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Ecological Study on Solanum incanum L. and Associated Flora in Lake Mareotis Coast, Egypt

Hend A. El-Emam[a], Ibrahim A. Mashaly[b], Sayed A. El-Hussieny[c], Ghada A. El-Sherbeny[d].

Researcher at Mansoura University[a], Professor of Plant Ecology[b], Botany Department, Researcher at Egyptian Environmental Affairs, Western Region[c] , Assistant professor of Plant Ecology[d], Botany Department.

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Abstract: This study was mainly planned to study the floristic and ecological features of *Solanum incanum* L. in Mareotis coast, Egypt to be able to identify abundance and distribution pattern of *Solanum incanum* and the co-existing species as well as, its soil controlling using two methods (TWINSPAN method and CCA bi-plot method) showed dominancy of *Solanum incanum* in the recognized 7 vegetation groups recording the highest IV in 6 of 7 the groups. Total 70 plant species recorded belonging to and 25 families of 6 different life forms where therophytes was the predominant life form (65.71% of recorded species) while only two species are cultivated and naturalized. CCA-ordination showed that clay, sand, silt, pH, saturation capacity, organic carbon and calcium carbonates are the most effective soil variables on the 7 vegetation groups.

keywords: Solanum incanum L, TWINSPAN classification, CCA

1.Introduction

Solanum genus is one of the largest and most complex between the angiosperms; the great numbers of Solanum L. species represent about 1% of the angiosperm flora of the world **(1).** The Egyptian flora has the Solanum genus represented by 9 wild species **(2 ; 3),** it also has a great economic potentialities as there are many cultivated species for their edible parts and their fruits **(4),** several medicinal plants cultivated or wild ones **(5 ; 6).** Solanum incanum which has no practical use despite containing a great variety of substances and components that can be used in many different fields if only invested into a useful form **(7),** leaves of S. incanum are rich with potassium **(8)**, and calcium **(9)**, about 6 compounds had been extracted from the ariel parts of Solanum incanum: flavonoids, chlorogenics, adenosine and phenolics, etc. **(10),** these compounds each or combined may have allelopathic effect. Allelopathy is defined as any direct or indirect stimulatory or non-stimulatory effect which is mediated through chemical compounds that are produced through a specific microorganism or plant **(11),** being the main factors in organizing the structure of the plant communities **(12)** secondary metabolites or allelochemicals not included in primary metabolism but they are observed to act as chemical inhibitors against many competing pests and plants as some of these active compounds have the ability to be used as herbicides **(13)**. Antimicrobial activity of S. incanum which showed that it's a promising antibiotic against multidrug resistant bacteria **(14),** phytochemical investigation on roots of S. incanum was done and resulted in the isolation of one compound and is reported to be a new discovery **(15),** Solanum incanum extract (SR-T100) was studied as it was used in inducing melanoma cell apoptosis and inhibits lung metastasis and its considered as a potential treatment for established tumors from regional and metastatic melanoma **(16)**. The nutritional value of S. incanum had been studied in north east region of India that proved that its fruit is a great source of vitamins, folic acid and carbohydrates, so this plant is a candidate for human nutrition in the future regardless of its bitterness **(17)**.

Study area

The study area is located along Mareotis coast at the western sector which extends about 550 Km **(18).** In the western Mediterranean coast the geological studies suggest that formations at Burg El-Arab are essentially Quaternary and Tertiary **(19; 20)**. Soil described by **(21)** as young, essentially alluvial and characterized by the absence of diagnostic horizons, The main water source in the study area is Mediterranean sea water, winter rainfall and the underground water **(22).** The climate of the study area is a Mediterranean type, area monthly average of 10 years (Jan. 2010 – Dec. 2019) recorded temperature (^oC), precipitation (mm/y), relative humidity (%) and direct solar radiation (Mj/m^2), **(23)**. **(Figure 3).**

2. Materials and methods

Forty stands (5 x 5 m^2) were chosen along the study coastal area to represent the ecological features and vegetation cover in the area. The sampling process was carried out during May 2018. In each stand relative density was estimated quantitatively using **(24) and (25)**. While relative cover was estimated by applying the line intercept method **(26)**. Importance value was estimated out of 200. Plant species (identification, nomenclature and classification) were recorded according to **(27,28,29,30,2)** and **(31)**, life form spectrum was according to **(32)** and chorological affinities were according to **(33)** and **(34)**. In data analysis two trends of multivariate analysis were used: classification and ordination. In the classification technique, Two Way Indicator Species Analysis (TWINSPAN) was applied. The values of importance of 70 species were applied in the TWINSPAN – classification of the 40 sampled stands. The ordination technique applied was Canonical Correspondence Analysis (CCA). Correlation of the vegetation distribution to the estimated soil variables were carried out by the ordination diagram produced by CCA-biplot. Sodium and potassium according to **(35)**, Magnesium, calcium and zinc were determined using **(36)** method and phosphorous was determined according to **(37).**

3. Results and Discussion

Life-form spectrum and phytogeographical affinity: The 70 species belonged to six life forms, therophytes were the predominant life form (65.71%) followed by hemicryptophytes (14.28%), chamaephytes (8.57%) then nanophanerophytes (7.14%), geophytes (2.85%). and helophytes (1.42%). The floristic analysis of the study area has showed that 14 species (20%) of the recorded species are Cosmopolitan, 4 species (5.7%) are Palaeotropical, 3 species (4.3%) are Neotropical, 14 species (20%) Monotropical, 21 species (30%) are Biregional, 12 species (17.1%) are Pluriregional and 2 species (2.9%) are Cultivated and Naturalized (Table 1).

TWINSPAN classification:

The denogram resulted from the TWINSPAN classification based on the importance values (out of 200) of 70 plant species recorded in 40 sampled stands, led to the recognition of seven vegetation groups or community types, labeled A ,B ,C ,D ,E ,F and G at the 3rd level of classification (Figure 1 and Table 3).

Vegetation group A includes 24 species distributed in 4 stands. The two codominant species were Solanum incanum (IV= 28.47) and Carthamus tenuis (IV= 16.66).

Group B includes four stands with16 species. Atriplex halimus (IV=47.58) and Solanum incanum (IV= 27.04) were the codominant species with highest values.

Group C comprises 18 species distributed in 3 stands. Solanum incanum (IV= 30.93) and Echium angustifolium (IV= 25.93) were the two codominant species.

Group D includes 30 species distributed in 14 stands. Solanum incanum (IV= 43.81) and Carthamus tenuis (IV= 27.93) were the codominant species.

Group E comprises 29 species distributed in eight stands. Solanum incanum (IV= 44.89) and Silybum marianum (IV= 26.52) are the codominant species.

Group F includes 26 species in four stands. Solanum incanum (IV= 34.82) and Carthamus tenuis (IV= 18.27) were the two codominant species.

Group G includes 21 species distributed in three stands. Solanum incanum (IV= 43.3) and Imperata cylindrica (IV= 23.72) were the codominant species of this group **Table (3).**

Soil factors variations: The soil variables of the seven groups identified by TWINSPAN classification are presented in Table (2). The soil texture of all groups is mostly formed of coarse sand and partly of fine and medium sand. Moisture content percentages of groups A, E, and F are slightly higher than other groups (23.93%, 23.17% and 23.66%, respectively). Saturation capacity is relatively comparable in all groups. $CaCO_3$ highest value was noticed in group C (41.33%) and the lowest in group E (34.94%), while organic carbon showed its greatest value in group D (0.85%) and lowest mean value in group C (0.48%). The values of the pH indicated that the soil reaction varies from neutral and slightly alkaline in different groups. The Electrical conductivity (EC) attained its highest value in groups A and D (3017 and 2759.14 mmhos/cm) and the lowest values (1237, 332.33, 460.88, 829.50 and 381 mmhos/cm, respectively) in groups B, C, E, F and G. Regarding chlorides, sulphates and bicarbonates contents almost all the groups had parallel results. The highest total dissolved nitrogen (3.22 mg/100gm dry soil) was obtained in group A and the lowest value in group F (1.99 mg/100gm dry soil). Total dissolved phosphate contents results were comparable in all groups. Total dissolved salts were the greatest values in groups A and D (1625 and 1512 Mg/L) and lower in groups B, C, E, F and G (658.25, 620.67, 244.38,440 and 202 Mg/L, respectively).

Canonical Correspondence Analysis (CCA-ordination): Clay, sand, silt, pH, saturation capacity, organic carbon and calcium carbonates represented the most effective soil variables which indicated significant correlations with axes**. (Figure 2).**

Discussion

This study revealed that the total number of the plant species recorded in the study area was 70 species for 25 plant families belonging to 62 genera. Asteraceae family was the richest family followed by Poaceae, Chenopodiaceae and Apiaceae.

This study contained six life forms of the communities present in Mareotis coast where therophytes as the predominant life form followed by hemicryptophytes, Chamaephytes, Nanophanerophytes, geophytes and helophytes recorded the lowest value.

Therophytes superiority over the other life forms is an indicator to the hot-dry climate and the change in the land surface and biotic factors in the study area, pointing that the study area flora is filled with high percentage of species and plants that has a short life cycle (therophytes), also its correspondent to the Mediterranean climate due to short life cycle, high capacity of production and ecological plasticity High contribution of annuals of the recorded species was noticed which may point to the time of the study where rainfall may have given annuals a good chance to appear and grow. Hemicryptophytes and cryptophytes have a great role in accumulation of sand and succession of vegetation in the study area. These life forms have the ability to act as wind and / or water barriers, which give these plants the advantage of generating adventitious roots and shoots originated from their buried organs and the ability to replace the dead parts **(22).**

This study area is noticed to be a mixture of different chorotypes such as Cosmopolitan, Palaeotropical, Neotropical, Cultivated and Naturalized, Irano-Turanian, Sudano-Zambezian, Euro-Siberian and Mediterranean elements with variable number of species. This result proves the ability of some floristic elements to penetrate the study area from neighboring phytogeographic regions **(18)**. The floristic analysis of this study revealed that, 21 species of the total number of the recorded species were worldwide elements, 15 species were Monoregional elements, 20 species were Biregional elements, 12 of the recorded species were Pluriregional elements and 2 species were Cultivated and Naturalized.

In this current study, two kind of multivariate analysis were used, classification and ordination. Classification by (TWINSPAN) Two-Way Indicator Species Analysis that revealed 7 vegtational groups. Each group consists of number of stands that are similar in vegetation features and characterized by dominant and a codominant species plus a number of indicator species. Vegetation analysis revealed that, the most dominant communities in the study area was Solanum incanum and Carthamus tenuis that were dominant in groups A, D and F.

The vegetation group A represents mostly the vegetation type of road side habitat, this group was codominant by Solanum incanum and Carthamus tenuis as a co dominant and it had a relative high percentage of saturation capacity, moisture content and high value of sand, vegetation group B also represents mostly road side habitat, which was codominated by Atriplex halimus and Solanum incanum and showed relatively high percentages of sand, saturation capacity and moisture content. While vegetation group C represents mostly orchards habitat that were codominated by Echium angustifolium and Solanum incanum had a relatively high pH, $CaCO_3$ percentage and high sand value. Vegetation group D mostly was road side habitat and it was codominated by Solanum incanum and Carthamus tenuis, which had a relatively high sand values, saturation capacity and pH. Vegetation group E may represent mostly road side habitat, which was codominated by Solanum incanum and Silybum marianum and had high values of electrical conductivity, total dissolved salts and pH. Vegetation group F may represent mostly barely fields and it was codominated by Solanum incanum and Carthamus tenuis, with high values of saturation capacity, moisture content and pH, and vegetation group G represents mostly orchards, which was codominated by Solanum incanum and Imperata cylindrica which showed relatively high values of sand, saturation capacity and $CaCO_3$ percentage.

CCA-biplot (Canonical Correspondence Analysis) application indicated that the most effective soil factors that affect the study area vegetation were clay, sand, silt, pH, saturation capacity, organic carbon and calcium carbonates which indicated significant correlations with axes.

These results are in agreement with other different studies on Mediterranean coast such as (38); (39), (2); (40) and (41,42).

Table (1). Floristic composition, families, life-span, life-form and chorotypes of the plant species associated with Solanum incanum in the study area.

Ann. = Annual, Bie. = Biennial, Per. = Perennial, Th= Therophytes, G= Geophytes, He= Helophyte, H= Hemicryptophytes, Ch.= Chamaephytes, NPh= Nanophanerophytes, COSM= Cosmopolitan, PAL= Palaeotropical, Neo= Neotropical, ME= Mediterranean, SA-SI= Saharo-Sindian, IR-TR= Irano-

Turanian, S-Z= Sudano-Zambezian, ER-SR= Euro-Siberian, Cult. & Nat. = Cultivated and Naturalized**.**

Table (2): Mean value of the soil variables in different TWINSPAN vegetation groups

No.	Species	Life span	Life from	*Chorotypes*
A	**Amaranthaceae:-**			
1	*Amaranthus hybridus* L.	Ann.	Th	*PAL*
2	*Amaranthus lividus* L.	Ann.	Th	*ME+IR-TR*
B	**Apiaceae:-**			
1	*Apium leptophyllum* (Pers.)F.Muell .ex Benth	Ann.	Th	*COSM*
2	*Deverra tortuosa* (Desf.) DC	Per.	Ch	*SA-SI*
3	*Eryngium creticum* Lam.	Per.	H	*ME+IR-TR*
C	**Asteraceae:-**			
1	*Achillea santolina* L.	Per.	Ch	*SA-SI+IR-TR*
2	*Carthamus tenuis (*Boiss. & Blanche) Bornm.	Ann.	Th	*ME*
3	*Centurea alexandrina* Delile	Bie.	Th	*SA-SI*
4	*Centurea glomerata* Vahl	Ann.	Th	*ME*
5	*Chrysanthemum coronarium* L.	Ann.	Th	*ME*
6	*Cichorium endivia* L.	Ann.	Th	*ME+IR-TR*
7	*Conyza aegyptiaca* (L.) Dryan	Ann.	Th	*ME*
8	*Conyza bonariensis* (L.) Crong.	Ann.	Th	*NEO*
9	*Echinops spinosus* L.	Per.	H	*ME+SA-SI*
10	*Lactuca serriola* L.	Ann.	Th	*ME+IR-TR+ER-SR*
11	*Launaea nudicaulis* (L) Hook.f.	Per.	H	*SA-SI+S-Z+IR-TR*
12	Boiss. *Onopordum alexandrinum*	Bie.	Th	*IR-TR+SA-SI*
13	*Pluchea dioscoridis* (L.) DC	Per.	NPh	*S-Z + SA-SI*
14	*Reichardia tingitana* (L.) Roth	Ann.	Th	*ME+SA-SI+IR-TR*
15	*Senecio glaucus* L.	Ann.	Th	*ME+SA-SI+IR-TR*
16	*Silybum marianum (*L.) Gaertn	Ann.	Th	*ME+IR-TR+ER-SR*
17	*Sonchus oleraceus* L.	Ann.	Th	*COSM*

18	*Urospermum picroides* (L.) F.w. Schmidt	Ann.	Th	*ME+IR-TR*
19	*Xanthium spinosum* L.	Ann.	Th	*NEO*
20	*Xanthium strumarium* L.	Ann.	Th	*COSM*
D	**Boraginaceae:-**			
1	*Anchusa hispida* Forssk.	Ann.	Th	*ME+SA-SI+IR-TR*
2	*Echium angustifolium* Mill.	Per.	H	*ME*
E	**Brassicaceae:-**			
1	*Brassica nigra* (L.) Koch	Ann.	Th	*COSM*
2	*Erucaria hispanica* (L.) Druce	Ann.	Th	*ME*
3	*Sisymbrium irio* L.	Ann.	Th	*ME+IR-TR+ER-SR*
F	**Caryophyllaceae:-**			
1	*Paronychia arabica* (L.) DC.	Ann.	Th	*SA-SI+ME+S-Z*
G	**Chenopodiaceae:-**			
1	*Atriplex halimus* L.	Per.	NPh	*ME+SA-SI*
2	*Atriplex leucoclade* Boiss.	Per.	H	*SA-SI+IR-TR*
Table (1): continued.				
3	*Atriplex semibaccata* R.Br.	Per.	H	*AUST*
4	*Bassia indica* (Wight) A.J. Scott.	Ann.	Th	*S-Z+IR-TR*
5	*Chenopodium album* L.	Ann.	Th	*COSM*
6	*Chenopodium murale* L.	Ann.	Th	*COSM*
7	*Salsola kali* L.	Ann.	Th	*COSM*
H	**Convolvulaceae:-**			
1	*Convolvulus althaeoides* L.	Per.	H	*ME+SA-SI+IR-TR*
2	*Convolvulus arvensis* L.	Per.	H	*COSM*
I	**Fabaceae:-**			
1	*Melilotus indicus* (L.) All.	Ann.	Th	*ME+IR-TR+SA-SI*
J	**Geraniaceae:-**			
1	*Erodium laciniatum* (Cav.) Willd.	Ann.	Th	*ME*
K	**Lamiaceae:-**			
1	*Marrubium alysson* L.	Ann.	Th	*SA-SI+ME*
L	**Malvaceae:-**			
1	*Malva parviflora* L.	Ann.	Th	*ME+IR-TR*
2	*Hibiscus trionum* L.	Ann.	Th	*PAL*
M	**Papaveraceae:-**			
1	*Papaver rhoeas* L.	Ann.	Th	*ME*
N	**Peganaceae:-**			
1	*Peganum harmala* L.	Per.	Ch	*IR-TR+SA-SI+ME+ER-SR*
O	**Plantaginaceae:-**			
1	*Plantago lagopus* L..	Ann.	Th	*ME*
P	**Poaceae :-**			
1	*Aegilops kotschyi* Boiss.	Ann.	Th	*IR-TR+SA-SI*
2	*Arundo donax* L.	Per.	He, G	*Cult. & Nat.*
3	*Avena fatua* L.	Ann.	Th	*PAL*
4	*Cynodon dactylon* (L.) Pers.	Per.	G	*COSM*
5	*Hordeum marinum* L.	Ann.	Th	*ME+IR-TR+ER-SR*
6	*Imperata cylindrica* (L.) Beauv.	Per.	H	*PAL*
7	*Phalaris minor* Retz.	Ann.	Th	*S-Z+SA-SI*
8	*Poa annua* L.	Ann.	Th	*COSM*
9	*Polypogon monspeliensis* (L.) Desf.	Ann.	Th	*COSM*
10	*Setaria glauca* (L.) P.Beauv	Ann.	Th	*COSM*
Q	**Polygonaceae:-**			
1	*Emex spinosa* (L.) Campd.	Ann.	Th	*ME+SA-SI*
2	*Polygonum equisetiforme* Sibth&Sm	Per.	G	*ME+ IR-TR*
R	**Portulaceae:-**			
1	*Portulaca oleracea* L.	Ann.	Th	*COSM*
S	**Primulaceae:-**			
1	*Anagallis arvensis* L. var. *arvensis*	Ann.	Th	*COSM*
T	**Rutaceae:-**			
1	*Haplophyllum tuberculatum* (Forssk.) Juss.	Per.	H	*ME+IR-TR*

U	**Scrophulariaceae:-**			
1	*Kickxia aegyptiaca* (L.) Nabelek	Per.	Ch	*ME+SA-SI*
V	**Solanaceae:-**			
1	*Datura innoxia* Mill.	Ann.	Th	*NEO*
2	*Nicotiana glauca* R.C.Graham	Per.	NPh	*Nat&Cult*
3	*Solanum incanum* L.	Per.	Ch	*S-Z*
Table (1): continued.				
W	**Tamaricaceae:-**			
1	*Tamarix nilotica* (Ehrenb.) Bge	Per.	NPh	*SA-SI+S-Z*
X	**Thymelaeaceae:-**			
1	*Thymelaea hirsuta* (L.) Endl.	Per.	NPh	*ME*
Y	**Zygophyllaceae:-**			
1	*Fagonia cretica* L.	Per.	Ch	*ME*

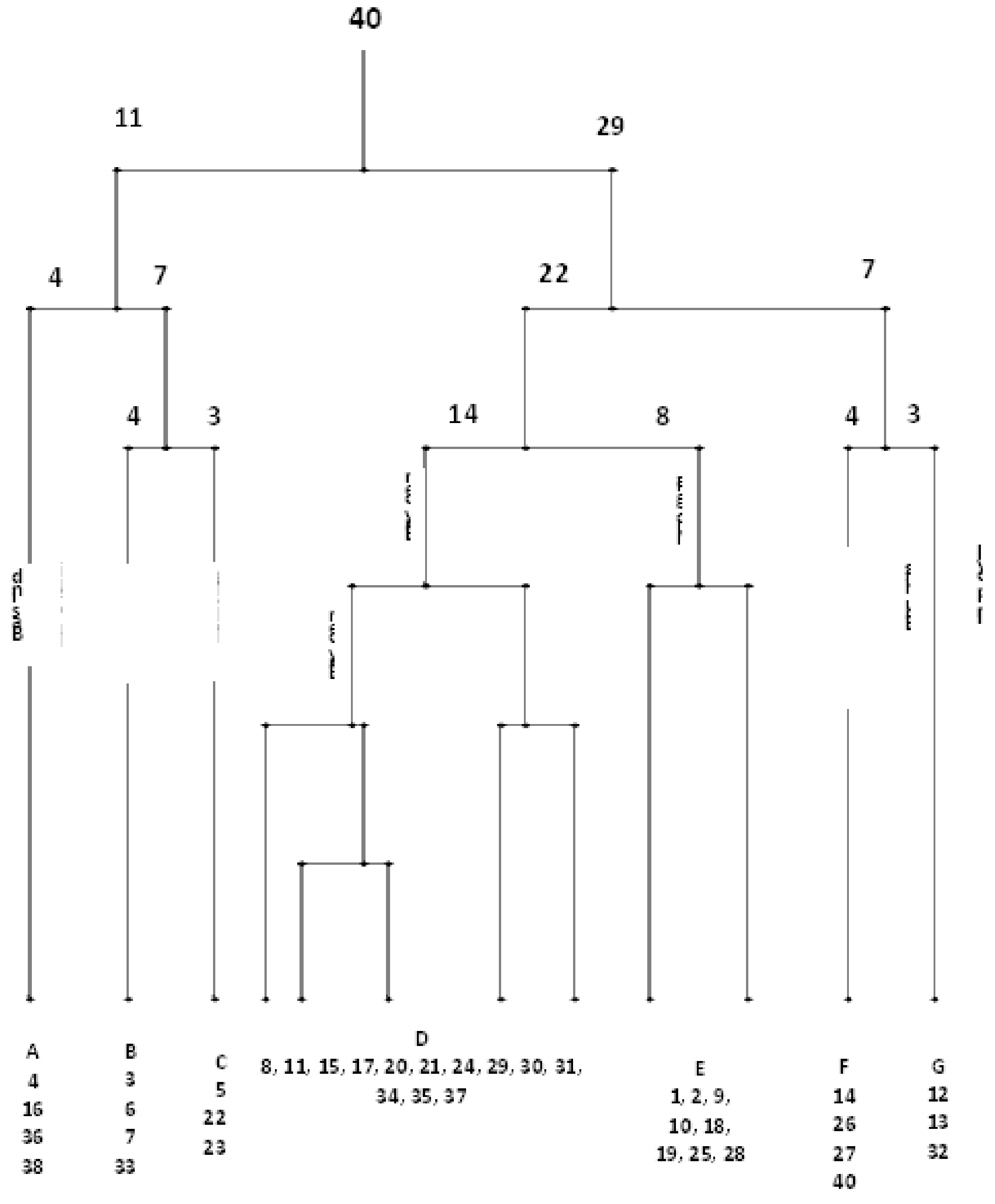

Figure (1): TWINSPAN dendrogram of the 40 stands based on importance values of 70 species at Mareotis coast. Indicator species are abbreviate to the first three letters of the

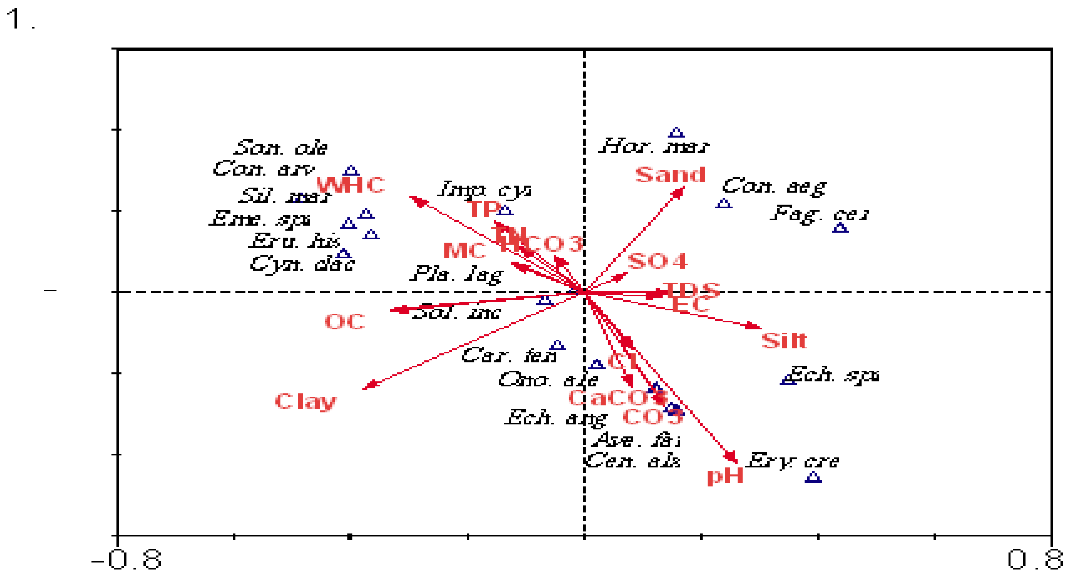

Figure (2). Canonical Correspondence Analysis (CCA) ordination biplot of the leading characteristic species and soil variables in the study areas.

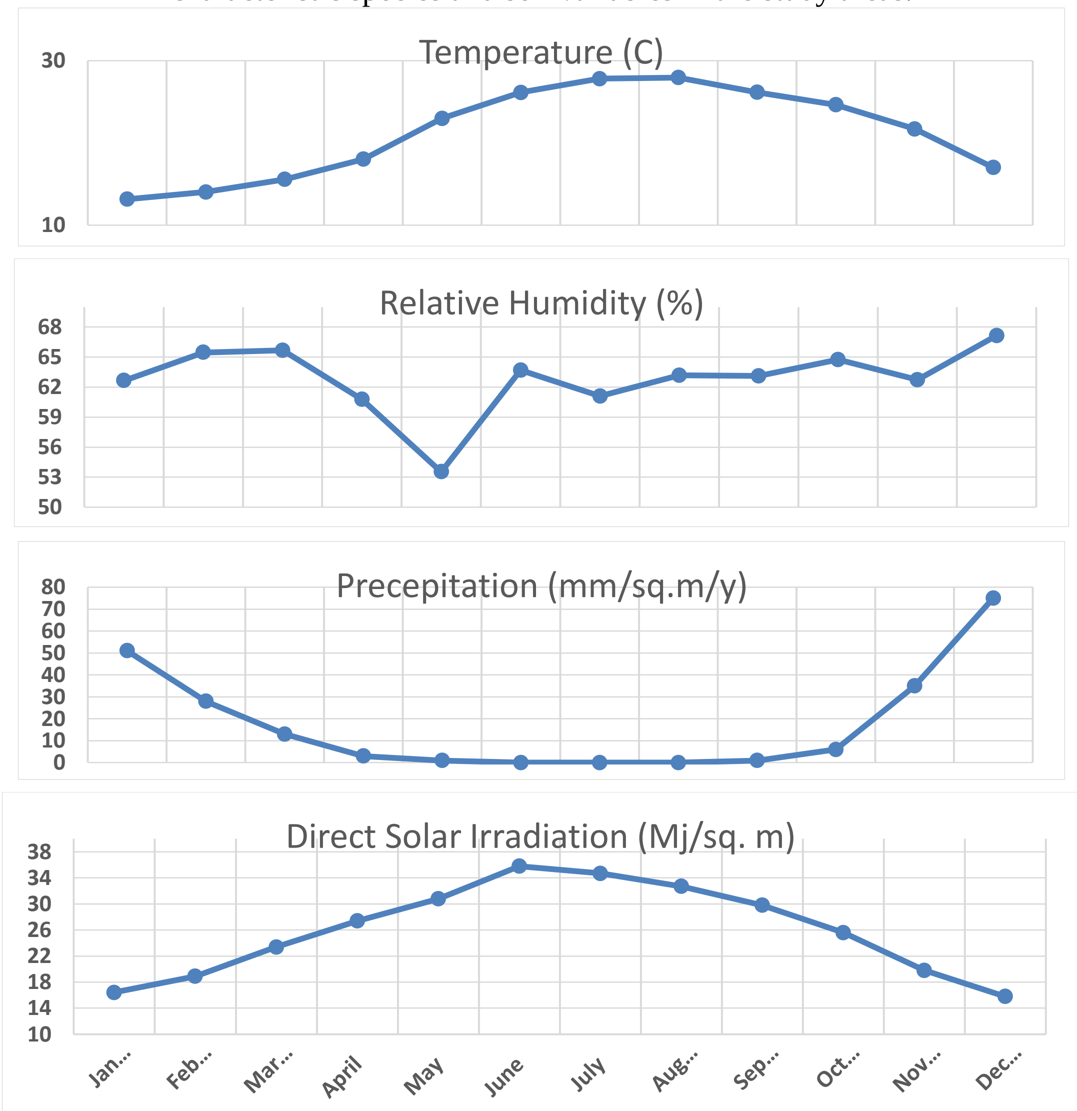

Figure (3). Ten years record of monthly average temperature (^{o}C), relative humidity (%), precipitation (mm/m^2/y) and direct solar irradiation (Mj/m^2).

Table (3): Mean and standard deviation of importance values belonging to the different vegtational groups of Mareotis coast produced by TWINSPAN classification.

No.	Species	Vegetation Groups						
		A	B	C	D	E	G	F
1	*Achillea santolina*	4.37 ±8.75	-	-	-	-	5.55 ±11.11	-
2	*Aegilops kotschyi*	-	-	-	-	1.5 ±4.24	-	-
3	*Amaranthus hybridus*	-	-	-	-	-	2.95 ±5.9	-
4	*Amaranthus lividus*	-	-	-	-	-	3.18 ±6.35	-
5	*Anagallis arvensis*	-	-	-	-	-	-	2.23 ±3.87
6	*Anchusa hispida*	-	-	-	-	2.08 ±5.87	-	-
7	*Apium leptophyllum*	-	-	-	-	1.01 ±2.86	-	-
8	*Arundo donax*	4.72 ±9.45	-	-	-	-	-	-
9	***Atriplex halimus***	14.63 ±16.92	47.58 ±14.19	-	-	-	-	**-**
10	*Atriplex leucoclada*	-	-	-	1.63 ±6.09	-	-	-
11	*Atriplex semibaccata*	13.3 ±11.16	12.42 ±8.80	-	-	-	-	-
12	*Avena fatua*	6.57 ±7.74	6.58 ±13.17	6.23 ±10.79	15.81 ±10.32	1.73 ±4.87	-	4.23 ±7.33
13	*Bassia indica*	12.05 ±10.36	-	-	2.23 ±5.77	2.31 ±6.54	-	3.8 ±6.58
14	*Brassica nigra*	-	-	-	-	-	-	4.96 ±8.60
15	***Carthamus tenuis***	16.66 ±2.76	10.92 ±7.88	16.71 ±14.67	27.93 ±8.52	17.96 ±9.55	18.27 ±13.28	**-**
16	*Centurea alxandrina*	6.43 ±7.71	9.78 ±7.08	14.38 ±3.62	9.36 ±13.94	-	2.07 ±4.15	-
17	*Centurea glomerata*	-	-	-	-	-	1.65 ±3.3	-
18	*Chenopodium album*	-	-	-	-	-	4.22 ±8.45	1.2 ±2.08
19	*Chenopodium murale*	-	-	-	-	1.13 ±3.18	12.1 ±11.04	-
20	*Chrysanthemum coronarium*	5.97 ±11.95	-	-	-	-	2.07 ±4.15	-
21	*Cichorium endivia*	-	-	-	-	2.18 ±6.15	-	-
22	*Convolvulus althaeoides*	-	-	-	0.38 ±1.42	-	-	-
23	*Convolvulus arvensis*	2.1 ±4.20	-	4.82 ±8.35	0.92 ±3.45	-	4.89 ±9.78	11.69 ±10.13
24	*Conyza aegyptiaca*	2.27 ±4.55	2.40 ±4.81	-	4.03 ±7.62	1.06 ±3.01	-	9.17 ±8.78
Table (3): continued.								
25	*Conyza bonariensis*	-	-	-	1.16 ±4.33	-	2.65 ±5.3	-
26	*Cynodon dactylon*	-	-	4.83 ±8.37	6.42 ±8.33	14.39 ±9.87	14.14 ±9.68	7.93 ±13.74
27	*Datura innoxia*	-	-	-	-	2.33 ±6.58	-	-
28	*Deverra tortuosa*	-	4.1 ±8.2	13.03 ±22.57	-	-	-	-
29	*Echinops spinosus*	4.5 ±9.00	19.45 ±6.63	23.75 ±4.77	8.90 ±12.74	3.92 ±11.08	-	-
30	*Echium angustifolium*	-	6.79 ±9.19	25.93 ±3.78	3.18 ±8.27	-	**-**	**-**
31	*Emex spinosa*	15.44	-	-	1.55	-	3.42 ±6.58	-

		±11.72			±5.80			
32	*Erodium laciniatum*	-	-	-	-	1.71 ±4.84	-	-
33	*Erucaria hispanica*	2.6 ±5.20	-	-	4.71 ±6.59	-	10.09 ±7.13	15.03 ±13.89
34	*Eryngium creticum*	-	6.79 ±8.66	11.44 ±10.09	10.41 ±12.44	-	-	3.56 ±6.18
35	*Fagonia certica*	5.21 ±6.46	8.55 ±10.08	5.6 ±9.69	0.70 ±2.62	1.83 ±5.16	3.75 ±7.5	-
36	*Haplophyllum tuberculatum*	-	-	-	2.61 ±9.77	-	-	-
37	*Hibiscus trionum*	-	-	-	-	-	-	1.6 ±2.77
38	*Hordeum marinum*	-	-	-	0.61 ±2.27	5.4 ±5.88	-	-
39	***Imperata cylindrical***	**-**	8.93 ±10.31	8.1 ±14.02	7.66 ±12.85	4.05 ±11.45	8.14 ±9.81	23.72 ±2.81
40	*Kickxia aegyptiaca*	-	-	4.06 ±7.04	-	-	-	-
41	*Lactuca serriola*	-	-	-	-	3.69 ±7.85	-	-
42	*Launaea nudicaulis*	4.72 ±9.44	-	-	0.70 ±2.62	-	-	-
43	*Malva parviflora*	-	-	-	0.56 ±2.11	2.46 ±4.77	8.45 ±5.87	-
44	*Marrubium alysson*	-	-	2.3 ±3.98	-	-	-	-
45	*Melilotus indica*	-	-	-	-	-	-	2.9 ±5.02
46	*Nicotiana glauca*	8.48 ±16.96	7.07 ±14.15	-	-	12.90 ±19.66	2.45 ±4.9	-
47	*Onopordum alexandrinum*	4.9 ±9.80	-	8.01 ±13.86	19.96 ±19.13	18.93 ±13.99	9.89 ±6.78	-
48	*Papaver rhoeas*	-	-	-	-	0.89 ±2.51	-	-
49	*Paronychia Arabica*	-	-	-	0.24 ±0.88	-	-	-
50	*Peganum harmala*	-	-	-	1.33 ±4.97	-	-	-
51	*Phalaris minor*	-	-	-	0.62 ±2.33	-	-	-
52	*Plantago lagopus*	13.53 ±9.31	18.23 ±13.77	7.86 ±13.62	10.84 ±11.47	10.48 ±13.18	6.1 ±12.2	8.82 ±15.28
Table (3): continued.								
53	*Pluchea dioscoridis*	-	2.75 ±5.51	-	-	-	10.37±20.75	-
54	*Poa annua*	-	-	-	0.46 ±1.71	-	-	-
55	*Polygonum equisetiforme*	4.22 ±4.95	-	-	-	-	3.29 ±6.58	-
56	*Polypogon monspeliensis*	-	-	-	-	1.11 ±3.15	-	-
57	*Portulaca oleracea*	-	-	-	-	-	-	4.83 ±8.37
58	*Reichardia tingitana*	2.6 ±5.20	-	-	-	-	-	-
59	*Salsola kali*	-	-	-	-	1.19 ±3.36	-	-
60	*Senecio glaucus*	-	-	-	-	-	-	-
61	*Setaria glauca*	-	-	-	-	-	3.48 ±4.39	5.1 ±8.83
62	***Silybum marianum***	13.13 ±17.35	-	-	6.78 ±11.33	26.52 ±11.61	12.16 ±8.68	5.8 ±10.05
63	*Sisymbrium irio*	-	-	-	-	-	8.87 ±7.17	-
64	***Solanum incanum***	28.47	27.04	30.93	43.81	44.89	34.82 ±3.60	43.3

		±1.94	±7.95	±6.54	±13.90	±18.36		±11.70
65	*Sonchus oleraceus*	1.07 ±2.15	-	2.59 ±4.49	-	1.74 ±4.91	-	6.52 ±11.30
66	*Tamarix nilotica*	-	-	-	3.89 ±14.57	-	-	21.97 ±38.06
67	*Thymelaea hirsuta*	-	-	8.63 ±14.95	-	-	-	-
68	*Urospermum picroides*	-	-	-	-	-	-	6.63 ±11.49
69	*Xanthium spinosum*	-	-	-	-	5.99 ±11.09	-	-
70	*Xanthium strumarium*	-	-	-	-	3.94 ±11.13	-	-

References

1. Whalen, M.D., Caruso, E. (1983). Phylogeny in Solanum sect. Lasiocarpa (Solanaceae). Congruence of morphological and molecular data. Syst Bot **8**:369–380.
2. Boulos, L. (2009). Flora of Egypt: Checklist. Revised Annotated Edition. Al-Hadara Publishing, Cairo, Egypt, P. 410.
3. Hepper, F.N., (2002). Solanaceae. Flora of Egypt (Verbenaceae-Compositae), vol. **3**. Al Hadara Publishing, Cairo, pp. 34–54.
4. Muthoni, J., Shimelis, H., Melis, R. and Kabira, J. (2012). Reproductive biology and early generation's selection in conventional potato breeding. Austral. *J. Crop Sci*. **6 (3)**, 488–497.
5. Pereira, T.M., Silva, V.C.B., Ribeiro Neto, J.A., Alves, S.N. and Lima, L.A.R.S. (2014). Larvicidal activity of the methanol extract and fractions of the green fruits of Solanum lycocarpum (Solanaceae) against the vector Culex quinquefasciatus (Diptera: Culicidae). Rev. Soc. Bras. Med. Trop. **47 (5)**, 646–648.
6. Rajathi, M., Anandan, R., Sindhu, R. and Logeshwari, M.N. (2015). Screening of Solanum nigrum for its phytochemical and antimicrobial activity against respiratory tract pathogen. Int. *J. Pure Appl. Zool.* **3 (3)**, 210–215.
7. Griffin S., et al., (2016). Turning waste into value: nanosized natural plant materials of Solanum incanum L. and Pterocarpus erinaceus Poir with promising Antimicrobial Activities, *Journal of Pharmaceutics*, https://www.mdpi.com/journal/pharmaceutics
8. Auta, R. and Ali, I. (2011). Nutritional and chemical value of *Solanum incanum* (bitter garden egg), *Intern. J. Trop. Med. Pub. Health* **1(1)** 96-107.
9. Abdalla, I.M.F.(2015). Leaves value of *Solanum incanum* (L.) at Khartoum North-Sudan. International *Journal of Engineering Science and Innovative Technology*, **4(1)**:25-28.
10. Lin, Y.L., Wang, W.Y., Kuo, Y.H. and Chen, C.F. (2000). Nonsteroidal constituents from *Solanum incanum* L. *J. Chin. Chem. Soc.* 47, 247-251.
11. Rice, E. L. (1984). Allelopathy. 2nd ed. Academic Press, Inc. Orlando.
12. Smith, A. E. and Martin, L. D. (1994). Allelopathic characteristics of 3 cool season grass species in the forage *ecosystem. Agronomy Journal*, **86:** 243-246.
13. Hoagland, R. E. (2001). Microbial allelochemicals and pathogens as bioherbicidal agents. Weed Technology, **15**: 835-857.
14. Ewais, E.A., ALy, M.M., et al., (2014). Antimicrobial activities of Solanum incanum, Elettaria Cardamomum and Zingiber officinale,used traditionally to treat pathogenic microbes. *Scientific J. Flowers & Ornamental Plants*, **1(3)**: 253-263.
15. Abebe, H., Gebre, T. and Haile, A. (2014). Phytochemical investigation on the roots of Solanum incanum, Hadiya Zone, Ethiopia. *J. Medicinal Plants Studies*, **2(2):** 83-93.
16. Sebastian Yu, *et al*. (2017). Solanum incanum extract (SR-T100) induces melanoma cell apoptosis and inhibits

established lung metastasis. www.impactjournals.com/oncotarget/ , Oncotarget, Vol. **8**, (No. 61), pp: 103509-103517.
17. Patel, R., Tyagi, V., *et al*. (2018). Nutritional analysis of Solanum incanum L. (Bitter Brinjal) cultivated in north east region of India, *International Journal of Advanced Educational Research*.; **3(2)**; 130-134.
18. Mashaly, I. A. (2001). Contribution to the ecology of the Deltaic Mediterranean coast, Egypt. Online *Journal of Biological Sciences*, **1(7)**: 628-635.
19. Phillip, G. and Said, R. (1956). The geology of the Mediterranean coast between Rosetta and Bardia, II. Pleistocene sediments, geomorphology and microfacies. Bull. Inst. Egypte, **37,** 395-433.
20. Shata, A. (1957). Remarks on the physiography of El-Amiria-Mariut area. Bull. Soc. Geogr. Egypte, **30**, 53-74.
21. Harga, A.A. (1967). Morphological and Physio-chemical Studies of Burg El-Arab – El-Hammam Area. M.Sc. Thesis, Faculty of Agriculture, Ain Shams University, Cairo.
22. Mashaly, I. A. (1987). Ecological and Floristic Studies of Dakahlia-Damietta Region, Ph.D. Thesis, Fac. Sci., Mansoura University, Egypt.
23. Weatherbase, (2020), http://www.weatherbase.com
24. Cottam, G. and Curtis, J.T. (1956). The use of distance measures in phytosological sampling Ecology, 37:451-460.
25. Ayyad, M.A. (1970). Application of the point-centered quarter method to the vegetation of two types of desert habitat at Mareotis. *U.A.R.J. Bot*.,**13**: 225-234.
26. Canfield, R. (1941). Application of the line interception method in sampling range vegetation. *Journal of Forestry,* **39:** 288-394.
27. Boulos, L. (1999). Flora of Egypt. Vol 1 (Azollaceae-Oxalidaeae). Al Hadara Publishing. Cairo, Egypt, p. 419.
28. Boulos, L. (2000). Flora of Egypt. Vol. II. (Geraniaceae-Boraginaceae). Al Hadara Publishing, Cairo, Egypt, p. 352.
29. Boulos, L. (2002). Flora of Egypt. Vol. IV. Verbenaceae – Compositae. Al-Hadara Publishing, Cairo, Egypt, P. 373.
30. Boulos, L. (2005). Flora of Egypt. Vol. IV. Monocotyledons (Alismataceae-Orchidaceae). Al Hadara Publishing, Cairo, Egypt, p. 617.
31. Täckholm, V. (1974). Students' Flora of Egypt. 2nd ed. Cairo Univ. Press (Publ.), Cooperative Printing Company, Beirut.
32. Raunkiaer, C. (1934). The Life Forms of Plants Geography. Translated by Carter Fausboll and Tansley; Oxford University Press, London.
33. Zohary, M. (1966 and 1972). Flora Palaestina. Parts 1 and 2. The Israel Academy of Science and Humanities, Jerusalem.
34. Feinbrun-Dothan, (1978 and 1986). Flora Palaestina, Parts. 3 and 4. The Israel Academy of Sciences and Humanities, Jerusalem.
35. Hesse, P. R. (1971). Alex Book of Soil Chemical Analysis. Jhan Murry (Publishers) Ltd., 50 Albemarle Street, London.
36. Cottenie, A., Verloo, M., Kiekens, L., Velghe, G. and Camerlynck (1982). Chemical Analysis of Plant and Soil. Lab. Anal. and Agrochemistry State Univ. Gent., Belgium.
37. Page, A. (1982). Method of Soil Analysis Part 2. Chemical and Microbiological Properties. 2nd edition. American Society of Agronomy and Soil Science Society of America, Madison, Wisconsin, USA.
38. El-Hadidi, M. N. (1993). Natural vegetation. In G.M. Craig (ed.) The Agriculture of Egypt, Oxford Univ. Press, 39-62.
39. Mashaly, I. A., El-Habashy, E. E., El-Halwany, 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.
40. Shaltout, K. H., Sharaf El-Din, A. and Ahmed, D. A. (2010). Plant Life in the Nile Delta. Tanta Univ. Press, Egypt.

41. 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.

42. 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.