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

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Abstract: This current study plans on examinition ecology of various Boraginaceae genera that grow naturally along Egypt Mediterranean coast. In the study region, 110 species were identified, representing 82 genera and 25 families. Three vegetation groups named after their dominant species were identified using TWINSPAN, which is used to categorize and rate the relevance of species in 11 sampled stands. Carum cervi dominated Group A, Salsola kali dominated Group B, and Borago officinalis dominated Group C. The use of Canonical Correspondence Analysis (CCA-biplot) between soil variables and vegetation groups revealed that saturation capacity , pH value, sand fraction, organic carbon, calcium, sulphates, bicarbonates, electrical conductivity, and porosity were the most efficient edaphic factors managing the distribution and abundance of the recognized vegetation groups dominated the different habitats in the stydy area.

keywords: Boraginaceae, classification , ordination, soil analysis, Mediterranean Coast.

1.Introduction

Juss. Boraginaceae. The 'Borragineae' were described in Antoine Laurent de Jussieu's 1789 Genera plantarum, a system for classifying plants. 'Borragineae' was based by De Jussieu on the genus Borago. The Latin term burra, which indicates appearance of hair, was given to the genus Borago by Linnaeus.

Boraginaceae Juss. is found all throughout the world, but mainly in the Mediterranean and tropical areas. It includes approximately 290 genera and more than 2,700 species in the third version of the Angiosperm Phylogeny Group [1,2]. In Egypt, the wild taxa of Boraginaceae is represented by 19 genera and 72 species [3] A significant number of species in the Boraginaceae family can be identified by their pollen grains, and the family contains a broad variety of morphological features [24].Annual, biennial or perennial herbs or less often shrublets or trees, usually with coarse hairs.

In terms of ecology, The desert of Egypt can be classified as either inland or coastal. The Mediterranean Sea, the Red Sea, and the two Gulfs of Sinai are connected to and have an impact on the coastal deserts. Deserts that are not impacted by the Deltiac seas are known as inland deserts, and they include oasis. . Salt marshes, sand formations, reed swamps, and fertile uncultivated areas are the four primary habitat types found along Egypt Mediterranean coast [4]. One important natural resource in Egypt Mediterranean coastline region is the vegetation. Its appropriate exploitation plays an important role in the sound of this region, which is believed to have enjoyed prosperity during the Graeco-Romoan times [5].Numerous scholars have examined the Mediterranean shore from a variety of ecological and phytosociological perspectives. [6- 8,4,9-13] [14-18]Recently, The various plant communities and habitats along the Mediterranean coast were examined by [19-21], geography and geology [22]. The purpose of this research is to analyze the vegetation of the Mediterranean coast in Egypt, as well as to investigate the relationship between soil characteristics and plant communities associated with the Boraginaceae family.

2. Materials and methods

1.Study Area

The Rosetta and Damietta branches embrace the beginning of the Nile Delta in 20 km north of Cairo, with an area of over 22,000 km2, it is 170 km long from north to south and 220 km wide from east to west. This area makes up 63% of Egypt's rich lands, whereas the Nile Valley is roughly 13,000 km2. [23,17].

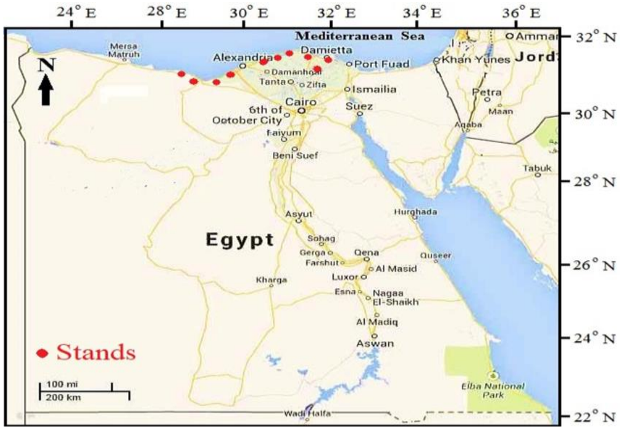

Fig 1. Location map showing study Sites

Vegetation Analysis

After a survey between 2017 and 2018, 11 sample stands (area of each plot about 25 m^2) were selected to represent physiographic and environmental variation in the studied Egyptian and Western Mediterranean coast. The ratio of density and cover of every species were determined (cover made by point sampling methods, density by the number of plants per unit area) in the examined stands stands. Relative values of density and cover, in addition to the importance value (IV = 200), were estimated for each plant species in each stand.

. Nomenclature, identification in addition to floristic categories were carried out according to [25-29]. Life forms were identified according to the scheme of [30].

Soil Analysis

Soil samples were taken at a depth 0-50 cm from every stand . All samples were then brought to the laboratory in closed plastic bags shortly after collection. Soil texture, sieve method (mechanical analysis) were used for the sandy soil, The proportions of clay, silt, and sand were determined using [31]**.** Saturation capacity and porosity were established in accordance with [32]. The amount of organic carbon was calculated using [33]. Using potassium chromate solution and N/35.5 silver nitrate as an indicator, the chloride level was ascertained [34]. Electrical conductivity and pH in a soil–water (1:5) suspension were measured using the method described by [35]. Titration with 0.1 N HCl was used to identify carbonates and bicarbonates, as described by [36].Atomic absorption spectroscopy was used to estimate calcium and magnesium, whereas flame photometry was used to quantify sodium and potassium.

(A Perkin-Elmer, Model 2380.USA).

Data Analysis

A floristic data matrix of 110 species and 11 stands was classified using two-way indicator species analysis (TWINSPAN, version 2.3) [37]. The association between soil gradients and vegetation was assessed using Canonical Correspondence Analysis (CCA) [38]. To ascertain the relationship between the measured soil variables, the linear correlation coefficient (r) was computed. SPSS 16 for Windows was used to statistical analysis for the collected data.

3. Results

Floristic Composition

Plant species recorded in the study area were 110 plant species identified in the current study, representing 82 genera and 25 families (Table 1). Species were divided into three main growth forms:52 annuals (52.13%), 2 biennials (2.13%) and 57 perennials (45.74%) (Figure 2). The most common families were Boraginaceae, 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.

As defined by [30] the classification and description of life-form spectrum of plant species recorded in the current research as follows: therophytes, hemicryptophytes, cryptophytes chamaephytes and phanerophytes (Figure 3). Therophytes accounted for 54.26% of the species that were recorded. then hemicryptophytes (21.28%), followed by cryptophytes (10.64%) and chamaephytes (9.57%). Phenerophytes were the life-forms with the lowest recorded value, at 4.26%.The floristic data's chorological study showed that 57 species were Mediterranean (60.64% Of these taxa, 23 species are either pluriregional.= 21.28%), Biregional (26 species = 23.40%) or Monoregional (22 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 (6 species = 5.32%) and palaeotropical (4 species = 4.26%). A little number of species represented chorotypes.

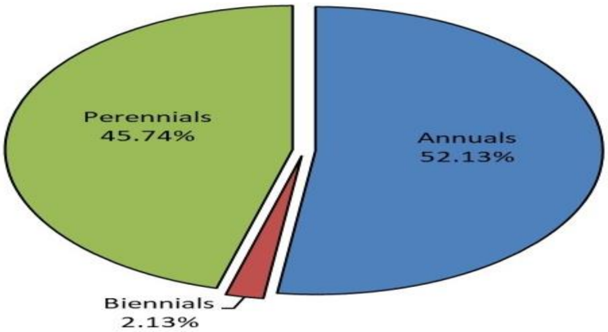

Figure 2. Plant life-span (%) for all recorded species.

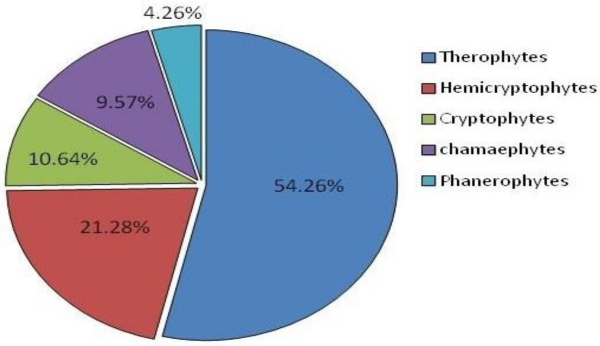

Figure 3. Species' life-form spectrum (%) .

Table 1. Floristic composition of the flora related to studied Boraginaceae taxa.

No	Plant Species	Life span	Life form	Chorotype
Aizoaceae				
1	*Mesembryanthemum crystallinum* L.	Ann.	Th.	ER-SR+ME
2	*M. nodiflorum* L.	Ann.	Th.	SA-SI+ER-SR+ME
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 carota* L.	Ann.	Th.	ME
10	*Deverra tortuosa* (Desf.)DC.	Per.	Ch.	SA-SI
11	*Eryngium creticum* Lam,.	Per	H	IR-TR+ME
12	*Foeniculum vulgare* Mill,.	Per.	H	IR-TR+ME
13	*Petroselinum crispum* Mill. Fuss	Bie.	Th.	CULT
14	*Pimpinella anisum* L.	Ann.	Th.	ME
15	*Daucus pumilus* Ball	Ann.	Th.	ME
16	*Torilis arvensis* (Huds.) Link	Ann.	Th.	IR-TR+ ME+ER-SR
Asclepiadaceae				
17	*Cynanchum acutum* L.	Per.	H	IR-TR+ME
Asteraceae				
18	*Achillea santolina* L.	Per.	Ch.	IR-TR +SA-SI
19	*Atractylis carduus* (Forssk.) C.Chr.	Per.	H	SA-SI+ME
20	*Bidens pilosa* L.,	Bie.	Th.	PAN
21	*Carthamu stenuis* (Boiss. & C.I.Blanche) Bornm.	Ann.	Th.	ME
22	*Nidorella aegyptiaca* (L.) J.C.Manning & Goldblatt.	Ann.	Th.	ME
23	*Erigeron bonariensis* L.	Ann.	Th.	ME
24	*Echinops spinosissimus* Turra.	Per.	H	SA-SI+ME
25	*Lactuca serriola* L.	Ann.	Th.	IR-TR+ER-SR+ME
26	*Launaea mucronata* (Forssk.) Muschl.	Per.	H	SA-SI+ME
27	*L. nudicaulis* (L.) Hook.f.	Per.	H	SA-SI
28	*Picris asplenioides* L,.	Ann.	Th.	IR-TR+ME

29	*Pluchea dioscoridis* (L.) DC.,	Per.	Ph.	SA-SI+S-Z
30	*Reichardia tingitana* (L.) Roth	Ann.	Th.	SA-SI+IR-TR+ME
31	*R.picroides* (L.), Roth	Per.	H	SA-SI+ME
32	*Senecio glaucus* L.,	Ann.	Th.	SA-SI+IR-TR+ME
33	*Sonchus oleraceus* L.	Ann.	Th.	COSM

34	*Silybum marianum*(L.) Gaertn.	Ann.	Th.	ME+IR-TR+ER-SR
Boraginaceae				
35	*Alkanna orientalis* (L.) Boiss.	Per.	H	IR+TR+ME
36	*Borago officinalis* L.	Ann.	Th.	SA-SJ+S-Z
37	*Cordia boissieri* A.DC.	Per.	Ch.	PAN+S-Z
38	. *C. dentata* Poir.	Per.	Ch.	ME
39	.*C.dichotoma* G.Forst.	Per.	Ch.	ME
40	*C. lutea* Lam.	Per.	Ch.	IR-TR+ME
41	*C. myxa* L.	Per.	Ch.	PAN
42	*C. sinensis* Lam.	Per.	Ch.	ME
43	*Echium angustifolium* Mill. subsp. *sericeum* (Vahl)Klotz.	Per.	H	ME
44	*E. humile* Desf.	Per.	H	ME
45	*Ehretia acuminata* R.Br.	Per.	H	ME
46	.*E. microphylla* Lam.	Per.	H	ME
47	*E.wallichiana Hook.f. & Thomson ex Gamble*	Per.	H	ME
48	*Heliotropium curassavicum* L.	Per.	Ch.	NEO
49	*H. supinum* L.	Ann.	Th.	SA-SJ+S-Z+ME
50	*Moltkiopsis ciliata* (Forssk.) I.M.Johnst.	Per.	Ch.	ME+SA-SI+ IR-TR
51	*Trichodesma africanum* (L.) Sm.	Ann.	Th.	S-Z+ SA-SI
Brassicaceae				
52	*Brassica tournefortii* Gouan,.	Ann.	Th.	IR-TR+SA-SI+ME
53	*Cakile maritima* Scop.	Ann.	Th.	ER-SR+ME
54	*Descurainia sophia*(L.) Webb ex Prantl	Ann.	Th.	IR-TR+ER-SR+ME
55	*Sisymbrium irio* L.	Ann.	Th.	IR-TR+ER-SR+ME
Caryophyllaceae				
56	*Silene succulenta* Forssk.	Per.	H	ME
Chenopodiaceae				
57	*Arthrocnemum macrostachyum* (Moric.) K.Koch	Per.	Ch.	SA-SI+ME
58	*Atriplex halimus* L.	Per.	Ph.	SA-SI+ME
59	*Bassia indica* (Wight), A.J.Scott,.	Ann.	Th.	S-Z+IR-TR
60	*Beta vulgaris* L.	Ann.	Th.	IR-TR+ER-SR+ME
61	*Chenopodium album* L.	Ann.	Th.	COSM
62	*C. murale* L.	Ann.	Th.	COSM
63	*Salsola kali* L.	Ann.	Th.	COSM
Convolvulaceae				
64	*Convolvulus arvensis* L.	Per.	H	COSM
65	*C. althaeoides* L.	Per.	H	SA-SI+IR-TR+ME
66	*C.lanatus* Vahl.	Per.	Ch.	SA-SI
67	*Ipomoea imperati* (Vahl) Griseb.	Per.	H	PAN
Cyperaceae				
68	*Cyperus capitatus* Vand.	Per.	Cr	ME
69	*C. rotundus* L.	Per.	Cr	PAN
Euphorbiaeae				
70	*Euphorbia terracina* L.	Per.	H	ME
Fabaceae				
71	*Alhagi graecorum* Boiss,.	Per.	H	PAL
72	*Lotus tenuis* Waldst. & Kit. ex Willd.	Per.	H	IR-TR+ER-SR+ME
73	*L. halophilus* Boiss. & Spruner.,	Ann.	Th.	SA-SI+ME
74	*Ononis vaginalis* Vahl	Per.	Ch.	SA-SI+ IR-TR+
Geraniaceae				
75	*Erodium laciniatum* (Cav.) Willd.	Ann.	Th.	ME
Malvaceae				
76	*Malva multiflora* (Cav.) Soldano, Banfi & Galasso	Ann.	Th.	IR-TR+ER-SR+ME
77	*Malva parviflora* L,	Ann.	Th.	IR-TR+ME

Neuradaceae				
78	*Neurada procumbens* L.	Ann.	Th.	IR-TR +SA-SI
Oxalidaceae				
79	*Oxalis corniculata* L,.	Per.	H	COSM
Plantaginaceae				
80	*Plantago squarrosa* Murray	Ann.	Th.	IR-TR+ER-SR+ME
81	*P. major* L.	Per.	H	COSM
Poaceae				
82	*Aegilops bicornis* (Forssk.) Jaub & Spach.	Ann.	Th.	ME+SA-SI
83	*Arundo donax* L.	Per.	Cr	NAT and CULT
84	*Avena fatua* L.	Ann.	Th.	PAL
85	*Bromus diandrus* Roth .	Ann.	Th.	ME
86	*Cynodon dactylon* (L.) ,Pers.	Per.	Cr	PAN
87	*Echinochloa colona* (L.) Link.	Ann.	Th.	PAN
88	Thinopyrum junceum (L.) Á.Löve	Per.	Cr	ME
89	*Hordeum murinum* L.	Ann.	Th.	IR-TR+ER-SR+ME
90	*Imperata cylindrica* (L.) Raeusch.	Per.	H	PAL
91	*Lolium perenne* L.	Ann.	Th.	IR-TR+ER-SR+ME
92	*Panicum coloratum* L.	Per.	Cr	SA-SI
93	*Phalaris minor* Retz.	Ann.	Th.	IR-TR+ME
94	*Phragmites australis* (Cav.) Steud.	Per.	Cr	IR-TR+SA-SI+ME
95	Cenchrus americanus (L.) Morrone	Ann.	Th.	COSM
96	*Sorghum virgatum* (Hack.) Stapf	Ann.	Th.	PAL
97	*Sporobolus spicatus* (Vahl) Kunth	Per.	Cr	S-Z+SA-SI+ME
98	*Stipagrostis lanata* (Forssk.) De Winter,.	Per.	Cr	SA-SI
Polygonaceae				
99	*Calligonum comosum* L'Hér.	Per.	Ph	SA-SI+IR-TR
100	*Emex spinosa* (L.) Campd.	Ann.	Th	SA-SI+ME
101	*Polygonum equisetiforme* Sm,.	Per.	Cr	IR-TR+ME
102	*Rumex dentatus* L.	Ann.	Th.	ME+IR-TR+ER-SR
103	*R. pictus* Forssk.	Ann.	Th.	ME+SA-SI
Portulacaceae				
104	*Portulaca oleracea* L.	Ann.	Th.	COSM

Rutaceae				
105	*Haplophyllum tuberculatum* (Forssk.) A.Juss.	Per.	H	IR-TR+ME
Scrophulariaceae				
106	*Kickxia aegyptiaca* (L.) Nábělek	Per.	Ch.	SA-SI+ME
Solanaceae				
107	*Solanum incanum* L.	Per.	Ch.	S-Z
108	*Withania somnifera* (L.), Dunal	Per.	Ch.	IR-TR+ME
Thymelaceae				
109	*Thymelaea hirsuta* (L.), Endl,.	Per.	Ph.	ME
Zygophyllaceae				
110	*Zygophyllum creticum* (L.) Christenh. & Byng	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.

Annual; Ann,, Perrenial; Per, Biennial; Bie.

Classification of Vegetation

Three vegetation groups were identified by TWINSPAN categorization. This is based on 110 plant species found in 11 stands and their importance values (out of 200). (A-C) , Table 2, Figure 4, at the second classification level. The dominant species in each vegetation group that had the highest importance value were used to name the groups as follows:

Group A includes one stand in which two species are recorded.

Carum cervi was dominanting (IV= 157.46). *Apium graveolens* was the most important associates in the community (IV= 42.54). Group B, which consists of 80 species spread across 6 stands *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 36 species. The codominant species were *Borago officinalis* (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).

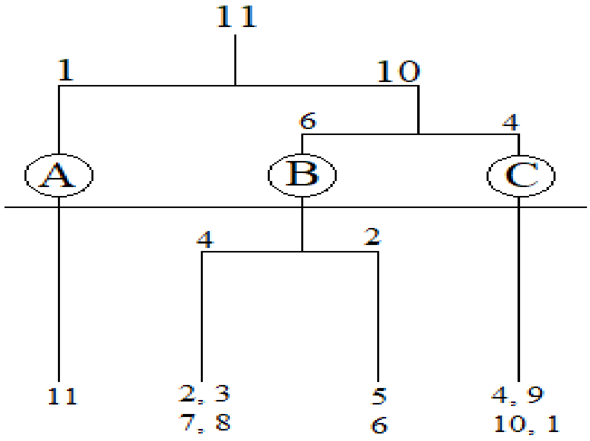

Figure 4. TWINSPAN dendrogram analysis of the selected stands showing three vegetation groups (A, B, and C) at the second level of classification.

Table 2. Mean value and coefficient of variation (value between brackets) of the important values (out of 200) of the recorded species in the various vegetation groups as a result of The TWINSPAN classification of the sampling stands in the study area.

Serial	Species	Vegetation groups		
		A	B	C
1	Achillea santolina L.	--	2.67 (1.57)	--
2	Aegilops bicornis(Forssk.) Jaub & Spach.	--	1.85 (2.45)	--
3	*Alhagi graecorum* Boiss.	--	1.17 (2.45)	--
4	*Alkanna orientalis* (L.) Boiss.	-	2.22 (2.64)	
5	*Ammi majus* L.	--	3.07 (2.45)	18.84 (2.00)
6	*Anethum graveolens* L.	--	6.93 (2.45)	--
7	*Apium leptophyllum* (Pers.)F.Muell.ex Benth	--	--	10.33 (2.00)
8	*A. graveolens*L.	42.54	--	--
9	*Arundo donax* L.	--	--	3.29 (2.00)
10	*Atractylis carduus* (Forssk.) C.Chr.	--	1.65 (2.45)	--
11	*Arthrocnemum macrostachyum* (Moric.) K.Koch	--	1.14 (2.45)	--
12	*Atriplex halimus* L.	--	1.95 (2.45)	--
13	*Avena fatua* L.	--	2.92 (1.55)	3.87 (2.00)
14	*Bassia indica* (Wight), A.J.Scott,.	--	0.79 (2.45)	--
15	*Beta vulgaris* L.	--	--	1.44 (2.00)
16	*Borago officinalis* L.	--	--	1.55(2.24)
17	*Bidens Pilosa* L.	--	--	1.37 (2.00)
18	*Brassica tournefortii* Gouan.	--	1.20 (2.45)	--
19	*Bromus diandrus* Roth.	--	3.36 (2.45)	3.22 (2.00)
20	*Cakile maritima* Scop.	--	5.74 (1.77)	--
21	*Calligonum comosum* L'Hér.	--	2.58 (2.45)	--
22	*Carthamustenuis*(Boiss.&C.I.Blanche) Bornm.	--	5.13 (1.66)	--
23	*Carum carvi* L.	157.4603		--
24	*Chenopodium album* L.	--	--	1.93 (2.00)
25	*C. murale* L.	--	3.29 (1.58)	2.23 (2.00)
26	*Convolvulus althaeoides L.*	--	1.36 (2.45)	--
27	*C. arvensis* L.	--	3.64 (1.56)	4.89 (1.17)
28	*C. lanatus* L.	--	2.50 (2.45)	--
29	*Nidorella aegyptiaca (L.) J.C.Manning & Goldblatt.*	--	--	1.95 (2.00)
30	*C. bonariensis* L.	--	1.10 (2.45)	3.99 (2.00)
31	*Coriandrum sativum* L.	--	--	18.48 (2.00)
32	*Cordia boissieri* A.DC.		2.88(2.53)	--
33	*C. dentata* Poir.	--	1.60(3.80)	--
34	*C. dichotoma* G.Forst.	--	0.81(2.49)	--

35	*C. lutea* Lam.	--	0.73(2.54)	--
36	*C. myxa* L.	--	0.39(3.16)	--
37	*C. sinensis* Lam.	--	3.79(2.13)	--
38	*Cynanchum acutum* L.	--	5.79 (1.41)	--
39	*Cynodon dactylon* (L.), Pers.	--	1.21 (2.45)	14.82 (0.17)
40	*Cyperus capitatus* Vand.	--	1.00 (2.45)	--
41	*C. rotundus* L.	--	--	3.13 (2.00)
42	*Daucus carota* L.	--	3.69 (2.45)	--
43	*Descurainia Sophia* (L.) Webb ex Prantl	--	1.00 (2.45)	--
44	*Deverra tortuosa* (Desf.)DC.	--	4.31 (2.45)	--
45	*Echinochloa colona* (L.) Link.	--	--	1.38 (2.00)
46	*Echinops spinosissimus Turra*.	--	7.17 (1.55)	--
47	*Echium angustifolium* Mill. subsp. sericeum (Vahl)Klotz.	--	7.10 (1.56)	--
48	*E. humile* Desf.	--	1.61(3.23)	--
49	*Ehretia acuminata* R.Br	--	0.26(4.49)	--
50	*E. microphylla* Lam.		0.25(4.54)	--
51	*E. wallichiana Hook.f. & Thomson ex Gamble*		1.77(1.28)	--
52	*Thinopyrum junceum* (L.) Á.Löve	--	0.71 (2.45)	--
53	*Emex spinosa (L.) Campd.*	--	2.65 (1.85)	--
54	*Erodium laciniatum* (Cav.) Willd.	--	1.30 (2.45)	--
55	*Eryngium creticum* Lam.	--	2.93 (1.56)	--
56	*Euphorbia terracina* L.	--	1.17 (1.71)	--
57	*Zygophyllum creticum* (L.) Christenh. & Byng	--	3.13 (1.91)	--
58	*Foeniculum vulgare* Mill.	--	--	21.46 (2.00)
59	*Heliotropium curassavicum* L.		0.78(2.44)	--
60	*H. supinum* L.	--	0.88(3.01)	--
61	*Haplophyllum tuberculatum*(Forssk.) A.Juss.	--	2.02 (2.45)	--
62	*Hordeum murinum* L.	--	2.06 (2.45)	
63	*Imperata cylindrica* (L.) Raeusch.	--	0.87 (2.45)	
64	*Ipomoea imperati* (Vahl) Griseb.	--	0.64 (2.45)	--
65	*Kickxia aegyptiaca* (L.) Nábělek	--	2.18 (2.45)	--
66	*Lactuca serriola* L.	--	0.49 (2.45)	--
67	*Launaea mucronate* (Forssk.) Muschl.	--	3.72 (1.63)	--
68	*L. nudicaulis* (L.) Hook.f.	--	1.01 (2.45)	--
69	*Malva multiflora* (Cav.) Soldano, Banfi & Galasso	--	--	1.73 (2.00)
70	*Lolium perenne* L.	--	1.28 (2.45)	--
71	*Lotus tenuis* Waldst. & Kit. ex Willd.	--	1.25 (2.45)	--
72	*L. halophilus* Boiss. & Spruner	--	1.28 (2.45)	--
73	*Malva parviflora* L.	--	--	4.22 (2.00)
74	*Mesembryanthemum crystallinum* L.	--	7.02 (1.32)	--
75	*Mesembryanthemum nodiflorum* L.	--	1.52 (2.45)	--
76	*Moltkiopsis ciliata* (Forssk.) I.M.Johnst.	--	0.81(2.44)	--
77	*Neurada procumbens* L.	--	3.50 (2.45)	--
78	*Ononis vaginalis* Vahl.	--	0.80 (2.45)	--
79	*Oxalis corniculate* L.	--	--	3.68 (2.00)
80	*Panicum coloratum* L.	--	--	2.52 (2.00)
81	*Petroselinum crispum* Mill. Fuss	--	--	21.28 (2.00)
82	*Phalaris minor* Retz.	--	0.36 (2.45)	--
83	*Phragmites australis* (Cav.) Steud.	--	--	3.62 (2.00)
84	*Picris asplenioides* L.	--	1.82 (1.84)	--
85	*Pimpinella anisum* L.	--	0.96 (2.45)	--
86	*Plantago major* L.	--	--	1.62 (2.00)
87	*P. squarrosa* Murray	--	2.24 (1.62)	--
88	*Pluchea dioscoridis*(L.) DC.	--	--	5.14 (1.42)
89	*Polygonum equisetiforme* Sm.	--	5.61 (1.18)	1.56 (2.00)
90	*Portulaca oleracea* L.	--	--	11.82 (1.16)
91	*Daucus pumilus* Ball	--	0.65 (2.45)	--
92	*Reichardia tingitana* (L.) Roth	--	3.21 (1.79)	--
93	*R. tingitana* (L.) Roth	--	0.85 (2.45)	--
94	*Rumex dentatus* L.	--	--	1.22 (2.00)

95	*R. pictus* Forssk.	--	1.29 (2.45)	--
96	*Salsola kali* L.	--	7.37 (2.01)	--
97	*Senecio glaucus* L.	--	5.13 (0.85)	--
98	*Cenchrus americanus* (L.) Morrone	--	--	1.63 (2.00)
99	*Silene succulenta* Forssk.	--	0.90 (2.45)	--
100	*Silybum marianum* (L.) Gaertn.	--	6.62 (2.45)	--
101	*Sisymbrium irio* L.	--	--	0.99 (2.00)
102	*Solanum incanum* L.	--	3.27 (2.45)	--
103	*Sorghum virgatum* (Hack.) Stapf	--	--	4.54 (2.00)
104	*Sonchus oleraceus* L.	--	3.17 (1.78)	0.89 (2.00)
105	*Sporobolus spicatus* (Vahl) Kunth	--	1.27 (2.45)	--
106	*Stipagrostis lanata* (Forssk.) De Winter,.	--	2.64 (2.45)	--
107	*Torilis arvensis* (Huds.) Link	--	--	10.44 (2.00)
108	*Thymelaea hirsute* (L.), Endl.	--	3.46 (2.45)	--
109	*Trichodesma africanum* (L.) Sm.	--	--	1.27(2.45)
110	*Withania somnifera* (L.).Dunal	--	0.61 (2.45)	2.75 (2.00)

Table 3.

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, EC = Electrical conductivity , OC = Organic carbon;

Table 4. Correlation matrix for soil variables in the assessed stands of 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	-0.513	0.6	0.432	1											
Saturation capacity	0.039	-0.006	-0.064	-0.037	1										
pH	-0.389	0.311	0.435	0.394	-0.298	1									
OC	-0.547	.629*	0.471	0.321	-0.139	-0.155	1								
EC	-0.439	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	-0.026	0.13	-0.462	0.418	.764**	0.472	0.274	.645*	1			
Cl^-	-0.351	0.365	0.33	-0.081	-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	-0.495	.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; , $*P \geq 0.05$; $**P \geq 0.01$

Variation in Soil Variables of the Vegetation Groups

The variation in soil variables (mean value ± standard value) of three vegetation groups 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) sand, or coarse fraction, made up 91.32% of its composition, with some 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%). PH fluctuated between neutral and slightly alkaline. The pH values ranged from 7.62 to 8. The greatest values in groups were found in the soil organic carbon (C & A) (3.72% and 3.6% correspondingly) .Whereas least value was achieved in group (B) (1.81 %). Group (C) had the greatest estimated mean electrical conductivity va (1.36 ds/m), whereas group (B) had the lowest value (0.43 ds/m). Group C had the highest mean concentrations of the monovalent cations potassium and sodium (4.69 meq/l and 0.76 meq/l, respectively), whereas group B had the lowest mean values (1.64 meq/l and 0.27 meq/l, correspondingly)

The maximum average divalent cation concentrations; calcium and magnesium (6.76 meq/l and 2.98 meq/l, correspondingly correspondingly) were also estimated in group C, while the lowest mean concentrations (1.03 meq/l and 0.477 meq/l, correspondingly correspondingly) 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 completely missed in all groups, but the mean values of bicarbonates varied from 1.70 meq/l in group B to 2.56 meq/l in group C.

Table 4 displays the correlation coefficient (r) between the soil variables in the stands that were sampled. Certain soil variables, including silt, organic carbon, electrical conductivity, and cations (Na+, K+, Ca++, and Mg++), have been shown to have a substantial positive correlation with one another. However, other variables including sand, clay, and porosity either had no link at all or a strong negative correlation with soil variables. Saturation capacity, pH and anions (Cl^-, sulphates, and bicarbonate).

Correlation Between Soil Variables and Vegetation

The link between vegetation and soil characteristics is depicted in the ordination diagram produced using Canonical Correspondence Analysis (CCA) of the observed species and environmental (soil) variables (Figure 5).The main and most significant species of vegetation group C, which is located in the upper-left quarter of the CCA diagram is *Anethum graveolens*, *Salsola kali*, *Mesembryanthemum crystallinum*, *Silybum marianum*, *Echinops spinosus*. As seen in Figure (5), Echium angustifolium were clearly regulated by saturation capacity. 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). Conversely, *Apium graveolens* and *Carum carvi*, a range of soil characteristics, such as sulphates, calcium, bicarbonates, electrical conductivity, organic carbon, and porosity, affected the codominant and most important species in group A, which were divided in the upper-right quarter of the CAA diagram.

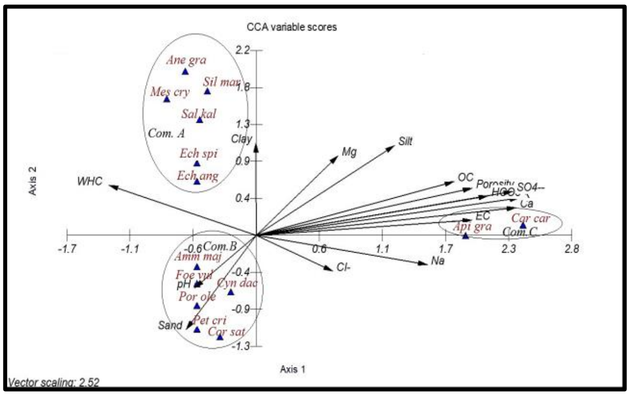

Figure 5. A Canonical Correspondence Analysis (CCA) ordination biplot showing the research areas' top distinctive species and soil variables.

Discussion

There were 110 plant species from 25 families and 82 genera in the Boraginaceae and related species that were found in the 11 examined stands in the research region.Over half of these species are members of six families, which are grouped as follows:

Asteraceae > Boraginaceae > Poaceae > Apiaceae > Chenopodiaceae > Polygonaceae. These results agreed with [17, 19, 39-44].

Information from the structure of life forms can be used to evaluate how vegetation reacts to changes in certain environmental conditions [45]. Ecologists and chorologists frequently use the life form spectrum, which are significant physiognomic characteristics, in vegetation and floristic investigations [46, 30, 47]. According to the previous study by [48], therophytes accounted for 50.3% of all Egyptian flora, whereas the Mediterranean region and the Egyptian Nile region had respective percentages of 58.7% and 59.4%. [17] said that the vegetation of the Mediterranean delta shoreline contains roughly 55.6% of therophytes. About 59.5% of the sand dune vegetation along the Nile Delta coast was made up of therophytes [19].Plant species in the present research were divided into five categories based on the description and classification of life forms:54 therophytes, 26 hemicryptophytes, 17 chamaephytes, 10 cryptophytes, and 4 phanerophytes. These results were agreed with the study by [17] in the vegetation along the Mediterranean coastline of the Delta. The 4 phytogeographical regions that merge in Egypt are the Afro-Asiatic Saharo-Sindian, the Asiatic Irano-Turanian, the African Sudano-Zambezian, and the Euro-Afro-Asiatic Mediterranean [49].

The research region belongs to the Mediterranean Territory and marginally extends into the Saharo-Sindian Territory. This explained through high percentage of Mediterranean and Saharo-Sindian chorotypes. This was confirmed by [6, 9, 12, 17-20, 39, 50, 51]. In the research area, there were a variety of floristic groupings with varying numbers of species, including Mediterranean, Saharo-Sindian, Sudano-Zambezian, Irano-Turanian, Euro-Siberian, Cosmopolitans, Pantropical, and Palaeotropical elements. This observation supports the ability of some floristic elements to enter the research region from nearby phytogeographical zones [52, 53, 44].

At the second level of classification, three vegetation groups or community types were identified applying the TWINSPAN classification, which was based on the importance value of 110 plant species found in 11 stands. The dominatinant species in each vegetation group that had the highest importance value were used to name the groups as follows: Carum carvi is in group A; Salsola kali is in group B; and Foeniculum vulgare is in group. These results were more or less similar to those reported by [17, 19, 39, 40, 44]**.**

Results of Canoncal Correspondence Analysis (CCA-biplot) in the present study indicated that, saturation capacity, pH, sand, sulphates, electrical conductivity the most significant soil variables influencing the distribution and abundance of the species under study were calcium cations and clay fractions. Saturation capacity clearly controlled group C Sand fractions, as shown in the lower-left quarter of the CAA diagram; sulphates and calcium cations, as shown in the upper-right quarter of the CCA diagram; and sand fractions, as shown in the upper-left quarter of the CCA figure.

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