081	2.07 ± 0.176
Mg^{++}	1.05 ± 0.205	0.96 ± 0.0938	1.5 ± 0.114	1.27 ± 0.194
Fe	24.72 ± 0.146	26.13 ± 0.5273	26.05 ± 0.185	25.79 ± 0.48
Mn	9.94 ± 0.274	10.51 ± 0.455	16.87 ± 7.60	13.37 ± 0.25
Zn	15.9 ± 0.096	16.47 ± 0.431	17.02 ± 0.256	16.9 ± 0.55
Cu	4.96 ± 0.138	6.2 ± 0.194	6.006 ± 0.112	5.3 ± 0.318
Co	0.74 ± 0.025	0.77 ± 0.029	0.594 ± 0.0148	0.59 ± 0.026
Cd	1.65 ± 0.013	1.67 ± 0.0294	1.613 ± 0.041	1.45 ± 0.039
Pb	7.49 ± 0.191	8.71 ± 0.171	0.210 ± 8.7	8.45 ± 0.13

DISCUSSION

Egypt is located in arid or semi-arid regions, is facing a severe problem of feed supply shortage or high cost especially green summer fodder (Shaltout *et al*., 2009). The main causes of this problem involve population increase, frequent drought, limited renewable natural resources, limited cultivated lands with forages and expansion of urbanization at the expense of agricultural areas. This problem reduces the enhancement of animal/meat production. Therefore, calls for searching for other non-conventional novel alternative sources for feed become required and urgent (Elias, 2015).

The decline in forage in Egypt has been generally attributed to a number of factors such as scarce of rainfall and frequent drought, overgrazing of range shrubs and bushes for fuel and expansion of urbanization. The forage value of a consumed plant is the result of two main components: 1) palatability and voluntary intake by livestock, and 2) nutritive value i.e. chemical composition and digestibility (Le Houerou, 1980). At the same time, the flora of the Nile Delta and its coast is rich by many weeds, which seem to be promising economically. Some weeds can be used as forages, and /or agro-industrial raw materials and in drug industry (El- Halawany *et al*., 2008).

The natural plant life in the present investigation was composed of 79 plant species belonging to 70 genera and related to 26 taxonomic families. These species were classified into 44 annuals and 33 perennials. The life- form spectra of the recorded species mainly include therophytes (55.69%), followed by cryptophytes (16.45%), then hemicryptophytes (10.12%) and finally chamaephytes and phanerophytes (8.80% each). This agrees more or less with the findings of (Mashaly, 2001&2002) on the ecology of the Deltaic.

Mediterranean coast and (Abd El Aal, 2013) on the plant life in the different habitats in El-Behira Governorate. The dominance of therophytes is probably due to their short life cycle that enables them to resist the instability of the environmental condition. They have also an ability to set seeds without the need of pollinator visit (Baker, 1974). Also, the relative high frequency of cryptophytes as an active life –form in the study area could be related to certain features of both their growth habit and nature of soil. Most of the recorded cryptophytes are rhizomatous species; this is an advantage for successful growth and their distribution (Shaltout *et al*.,1995).

In the present study, the chorological affinities revealed that the Sahro-Sindian element was represented by 34 species which can be distinguished into 15 Biregional, 11 Pluriregional and eight Monoregional elements. Irano-Turanian element was represented by 21 species which can be classified into 11Pluriregional and 10 Biregional elements. Euro-Siberian element was represented by 10 species which can be divided into eight Pluriregional and two Biregional elements. Sudano-Zambezian element was represented by nine species which distinguished into seven Biregional and two Pluriregional elements. Cosmopolitan element was represented by six species, Pantropical element by three species, Palaeotropical and Neotropical by one species each. This was Confirmed by (Mashaly *et al*., 2008, 2014 &2015a&bc), (El-Halawany *et al*., 2010) and (Abu-Zida *et al*.2015).

Phytosociologically, the vegetation that characterizes classification into four groups (A, B, C& D). Each group comprises a number of sampled stands which are similar in terms of vegetation and characterized by dominant and / or codominant species as well as by a number of indicator species. Group A includes 21 species in 4 stands and it was codominant by *Elymus farctus* and *Calligonum polygnoides* no indicator species in this group was detected. Group B comprises 50 species in 13 stands and it was dominated by *Hordeum murinum*, the indicator species in this grpup include *Lactuca serriola*, *Tamrix tetragyna*, *Lotus halophilus*, *Melilotus indicus* and *Rumex pictus*. Group C includes 38 species in 11 stands and it was codominated by *Stipagrostis lanata* and *Echinops spinosus*, two indicator species in this group were *Plantago squarrosa* and *Senecio glaucus*. Group D comprises 43 species in 8 stands and it wsa codominated by *Lycium schweinfurthii* and *Echinops spinosus*, also two indicator species in this group were *Atriplex halimus* and *Rumex pictus*. The identified association in the present study might be coincide with numerous previous studies in various regions of Egypt (viz Shaltout and Sharf El Din. 1988), (Shaltout *et al*. 2008&2010), (Mashaly, 2001&2002), (El-Halawany *et al*., 2010), (Mashaly *et al*., 2014,2015 a,b&d), (Abu-Zaida *et al*., 2015) and (Al-Barti, 2018).

The Detreanded Correspondence Analysis (DCA) ordination plot of the 36 stands on axes 1 and 2 exhibited that the four vegetation groups obtained by TWINSPAN classification were markedly undistin-guishable and super-imposed, this may be due to the close similarities in the floristic composition of these vegetation groups. The ordination of the vegetation groups in the present study may be coincide with many previous studies in different regions of Egypt e.g (Tak-sera, 2014), (Yahia, 2015), (Elias, 2015), (Abdrabbu, 2016), (EL-Naggar, 2018) and (Al-Barati, 2018).

The correlation between vegetation and soil charac-teristics as indicated on the ordination diagram (CCA-biplot) revealed that sulphates, calcium, magnesium, potassium, cobalt, calcium carbonate, cadmium and copper were the most effective soil variables contro-lling the distribution and abundance of vegetation groups in the study area. These results are in agreement with other many previous studies on the vegetation-soil relationship in Egypt as (Sharf EL-Din and Shaltout. 1985), (Abd El- Ghani and Amer. 2003), (Hegazy *et al*., 2004&2006), (Mashaly *et al*., 2011,2012&2013), (Salama *et al*., 2013&2015) and (El-Naggar, 2018).

In conclusion, the present work is attempt to investigate the floristic composition and vegetation analysis of the flora associated with some grasses growing naturally in the coast of Nile Delta region which can be used as renewable natural resources.

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دراسات على بعض الحشائش المعمرة والحولية النامية على التكوينات الرملية بساحل البحر المتوسط الدلتاوى بمصر

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الملخص العربـــي

تهدف هذه الدراسه الى اجراء دراسات بيئية تفصيلية على بعض الحشائش الناميه بريا بساحل الدلتا المطل على البحر المتوسط وتشمل حشائش سفسوف وشعير بري وشعير الفار وشفشوف والجازوف وتهدف هذه الدراسة إلى ما يلي:اولا دراسة السمات الفلورية والتي تشتمل تسجيل الانواع النباتية و المظاهرالمفصلية (Life-span) وتصنيف الطرز الحياتية (Life-form) وتحليل العناصر الفلورية (Chorotypes) للأنواع النباتية المصاحبة للحشائش المختارة بمنطقه الدراسة. ثانيا تحليل كمي لتركيب ووفره المجتمعات النباتيه المصاحبه لانواع الحشائش المختاره باستخدام طرق التحليل المتعددة للتصنيف والتسلسل (Class.& ordina.). ثالثا تحليل التغيرات في عوامل التربة وذلك لتحديد اهم العوامل المؤثره في توزيع ووفرة المجتمعات النباتية المرافقة للحشائش المختارة بمنطقه الدراسة. رابعا التعرف على النباتات التي كانت تتغذى عليها الحيوانات في الماضي. تتميز منطقه الدراسه بتنوع عالي في الانواع النباتية حيث ان العدد الكلي الذي تم تسجيله في عدد 36 واقفقة كان 79 نوعا تم تقسيمها الي 44 نوعا من طراز الحوليات و13 نوعا من طراز المختفيات وثمانية انواع من طراز شبة المختفيات وسبعه انواع لكل من طرازي النباتات الظاهرة والنباتات الخشبية، كما اتضح ان النباتات المسجلة تتبع 70 جنسا و26عائله نباتيه وظهر ان اكثر العائلات وفرة بالأنواع النباتية هي المركبة (15 نوعا) والنجيلية (12 نوعا) والرمرامية (7 انواع) والصليبية (5 انواع) والبقولية (5 انواع) والحماضية (4 انواع) حيث ان هذه العائلات الست تمثل التكوين الاكبر (48 نوع= 60.76%) لفلورا منطقة الدراسة، اما التحليل الفلوري فقد اوضح ان هناك 52 نوع نباتي تتبع عنصر البحر المتوسط و34 نوعا تتبع عنصر الصحاري- السندي و21 نوعا تتبع العنصر الايراني- الاناضول و10 انواع تتبع العنصر الاوربي– السيبري و9 انواع تتبع العنصر السوداني– الزمبزي و6 انواع تتبع العنصر العالمي و3 انواع تتبع العنصر الاستوائي ونوع واحد لكل العنصر الاستوائي القديم والعصر الاستوائي الحديث والمنزرعة أو المستأنسة. وبيئيا فقد تم تحليل الغطاء النباتي المرافق لأنواع الحشائش المختارة باستخدام تقنيات التحاليل المتعددة (التصنيف والتسلسل) اما تقنية التصنيف فقد تم تطبيق برنامج التصنيف ثنائي الاتجاه (TWINSPAN) بينما في تقنية التسلسل فقد تم تطبيق برنامج التوزيع الطابقي الانعكاسي (DCA) وبرنامج التوزيع التطابقي الكنسي (CCA). وباستخدام وتطبيق برامج

التصنيف ثنائى الاتجاه لقيم الاهميه لعدد 79 نوعا نباتيا مسجله داخل 36 موقعا فقد ادى الى التعرف على اربعه مجموعات نباتيه (A-D) سميت كما يلي:مجموعة (ا) يسودها كل من نباتي الجازوف– الارطة؛ مجموعة (ب) يسودها نبات شعير بري؛ مجموعة (ج) يسودها نباتي شفشوف- الكداد؛ مجموعة (د) يسودها نبات العوسج- الكداد.

بتطبيق برنامج التوزيع التطابقى العكسى (DCA) فقد أوضح ان المجموعات النباتية الاربعة متراكبة ومتداخلة مع بعضها بوضوح وغير منفصلة، اما عند تطبيق برنامج التطابق الكنسي (CCA) لايضاح العلاقة بين المجموعات النباتية وعوامل التربة فقد اتضح ان كل من الكبريتات والكالسيوم و الماغنسيوم و البوتاسيوم و والكوبلت وكربونات الكالسيوم والكادميوم والنحاس كانت اكثر عوامل التربة تاثيرا على وفره وتزيع المجموعات النباتيه في منطقة الدراسة. وهذه الدراسة توصي بان الخمس حشائش المختارة والتي تضم كل من حشائش سفسوف والجازوف وشعير الفار وشفشوف وشعير بري تصلح لان تكون نباتات رعي للحيوانات، وايضا فان تحليل حفريات حبوب اللقاح فقد اثبتت ان ليست افراد العائلة النجيلية وحدها تصلح كاعلاف ولكن ايضا هناك عائلات نباية اخرى تصلح في هذا الصدد.