MANSOURA JOURNAL OF BIOLOGY
Official Journal of Faculty of Science, Mansoura University, Egypt
E-mail: scimag@mans.edu.eg ISSN: 2974-492X

Ecological study on some genera of family apiaceae growing in the mediterranean coast, egypt

Ibrahim[A]. Mashaly[a], Ihsan E. El-Habashy[a], Usama K Abdel-Hameed[b&c], Mai M. Wahba[a]

[a] *Botany Department, Faculty of Science, Mansoura University, Egypt*

[b] *Botany Department, Faculty of Science, Ain Shams University, Egypt*

[c] *Biology Department, College of Science, Taibah University, Kingdom of Saudi Arabia *correspondent author: maiwahba18@gmail.com 01021450980*

Received: 22 / 5 /2019
Accepted: 11 / 6 /2019

Abstract: The present study aims to investigate the ecology of some genera of family Apiaceae growing naturally in the Mediterranean coast of Egypt. In study area the total number of the recorded species was 94 species belonging to 82 genera and 25 families. The application of TWINSPAN classification on the importance values of the recorded species in 11 sampled stands led to the recognition of 3 vegetation groups named after their dominant species. Group (A) was dominant by *Carum carvi*, while group (B) was dominated by *Salsola kali* and group (C) was dominated by *Foeniculum vulgare*. The Canonical Correspondence Analysis (CCA-biplot) between the soil variables and vegetation groups exhibited that the highly effective factors were saturation capacity, sand fraction, pH value, sulphates, calcium, bicarbonates, porosity, electrical conductivity and organic carbon and that control the distribution of vegetation groups in the different habitats in the present study area

keywords: Apiaceae, Mediterranean coast, classification, ordination, soil.

1.Introduction

The Umbelliferae family (Apiaceae) is commonly known as celery, carrot, or parsley family. It is one of the large families of angiosperms, comprises 300–455 genera and some 3000–3750 species [1, 2]. In Egypt, the family comprises 26 genera and 49 species [3]. The family is cosmopolitan, but especially north temperate and tropical mountains [4]. Apiaceae has two major centers of distribution: one includes the Western United States, Mexico and one in the Mediterranean region [5]. The members of Apiaceae are characterized by umbellate inflorescences that made them task recognition in the field.

The Egyptian deserts are classified ecologically into: coastal and inland deserts. The coastal deserts are associated with and affected by the Mediterranean Sea, Red Sea and the two Gulfs of Sinai. The inland deserts are those far from the effects of the seas including the oases**.** The Mediterranean coast of Egypt comprises four main habitats: salt marshes, sand formations, reed swamps and fertile non-cultivated lands [6]**.** Mediterranean coastal region of Egypt is considered one of many natural resources for vegetation so plays an important role during the Graeco-Romoan times [7].

Ecologically and phytosociologically many authors studied the Mediterranean coast from many stand points [8- 10, 6, 11-15] some ecological study on halophytes [16-20]. Recently, different habitats and plant communities in the Mediterranean coast were studied by [21-23], geography and geology [24]. This work aims to study the vegetation analysis of Mediterranean coast, Egypt by using multivariate analyses and to detect the relationship between soil variables and plant communities associated with family Apiaceae.

MATERIAL AND METHODS

Study Area

The Nile Delta starts, 20 km north of Cairo, it is embraced by the Rosetta and Damietta branches. Its length from north to south is 170 km, and their breadth from east to west is 220 km with an area about of 22,000 km^2 and thus comprises 63% of the Egyptian fertile lands, while the area of the Nile Valley is about 13.000 km2 [25]. Mediterranean Coast of Egypt extends for 970 km from Sallum eastward to Rafah in three sections: the western sector (Mareotis coast) extends from Sallum to Abu-Qir for about 550 km, the middle section (Deltaic coast) runs from Abu-Qir to Port-Said for about 220 km, and the eastern section (Sinai coast) stretches from Port-Said to Rafah for about 200 km [19]. Climatologically, the Mediterranean coastal region of Egypt belongs to the dry arid climate zone of Koppen's Classification System, the arid mesothermal province of [26].

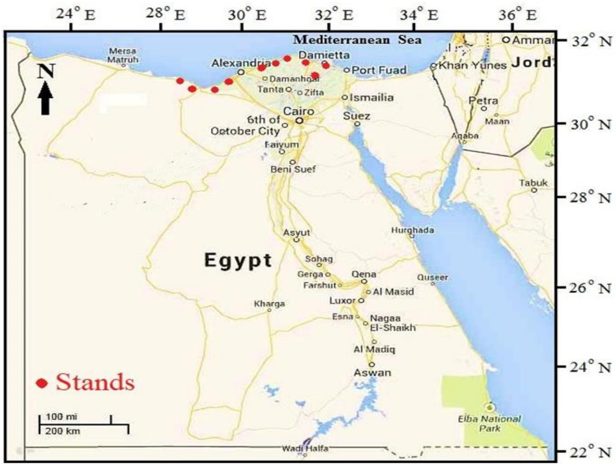

Figure1. Location map showing study sites.

Vegetation Analysis

After a study between 2017 and 2018, 11 stands (25×25) were selected to represent physiographic and environmental variation in the studied Egyptian and Western Mediterranean coast. The relative density and cover of each species was determined in the studied stands. Relative values of density and cover as well as importance value (IV = 200) for each plant species in each stand were estimated. Nomenclature, identification and floristic categories were carried out according to [27-31]. Life forms were characterized according to the scheme of [32].

Soil Analysis

Soil samples (n=11) were collected from each stand at a depth of 0-50 cm. All samples were then brought to the laboratory in closed plastic bags shortly after collection. Soil texture, sieve method (mechanical analysis) was used for the sandy soil, the percentage of sand, silt and clay were calculated according to [33]**.** Saturation capacity and porosity were determined according to [34]**.** Organic carbon was determined according to [35]**.** Chloride content was determined by method using N/35.5 silver nitrate and potassium chromate solution as indicator [36]. Electrical conductivity and pH were determined in soil–water (1:5) suspension by the method adopted by [37]**.** Carbonates and bicarbonates were determined by titration using 0.1 N HCl as described by [38]. Sodium and potassium were given by flame photometry, while calcium and magnesium were indicated by using atomic absorption spectrometer (A Perkin-Elmer, Model 2380.USA).

Data Analysis

A floristic data form of 11 stands and 94 species was subjected for classification by two-way indicator species analysis (TWINSPAN, version 2.3) [39]. The relation between the vegetation and soil gradients was assessed using Canonical Correspondence Analysis (CCA) [40]**.** The obtained data were statistically evaluated using SPSS 16 for Windows.

RESULTS

Floristic Composition

Plant species recorded in the study area showed that the total number of plant species recorded in the present study was 94 species belonging to 82 genera and 25 families (Table 1). These species were classified into three major groups: 49 annuals (52.13%), 2 biennials (2.13%) and 43 perennials (45.74%) (Figure 2). The most common families were Asteraceae and Poaceae which comprise 17 species (18.09%). 14 species (14.89%) in Apiaceae, 7 species (7.45%) in Chenopodiaceae, 5 species (5.32%) in Polygonaceae, 4 species (4.26%) in Brassicaceae, Convolvulaceae and Fabaceae, 2 species (2.13%) in Aizoaceae, Cyperaceae, Malvaceae, Plantaginaceae and Solanaceae. The remaining families (12) Asclepiadaceae, Boraginaceae, Caryophyllaceae, Euphorbiaeae, Geraniaceae, Neuradaceae, Oxalidaceae, Portulacaceae, Rutaceae, Scrophulariaceae, Thymelaceae and

Zygophyllaceae were represented by only one species each.

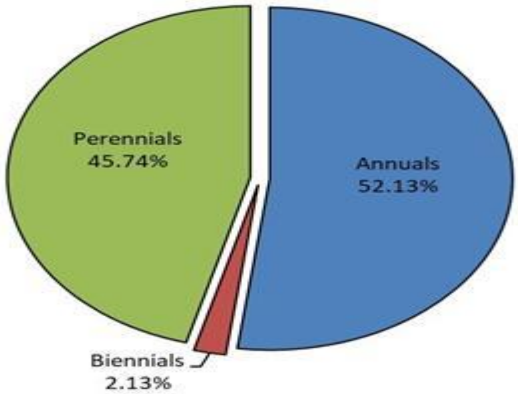

Figure 2. Plant life-span (%) of the recorded species in the study areas.

According to [32] the description and classification of life-form of plant species recorded in the present study as follows: therophytes, hemicryptophytes, cryptophytes chamaephytes and phanerophytes (Figure 3). The majority of the recorded species were therophytes (54.26%), followed by hemicryptophytes (21.28%), then cryptophytes (10.64%) and chamaephytes (9.57%). The lowest value of life-forms was recorded as phanerophytes which attained value of 4.26%.

The chorological analysis of the floristic data revealed that 57 species were Mediterranean (60.64% of the total number of species). The taxa are Pluriregional (20 species = 21.28%), Biregional (22 species = 23.40%) or Monoregional (15 species = 15.96%), Irano-Turaninan (32 species = 34.04%), Saharo-Sindian (28 species = 29.79%), Euro-Siberian (16 species = 17.02%), Cosmopolitan (11 species = 11.70%), pantropical (5 species = 5.32%) and palaeotropical (4 species = 4.26%). Other chorotypes were represented by little number of species.

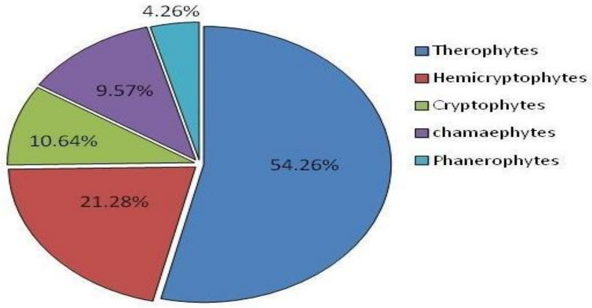

Figure 3. Life-form spectrum (%) of the recorded species in the study area.

Table 1. Floristic composition of the flora associated with the studied Apiaceae taxa.

o	Plant Species	Life span	Life form	Chorotype
Aizoaceae				
1	*Mesembryanthemum crystallinum* L.	Ann.	Th	ME+ER-SR
2	*M. nodiflorum* L.	Ann.	Th	ME+SA-SI+ER-SR
Apiaceae				
3	*Ammi majus* L.	Ann.	Th	ME+IR-TR+ER-SR
4	*Anethum graveolens* L.	Ann.	Th	CULT
5	*Apium graveolens* L.	Ann.	Th	COSM
6	*A. leptophyllum* (Pers.)F.Muell.ex Benth	Ann.	Th	COSM
7	*Carum carvi* L.	Ann.	Th	CULT
8	*Coriandrum sativum* L.	Ann.	Th	CULT
9	*Daucus litoralis* Sm.	Ann.	Th	ME
10	*Deverra tortuosa* (Desf.) DC.	Per.	Ch	SA-SI
11	*Eryngium creticum* Lam.	Per.	H	ME+IR-TR
12	*Foeniculum vulgare* Mill.	Per.	H	ME+IR-TR
13	*Petroselinum crispum* Mill.	Bie.	Th	CULT
14	*Pimpinella anisum* L.	Ann.	Th	ME
15	*Pseudoralya pumila* (L.) Grande	Ann.	Th	ME
16	*Torilis arvensis* (Huds.) Link	Ann.	Th	ME+IR-TR+ER-SR
Asclepiadaceae				
17	*Cynanchum acutum* L.	Per.	H	ME+IR-TR
Asteraceae				
18	*Achillea santolina* L.	Per.	Ch	SA-SI+IR-TR
19	*Atractylis carduus* (Forssk.) C.Chr.	Per.	H	ME+SA-SI
20	*Bidens pilosa* L.	Bie.	Th	PAN
21	*Carthamus tenuis* (Boiss & Blanche) Bornm.	Ann.	Th	ME
22	*Conyza aegyptiaca* (L.)Dryand.	Ann.	Th	ME
23	*C. bonariensis* (L.) Cronquist	Ann.	Th	ME
24	*Echinops spinosus* L.	Per.	H	ME+SA-SI

25	*Lactuca serriola* L.	Ann.	Th	ME+IR-TR+ER-SR
26	*Launaea mucronata* (Forssk.) Muschl.	Per.	H	ME+SA-SI
27	*L. nudicaulis* (L.) Hook.f.	Per.	H	SA-SI
28	*Picris asplenioides* L.	Ann.	Th	ME+IR-TR
29	*Pluchea dioscoridis* (L.) DC.	Per.	Ph	SA-SI+S-Z
30	*Reichardia tingitana* (L.) Roth.	Ann.	Th	ME+SA-SI+IR-TR
31	*R.picroides* (L.) Roth	Per.	H	ME+SA-SI
32	*Senecio glaucus* L.	Ann.	Th	ME+SA-SI+IR-TR
33	*Sonchus oleraceus* L.	Ann.	Th	COSM
34	*Silybum marianum* (L.) Gaertn.	Ann.	Th	ME+IR-TR+ER-SR
Boraginaceae				
35	*Echium angustifolium* Mill. subsp. sericeum (Vahl)Klotz.	Per.	H	ME
Brassicaceae				
36	*Brassica tournefortii* Gouan.	Ann.	Th	ME+IR-TR+SA-SI
37	*Cakile maritima* Scop.subsp. aegyptiaca (Willd.) Nyman	Ann.	Th	ME+ER-SR
38	*Descurainia sophia*(L.) Webb ex Prantl	Ann.	Th	ME+IR-TR+ER-SR
39	*Sisymbrium irio* L.	Ann.	Th	ME+IR-TR+ER-SR
Caryophyllaceae				
40	*Silene succulenta* Forssk.	Per.	H	ME
Chenopodiaceae				
41	*Arthrocnemum macrostachyum* (Moric.) K.Koch	Per.	Ch	ME+SA-SI
42	*Atriplex halimus* L.	Per.	Ph	ME+SA-SI
43	*Bassia indica* (Wight) A.J.Scott	Ann.	Th	S-Z+IR-TR
44	*Beta vulgaris* L.	Ann.	Th	ME+IR-TR+ER-SR
45	*Chenopodium album* L.	Ann.	Th	COSM
46	*C. murale* L.	Ann.	Th	COSM
47	*Salsola kali* L.	Ann.	Th	COSM
Convolvulaceae				
48	*Convolvulus arvensis* L.	Per.	H	COSM
49	*C. althaeoides* L.	Per.	H	ME+SA-SI+IR-TR
50	*C.lanatus* Vahl	Per.	Ch	SA-SI
51	*Ipomoea stolonifera* (Cyr.) J.F.Gmelin	Per.	H	PAN
Cyperaceae				
52	*Cyperus capitatus* Vand.	Per.	Cr	ME
53	*C. rotundus* L.	Per.	Cr	PAN
Euphorbiaeae				
54	*Euphorbia terracina* L.	Per.	H	ME
Fabaceae				
55	*Alhagi graecorum* Boiss.	Per.	H	PAL
56	*Lotus glaber* Mill.	Per.	H	ME+IR-TR+ER-SR
57	*L. halophilus* Boiss. & Spruner	Ann.	Th	ME+SA-SI
58	*Ononis vaginalis* Vahl	Per.	Ch	IR-TR+SA-SI
Geraniaceae				
59	*Erodium laciniatum* (Cav.) Willd.	Ann.	Th	ME
Malvaceae				
60	*Lavatera cretica* L.	Ann.	Th	ME+IR-TR+ER-SR
61	*Malva parviflora* L.	Ann.	Th	ME+IR-TR
Neuradaceae				
62	*Neurada procumbens* L.	Ann.	Th	SA-SI+IR-TR
Oxalidaceae				
63	*Oxalis corniculata* L.	Per.	H	COSM
Plantaginaceae				
64	*Plantago squarrosa* Murray.	Ann.	Th	ME+IR-TR+ER-SR
65	*P. major* L.	Per.	H	COSM
Poaceae				
66	*Aegilops bicornis* (Forssk.) Jaub & Spach	Ann.	Th	ME+SA-SI
67	*Arundo donax* L.	Per.	Cr	NAT and CULT
68	*Avena fatua* L.	Ann.	Th	PAL
69	*Bromus diandrus* Roth	Ann.	Th	ME
70	*Cynodon dactylon* (L.) Pers.	Per.	Cr	PAN

71	*Echinochloa colona* (L.) Link	Ann.	Th	PAN
72	*Elymus farctus* (viv.)Runem.ex Melderis	Per.	Cr	ME
73	*Hordeum murinum* L.	Ann.	Th	ME+IR-TR+ER-SR
74	*Imperata cylindrica* (L.) Raeusch.	Per.	H	PAL
75	*Lolium perenne* L.	Ann.	Th	ME+IR-TR+ER-SR
76	*Panicum coloratum* L.	Per.	Cr	SA-SI
77	*Phalaris minor* Retz.	Ann.	Th	ME+IR-TR
78	*Phragmites australis* (Cav.) Trin. ex Steud.	Per.	Cr	ME+IR-TR+SA-SI
79	*Setaria glauca* (L.) P.Beauv	Ann.	Th	COSM
80	*Sorghum virgatum* (Hack.) Stapf	Ann.	Th	PAL
81	*Sporobolus spicatus* (Vahl) Kunth	Per.	Cr	S-Z+SA-SI+ME
82	*Stipagrostis lanata* (Forssk.) De Winter	Per.	Cr	SA-SI
Polygonaceae				
83	*Calligonum polygonoides* L. subsp. comosum (L' Her.) Soskov	Per.	Ph	SA-SI+IR-TR
84	*Emex spinosa* (L.) Campd.	Ann.	Th	ME+SA-SI
85	*Polygonum equisetiforme* Sibthi & Sm.	Per.	Cr	ME+IR-TR
86	*Rumex dentatus* L.	Ann.	Th	ME+IR-TR+ER-SR
87	*R. pictus* Forssk.	Ann.	Th	ME+SA-SI
Portulacaceae				
88	*Portulaca oleracea* L.	Ann.	Th	COSM
Rutaceae				
89	*Haplophyllum tuberculatum* (Forssk.) Juss.	Per.	H	ME+IR-TR
Scrophulariaceae				
90	*Kickxia aegyptiaca* (L.) Nabelek	Per.	Ch	ME+SA-SI
Solanaceae				
91	*Solanum incanum* L.	Per.	Ch	S-Z
92	*Withania somnifera* (L.) Dunal	Per.	Ch	ME+IR-TR
Thymelaceae				
93	*Thymelaea hirsuta* (L.) Endl.	Per.	Ph	ME
Zygophyllaceae				
94	*Fagonia cretica* L.	Per.	Ch	ME

Abbreviation: Life-form: Th, Therophytes; Cr, Cryptophytes; Ch, Chamaephytes; H, Hemicryptophytes; ph, phanerophytes. Chorotype: COSM, Cosmopolitan; PAN, Pantropical; PAL, Palaeotropical; ME, Mediterranean; ER-SR, Euro-Siberian; SA-SI, Saharo-Sindian; IR-TR, Irano-Turanina; S-Z, Sudano-Zambezian; CULT, cultivated.

Classification of Vegetation

The dendrogram resulting from the application of TWINSPAN classification based on the importance values (out of 200) of 94 plant species recongnized in 11 stands, led to the identification of three vegetation groups (A-C) at the 2nd level of classification (Figure 4, Table 2). The vegetation groups were named based on dominant species with the highest importance value in each group as follow:

Group A includes 2 species distributed in one stand. The dominant species was *Carum carvi* (IV= 157.46). *Apium graveolens* was the most important associates in the community (IV= 42.54). Group B includes 68 species distributed in 6 stands and it was codominated by *Salsola kali* (IV= 7.37). *Echinops spinosus* (IV= 7.17) and *Echium angustifolium* (IV= 7.10). The most

important species were *Mesembryanthemum crystallinum* (IV= 7.02), *Anethum graveolens* (IV= 6.93) and *Silybum marianum* (IV= 6.62). Group C comprises 4 stands with 34 species. The codominant species were *Foeniculum vulgare* (IV= 21.46) and *Petroselinum crispum* (IV= 21.28). *Ammi majus* (IV= 18.84), *Coriandrum sativum* (IV= 18.48) and *Cynodon dactylon* (IV= 14.82) were the most important associates in this community.

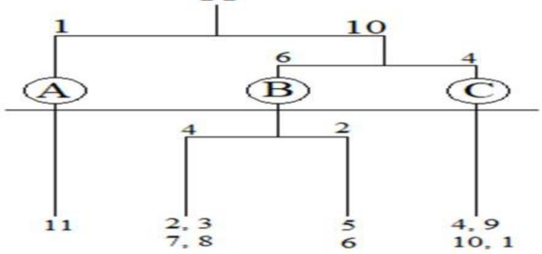

Figure4. TWINSPAN dendrogram showing the three vegetation groups (A, B and C) at

the 2nd level of classification resulting from the cluster analysis of 11 sampled stands.

Table2. Mean value and coefficient of variation (value between brackets) of the importance values (out of 200) of recorded species in the different vegetation groups resulting from the TWINSPAN classification of the sampling stands in the study area.

o.	Species	Vegetation groups		
		A	B	C
1	*Achillea santolina*	--	2.67 (1.57)	--
2	*Aegilops bicornis*	--	1.85 (2.45)	--
3	*Alhagi graecorum*	--	1.17 (2.45)	--
4	*Ammi majus*	--	3.07 (2.45)	18.84 (2.00)
5	*Anethum graveolens*	--	6.93 (2.45)	--
6	*Apium leptophyllum*	--	--	10.33 (2.00)
7	*A. graveolens*	42.54	--	--
8	*Arundo donax*	--	--	3.29 (2.00)
9	*Atractylis carduus*	--	1.65 (2.45)	--
10	*Arthrocnemum macrostachyum*	--	1.14 (2.45)	--
11	*Atriplex halimus*	--	1.95 (2.45)	--
12	*Avena fatua*	--	2.92 (1.55)	3.87 (2.00)
13	*Bassia indica*	--	0.79 (2.45)	--
14	*Beta vulgaris*	--	--	1.44 (2.00)
15	*Bidens pilosa*	--	--	1.37 (2.00)
16	*Brassica tournefortii*	--	1.20 (2.45)	--
17	*Bromus diandrus*	--	3.36 (2.45)	3.22 (2.00)
18	*Cakile maritima*	--	5.74 (1.77)	--
19	*Calligonum polygonoides*	--	2.58 (2.45)	--
20	*Carthamus tenuis*	--	5.13 (1.66)	--
21	*Carum carvi*	157.4603	--	--
22	*Chenopodium album*	--	--	1.93 (2.00)
23	*C. murale*	--	3.29 (1.58)	2.23 (2.00)
24	*Convolvulus althaeoides*	--	1.36 (2.45)	--
25	*C. arvensis*	--	3.64 (1.56)	4.89 (1.17)
26	*C. lanatus*	--	2.50 (2.45)	--
27	*Conyza aegyptiaca*	--	--	1.95 (2.00)
28	*C. bonariensis*	--	1.10 (2.45)	3.99 (2.00)
29	*Coriandrum sativum*	--	--	18.48 (2.00)
30	*Cynanchum acutum*	--	5.79 (1.41)	--
31	*Cynodon dactylon*	--	1.21 (2.45)	14.82 (0.17)
32	*Cyperus capitatus*	--	1.00 (2.45)	--
33	*C. rotundus*	--	--	3.13 (2.00)
34	*Daucus litoralis*	--	3.69 (2.45)	--
35	*Descurainia sophia*	--	1.00 (2.45)	--
36	*Devera tortuosa*	--	4.31 (2.45)	--
37	*Echinochloa colona*	--	--	1.38 (2.00)
38	*Echinops spinosus*	--	7.17 (1.55)	--
39	*Echium angustifolium*	--	7.10 (1.56)	--
40	*Elymus farctus*	--	0.71 (2.45)	--
41	*Emex spinosa*	--	2.65 (1.85)	--
42	*Erodium laciniatum*	--	1.30 (2.45)	--
43	*Eryngium creticum*	--	2.93 (1.56)	--
44	*Euphorbia terracina L*	--	1.17 (1.71)	--
45	*Fagonia cretica*	--	3.13 (1.91)	--
46	*Foeniculum vulgare*	--	--	21.46 (2.00)
47	*Haplophyllum tuberculatum*	--	2.02 (2.45)	--
48	*Hordeum murinum*	--	2.06 (2.45)	--
49	*Imperata cylindrica*	--	0.87 (2.45)	--
50	*Ipomoea stolonifera*	--	0.64 (2.45)	--
51	*Kickxia aegyptiaca*	--	2.18 (2.45)	--
52	*Lactuca serriola*	--	0.49 (2.45)	--
53	*Launaea mucronata*	--	3.72 (1.63)	--

54	*L. nudicaulis*	--	1.01 (2.45)	--
55	*Lavatera cretica*	--	--	1.73 (2.00)
56	*Lolium perenne*	--	1.28 (2.45)	--
57	*Lotus glaber*	--	1.25 (2.45)	--
58	*L. halophilus*	--	1.28 (2.45)	--
59	*Malva parviflora*	--	--	4.22 (2.00)
60	*Mesembryanthemum crystallinum*	--	7.02 (1.32)	--
61	*Mesembryanthemum nodiflorum*	--	1.52 (2.45)	--
62	*Neurada procumbens*	--	3.50 (2.45)	--
63	*Ononis vaginalis*	--	0.80 (2.45)	--
64	*Oxalis corniculata*	--	--	3.68 (2.00)
65	*Panicum coloratum*	--	--	2.52 (2.00)
66	*Petroselinum crispum*	--	--	21.28 (2.00)
67	*Phalaris minor*	--	0.36 (2.45)	--
68	*Phragmites australis*	--	--	3.62 (2.00)
69	*Picris asplenioides*	--	1.82 (1.84)	--
70	*Pimpinella anisum*	--	0.96 (2.45)	--
71	*Plantago major*	--	--	1.62 (2.00)
72	*P. squarrosa*	--	2.24 (1.62)	--
73	*Pluchea dioscoridis*	--	--	5.14 (1.42)
74	*Polygonum equisetiforme*	--	5.61 (1.18)	1.56 (2.00)
75	*Portulaca oleracea*	--	--	11.82 (1.16)
76	*Pseudoralya pumila*	--	0.65 (2.45)	--
77	*Reichardia picrodies*	--	3.21 (1.79)	--
78	*R. tingitana*	--	0.85 (2.45)	--
79	*Rumex dentatus*	--	--	1.22 (2.00)
80	*R. pictus*	--	1.29 (2.45)	--
81	*Salsola kali*	--	7.37 (2.01)	--
82	*Senecio glaucus*	--	5.13 (0.85)	--
83	*Setaria glauca*	--	--	1.63 (2.00)
84	*Silene succulenta*	--	0.90 (2.45)	--
85	*Silybum marianum*	--	6.62 (2.45)	--
86	*Sisymbrium irio*	--	--	0.99 (2.00)
87	*Solanum incanum*	--	3.27 (2.45)	--
88	*Sorghum virgatum*	--	--	4.54 (2.00)
89	*Sonchus oleraceus*	--	3.17 (1.78)	0.89 (2.00)
90	*Sporobolus spicatus*	--	1.27 (2.45)	--
91	*Stipagrostis lanata*	--	2.64 (2.45)	--
92	*Torilis arvensis*	--	--	10.44 (2.00)
93	*Thymelaea hirsuta*	--	3.46 (2.45)	--
94	*Withania somnifera*	--	0.61 (2.45)	2.75 (2.00)

Table3. Mean value and standard error of the different soil variables in the stands representing the different vegetation groups obtained by TWINSPAN classification in the study area.

Soil variable	**Vegetation group**		
	A	**B**	**C**
Sand %	23.24 ±0	91.32±7.32	37.26±13.29
Silt %	32±0	4.71 ± 3.93	30.16±3.71
Clay %	44.76 ± 0	4.12 ± 3.35	32.58±9.64
Por %	49.24 ± 0	37.21 ± 3.19	44.75±3.30
Saturation capacity	28.19 ± 0	35.43 ± 1.64	34.36±4.25
pH	8 ± 0	7.62 ± 0.07	7.63±0.13
O.C %	3.6 ± 0	1.81 ± 0.55	3.72±0.36
EC (dS/m)	0.58 ± 0	0.43 ± 0.17	1.36±0.29
Na+ (meq/l)	4.609 ± 0	1.64 ± 0.95	4.69±1.18
K+ (meq/l)	0.102 ± 0	0.27 ± 0.10	0.76±0.36
Ca++ (meq/l)	1.03 ± 0	1.99 ± 0.46	6.76±2.24
Mg++ (meq/l)	0.477 ± 0	0.70 ± 0.21	2.98±1.06
Cl- (meq/l)	1.946 ± 0	1.97 ± 1.28	4.83±1.53
SO4-- (meq/l)	1.596 ± 0	1.04 ± 0.43	7.67±2.52
HCO3 (meq/l)	2.399 ±0	1.70 ± 0.38	2.56±0.65

Abbreviations: Por= Porosity, OC = Organic carbon; EC = Electrical conductivity

Table 4. Correlation matrix between the soil variables in the stands surveyed in the study area.

Soil variables	**Sand**	**Silt**	**Clay**	**Porosity**	**Saturation capacity**	**pH**	**OC**	**EC**	**Na^+**	**K^+**	**Ca^{++}**	**Mg^{++}**	**Cl^-**	**SO_4^{--}**	**HCO_3^-**
Sand	1														
Silt	.981**	1													
Clay	989**	.940**	1												
Porosity	-.513	0.6	0.432	1											
Saturation capacity	0.039	-0.006	-0.064	-.037	1										
pH	-.389	0.311	0.435	0.394	-0.298	1									
OC	-.547	.629*	0.471	0.321	-0.139	0.155	1								
EC	-.439	0.535	0.352	0.249	-0.19	0.404	.678*	1							
Na	0.532	0.575	0.483	0.326	-0.417	0.036	.666*	.846**	1						
K	-0.05	0.233	-0.091	0.493	0.049	-0.44	.630*	.653*	0.401	1					
Ca	0.194	0.337	0.077	0.282	-0.129	-0.497	0.567	.911**	.613*	.826**	1				
Mg	-0.54	0.571	0.502	-.026	0.13	-0.462	0.418	.764**	0.472	0.274	.645*	1			
Cl^-	-.351	0.365	0.33	-.081	-0.26	-0.354	0.442	.843**	.863**	0.224	0.597	.686*	1		
SO_4^{--}	-0.27	0.418	0.148	0.425	-0.076	-0.397	.667*	.857**	0.58	.889**	.961**	0.554	0.467	1	
HCO_3	-.495	.605*	0.396	0.471	0.014	-0.152	0.455	.645*	0.497	0.526	.628*	0.599	0.402	0.554	1

OC: organic carbon, EC: Electrical conductivity; *P ≥ 0.05; **P ≥ 0

Variation in Soil Variables of the Vegetation Groups

The variation in soil variables (mean value ± standard value) of three groups of stands derived from TWINSPAN classification are shown in Table (3). The soil texture in group (A) was formed mainly of clay (44.76%), sand and silt (55.24%), also in group (B) it was formed mainly of coarse fraction (sand) (91.32 %) and partly of fine fractions (silt and clay) (8.83%). Also, in group (C) it was formed of coarse fraction (sand) (37.26%) and fine fraction (silt and clay) (62.74%). The percentages of soil porosity were relatively high in all groups A, B, C (49.24%, 37.21% and 44.75% respectively). The mean value of saturation capacity was relatively high in group B & C (35.43% and 34.36%, respectively) and relatively low in group (A) (28.19%). The soil pH value varied from neutral to slightly alkaline in soil reaction. The pH values ranged from 7.62-8. The organic carbon content of the soil showed the highest values in groups (C & A) (3.72% and 3.6%, respectively), while the lowest value was attained in group (B) (1.81 %). The highest mean value of electrical conductivity was estimated in group (C) (1.36 ds/m), while the lowest value was in group (B) (0.43 ds/m). The monovalent cations: sodium and potassium attained their highest mean concentrations in group C (4.69 meq/l and 0.76 meq/l, respectively) while, the lowest mean concentrations (1.64 meq/l and 0.27 meq/l, respectively) in group B. The highest mean concentrations of divalent cations; calcium and magnesium (6.76 meq/l and 2.98 meq/l, respectively) were also estimated in group C, while the lowest mean concentrations (1.03 meq/l and 0.477 meq/l, respectively) were attained in group A. In chlorides, the highest value was estimated in group (C) (4.83 meq/l), but the lowest value was in group (A) (1.946 meq/l). Sulphate content showed the highest value in group (C) (7.67 meq/l) but the lowest in group (B) (1.04 meq/l). The soluble carbonates were compeletely missed in all groups, but the mean values of bicarbonates ranged between 1.70 meq/l in group B to 2.56 meq/l in group C.

The correlation coefficient (r) between the different soil variables in the sampled stands are shown in Table 4. Some soil variables showed significant positive correlated with other soil variables such as silt, organic carbon, electrical conductivity, cations (Na^+, K^+, Ca^{++}, Mg^{++}). On the other hand, some other variables showed significant negative correlation or none with soil variables such as sand, clay, porosity, saturation capacity, PH and anions (Cl^-, sulphates and bicarbonate).

4. Correlation Between Soil Variables and Vegetation

The correlation between vegetation and soil characteristics is indicated on the ordination diagram produced by Canonical Correspondence Analysis (CCA) of the recorded species and environmental (soil) variables (Figure 5). In the upper-left quarter of CCA diagram, the dominant and the most important species of vegetation group C namely, *Anethum graveolens*, *Salsola kali*, *Mesembryanthemum crystallinum*, *Silybum marianum*, *Echinops spinosus* and *Echium angustifolium* were obviously controlled by saturation capacity as shown in Figure (5). In the lower-left quarter of CAA diagram, the codominant and important plant species in group B namely, *Ammi majus*, *Foeniculum vulgare*, *Cynodon dactylon*, *Portulaca oleracea*, *Petroselinum crispum* and *Coriandrum sativum* were correlated with sand and pH value as shown in Figure (5). On the other hand, the codominant and most important species in group A namely, *Apium graveolens* and *Carum carvi* was separated at the upper-right quarter of CAA diagram, and it was controlled by numerous soil variables as sulphates, calcium, bicarbonates, electrical conductivity, organic carbon and porosity.

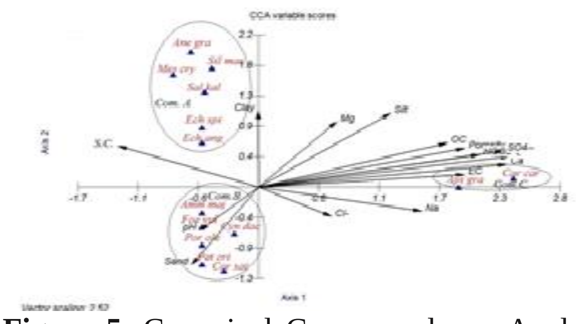

Figure 5. Canonical Correspondence Analysis (CCA) ordination biplot of the leading characteristic species and soil variables in the study areas.

Discussion

The number of species of Apiaceae and their associated species that recorded in the 11 surveyed stands in the study area was 94 plant species belonging to 82 genera and 25 families. About more than half of these species belongs to five families arranged in the following sequence: Asteraceae > Poaceae > Apiaceae > Chenopodiaceae > Polygonaceae. These results agreed with [19, 21, 41-46].

The structure of life forms gives information that may help in assessing the response of vegetation to variation in certain environmental factors [47]. The life form spectra have physiognomic attributes that used by ecologists and chorologists in the vegetation and floristic studies [48]. According to [32, 49] Mediterranean climate is type as a therophyte climate. In the earlier study by [50], therophytes were estimated by 50.3% for the whole Egyptian flora compared with 58.7% for the Mediterranean region and 59.4 % for Egyptian Nile region. [19] reported that about 55.6 % of therophytes are represented in the vegetation of the Deltaic Mediterranean coast. Therophytes of sand dune vegetation in the coast of the Nile Delta were about 59.5% [21].

In the present study and according to the life forms description and classification, plant species were grouped into five types: 51 therophytes, 20 hemicryptophytes, 10 cryptophytes, 9 chamaephytes and 4 phanerophytes. These results were agreed with the study by [19] in the vegetation of the Deltaic Mediterranean coast.

Phytogeographically, Egypt is the meeting point of floristic elements belonging to 4 phytogeographical districts: the African Sudano-Zambezian, the Asiatic Irano-Turanian, the Afro-Asiatic Saharo-Sindian and the Euro-Afro-Asiatic Mediterranean [51]. The study area is belonging to the Mediterranean Territory with slightly extending into Saharo-Sindian Territory. This explained through high percentage of Mediterranean and Saharo-Sindian chorotypes. This was confirmed by [8, 11, 14, 19-22, 41, 52, 53]. There were a mixture of floristic categories in the study area such as Mediterranean, Saharo-Sindian, Sudano-Zambezian, Irano-Turanian, Euro-Siberian, Cosmopolitans,Pantropical and Palaeotropical elements with variable number of species. This finding confirms the ability of some floristic elements to penetrate the study area from other adjacent phytogeographic regions [54, 55, 46].

TWINSPAN classification based on the importance value of 94 plant species recorded in 11 stands, led to the recognition of three vegetation groups or community types at the second level of classification. The vegetation groups were named based on dominant species with the highest importance value in each group as follow: group A: *Carum carvi*, group B: *Salsola kali* and group C: *Foeniculum vulgare*. These results were more or less similar to those reported by [19, 21, 41, 42, 46]**.**

Results of Canoncal Correspondence Analysis (CCA-biplot) in the present study indicated that, saturation capacity, pH, sand, sulphates, electrical conductivity, clay fractions and calcium cation were the highly effective soil variables that affected the distribution and abundance of the studied species. Group C was obviously controlled by saturation capacity as shown in the upper-left quarter of CCA plot, group B was obviously controlled by sand fractions as shown in the lower-left quarter of CCA diagram and group A was obviously controlled by sulphates and calcium cation as shown in the upper right quarter of CCA diagram.

These results are in agreement with other different studies on Mediterranean coast according to [56-58].

References

1. Constance, L. (1971). History of the classification of Umbelliferae (Apiaceae). In Heywood, V. H. (ed.), The Biology and chemistry of the Umbelliferae, pp. 1-11. Academic Press, London, UK.

2. Pimenov, M. G. and Leonov, M. V. (1993). The genera of the Umbelliferae: a Nomenclator. 156 pp. Royal Botanic Gardens Kew, Kew (London, U.K.).

3. Boulos, L. (2000). Flora of Egypt. Vol. 2. Geraniaceae-Boraginaceae. Al Hadara Publishing, Cairo, Egypt, p. 352.

4. Mathias, M. (1971). Systematic survey of New World Umbelliferae. In Heywood, V. H. (ed.), The Biology and chemistry of the Umbelliferae, pp. 13-29. Academic Press, London, UK.

5. Schlessman, M. A. (1984). Systematics of tuberous lomatiums (Umbelliferae). 55 pp. American Society of Plant Taxonomists, Ann Arbror, Mich.

6. Zahran, M.A., El-Demerdash, M.A. and Mashaly, I. A. (1990). Vegetation types of the Deltaic Mediterranean coast of Egypt and their environment. *Journal of Vegetation Science*, **1**: 305-310.

7. Kassas, M. (1972) A brief history of land-use in Mareotis region, Egypt. Minerva Biological,167-174.

8. Mashaly, I. A. (1987). Ecological and Floristic Studies of Dakahlia-Damietta Region, Ph.D. Thesis, Fac. Sci., Mansoura Univ., Egypt.

9. Zahran, M.A., El-Demerdash, M.A., Abu-Ziada, M.E. and Serag, M.S. (1988). On the ecology of the Deltaic Mediterranean coastal land, Egypt. II. Sand formation of Damietta– Port-Said coast. Bull. Fac. Sci., Mansoura Univ., **15**(2): 581-606.

10. El-Demerdash, M. A., Zahran, M. A., & Serag, M. S. (1990). On the ecology of the deltaic Mediterranean coastal land, Egypt. III. The habitat of salt marshes of Damietta-Port Said coastal region. *Arab Gulf Journal of Scientific Research*, **8**(3), 103-119.

11. Al-Sodany, Y.M. (1992). Vegetation Analysis of the Northern Part of Nile Delta Region. M.Sc. Thesis, Fac. Sci., Tanta Univ., Egypt.

12. El-Kady, H.F. and Sharaf El-Din, A. (1993). Roadside vegetation of Alexandria – Rosetta in the Nile Delta region. *Delta Journal of Science*, **17**(2): 267-281.

13. Mashaly, I.A. (1993). Comparative ecological studies on two halophytes: *Juncus subulatus* and *Diplochne fusca*, Deltaic Mediterranean coast, Egypt. *Journal of Environmental Sciences, Mansoura University*, **5**: 279-295.

14. Shaltout, K.H., El-Kady, H.F. and Al-Sodany, Y.M. (1995). Vegetation analysis of the Mediterranean region of Nile Delta. Vegetatio, **116**: 73-83.

15. El-Halawany, E.F. (1999). Effect of protection on coastal and inland vegetation in the Nile Delta, Egypt. *Journal Union Arab Biologist, Cairo,* **9**(**B**):71-84.

16. Zahran, M.A., Soliman, M.I. and Serag, M.S. (1994). Analysis of habitats and anatomy of *Juncus subulatus* Forssk., Deltaic Mediterranean coast, Egypt. *The Arab Gulf Journal of Scientific Research,* **12**(**2**): 301-319.

17. Hegazy, A.K., Soliman, M.I. and Mashaly, I.A. (1994). Perspectives on the biology of Heliotropium curassavicum in the Deltaic Mediterranean coast of Egypt. *Arab Gulf Journal of Scientific Research*, **12**(**3**): 525-545.

18. Serag, M.S. (1999). Ecology of four succulent halophytes in the Mediterranean coast of Damietta, Egypt. Estuarina, Coastal and Shelf Science, **49**: 29-36.

19. Mashaly, I.A. (2001). Contribution to the ecology of the Deltaic Mediterranean coast, Egypt. Online *Journal of Biological Sciences*, **1**(**7**): 628-635.

20. Mashaly, I.A. (2002). Ecological studies on *Zygophyllum aegyptium* in the Deltaic Mediterranean coast of Egypt. Pakistan *Journal of Biological Sciences*, **5**(**2**): 152-160.

21. Galal, T.M. and Fawzy, M. (2007). Sand dune vegetation in the coast of the Nile Delta, Egypt. Global *Journal of Environmental Research*, **1**(2): 74-85.

22. Maswada, H. F. (2009). Ecological and Physiological Studies on some Geophytes in the Mediterranean Coastal Region of Kafr El-Sheikh Governorate, Egypt. Ph.D. Thesis, Fac. Agric., Tanta Univ., Egypt.

23. Mashaly, I. A., El-Halawany, E. F. and Abd El-Hady, N. A. (2011). Weed vegetation-soil relationship in the Deltaic Mediterranean coast of Egypt. *Journal of Environmental Sciences, Mansoura University*, **40**(4): 501-519.

24. Vieira, Â. F., Dias, E. F., and Moura, M. (2018). Geography, geology and ecology influence population genetic diversity and structure in the endangered endemic Azorean Ammi (Apiaceae). Plant Systematics and Evolution, **304**(**2**), 163-176.

25. Abu Al-Izz, M. S. (1971). Land forms of Egypt. Translated by Dr YA Fayid. American Univ.

26. Thornthwaite, C.W. (1948). An approach towards a national classification of climate. Geographical Review, **38**: 55-94.

27. Zohary, M. (1966 and 1972). Flora Palaestina. Parts 1 and 2. The Israel Academy of Sciences and Humanities, Jerusalem.

28. Täckholm, V. (1974). Student's Flora of Egypt. 2nd ed. Cairo Univ. Press (Publ.), Cooperative Printing Company, Beirut.

29. Feinbrun-Dothan, N. (1978 and 1986). Flora Palaestina, Parts. 3 and 4. The Israel Academy of Sciences and Humanities, Jerusalem.

30. Boulos, L. (1999). Flora of Egypt. Vol. **1** (Azollaceae-Oxalidaceae). Al Hadara Publishing, Cairo, Egypt, p. 419.

31. Boulos, L. (2005). Flora of Egypt. Vol. **4.** Monocotyledons (Alismataceae-Orchidaceae). Al Hadara Publishing, Cairo, Egypt, p. 617.

32. Raunkiaer, C. (1934). The Life Forms of Plants Geography. Translated by Carter Fausboll and Tansley; Oxford Univ. Press, London.

33. Richards, L. A. (1954). Diagnosis and improvement of saline and alkali soils. Uni. St. Dept. of Agri., 60:160.

34. Klute, A. (1986). Methods of Soil Analysis, Part 1 Physical and Mineralogical Methods, Second Edition. Soil Science Society of America, Inc., Madison, WI, pp. 653-661.

35. Piper, C.S. (1947). Soil and Plant Analysis, Interscience Publishers, Inc. New York.

36. APHA (American Public Health Association) (1998). Standard Methods for the Examination of Water and Waste Water, 19th Edition. Water Pollution Control Federation, Washington, D.C.

37. Pansu, M. and Gautheyrou, J. (2006). Handbook of Soil Analysis, Mineralogical, Organic Methods. With 183 Figures and 48 Tables, Springer-Verlag, Berlin, Heidelberg, Printed in The Netherland, pp 993.

38. Baruah T. C. and Barthakur H. P. (1997). A text book of soil analysis. Vikas publishing, PVT Ltd, New Delhi.

39. Hill, M. O., and Šmilauer, P. (2005). WinTWINs. TWINSPAN for Windows Version 2.3.

40. Ter Braak, C. J. (1987). The analysis of vegetation-environment relationships by canonical correspondence analysis. Vegetatio, **69**(**1-3**), 69-77.

41. Mashaly, I.A., El-Habashy, E.E., El-Halawany, E.F. and Omar, G. (2008).

Habitats and plant communities in the Nile Delta of Egypt. I- Deltaic Mediterranean coastal habitat. Pakistan *Journal of Biological Sciences*, **11**(**22**): 2532-2544.

42. Shaltout, K.H., Sharaf El-Din, A. and Ahmed, D.A. (2010). Plant Life in the Nile Delta. Tanta Univ. Press, Egypt.

43. Shaltout, K. H., Hosni, H. A., El-Fahar, R. A. and Ahmed, D. A. (2015). Flora and vegetation of the different habitats of the Western Mediterranean region of Egypt. Taeckholmia, **35**: 45-76.

44. Mashaly, I.A, Abu- Ziada, M.E., El-Ameir, Y.A. and Khorshied, R.M. (2015a). Ecological study on two species of genus Rumex in the Nile Delta, Egypt. *Journal of Environmental Sciences, Mansoura University* **44**(**2**):403-425.

45. Mashaly, I. A., Abu- Ziada, M. E., El-Ameir, Y.A. and Khalifa, S.M. (2015b). Floristic features of the plant communities associated with some species of genus Euphorbia in Egypt. *Journal of Environmental Sciences, Mansoura University*, **44**(**3**):525-548.

46. Mashaly, I. A., Abd El-Aal, M., Aldesuquy, H. S., and Mahdee, B.A. (2016). Floristic perspective for some medicinal plants growing in the coastal and inland deserts of Egypt. *International Journal of Current Research*, **8** (1):In Press

47. Ayyad, M. A. and El-Ghareeb, R. M. (1982). Salt marsh vegetation of the Western Mediterranean desert of Egypt. Vegetatio, **49**(1): 3-19.

48. Cain, S.A. and Castro, G.M. (1959). Manual of Vegetation Analysis. Harper and Brothers, New York.

49. Raunkiaer, C. (1937). Plant Life Forms. Clarendon, Oxford.

50. Hassib, M. (1951). Distribution of plant communities in Egypt. Bull. Fac. Sci., Fouad University, **29**: 259-261.

51. El-Hadidi, M.N. (1993). The Agriculture of Egypt. In G.M. Craig (ed.). Oxford Univ. Press.

52. El-Halawany, E.F. (2003). Vegetation changes in north Nile Delta within two decades, *Journal of Environmental Sciences, Mansoura University*, **26**(2): 153-180.

53. El-Halawany, E. F., Mashaly, I. A., Abu Ziada, M. E. and Abd El-Aal, M. (2010). Habitat and plant life in El-Dakahlyia Governorate, Egypt. *Journal of Environmental Sciences, Mansoura University*, **39**(1): 83-108.

54. Seif El-Nasr, M. and Bidak, L. (2006). Conservation and Sustainable Use of Medicinal Plants Project: National Survey, North Western Coastal Region. Vol **II**. Medicinal Plants in the Area. Final Report. Mubarak City for Scientific Research and Technology Applications. 178 pp.

55. Shaltout, K. H., Hosni, H. A., El-Fahar, R. A. and Ahmed, D. A. (2015). Flora and vegetation of the different habitats of the Western Mediterranean region of Egypt. Taeckholmia, **35**: 45-76.

56. Ayyad, M. A. (1973). Vegetation and environment of the western Mediterranean coastal land of Egypt: I. The habitat of sand dunes. *The Journal of Ecology,* **2**: 509-523.

57. Ayyad**,** M. A. (1976). Vegetation and environment of the Western Mediterranean coastal land of Egypt: IV. The habitat of non-saline depressions. *The Journal of Ecology*, **5**: 713-722.

58. Ayyad, M. A. and El-Ghareeb, R.M. (1974). Vegetation and environment of the Western Mediterranean coastal land of Egypt. III. The habitat of saline depressions. Bull. Inst. Desert Egypt, **2:** 24-32.