

Floristic and Ecological Features of Two Islands (Ebn-Salam and Tinnis) in Lake Manzala, Egypt

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Abstract: Lake Manzala is the biggest lake at the northeastern corner of the Nile Delta and along the Mediterranean coast of Egypt. It comprises over 1000 islands of various sizes. The present study compared the floristic and ecological features of two islands Ebn-Salam and Tinnis as well as examined the vegetation analysis in correlation with environmental factors. Vegetation and soil were investigated in seven stands in Ebn-Salam Island and 17 stands in Tinnis Island. For each species, relative cover and density values were calculated and summarized in order to estimate its importance value. For each soil stand, the physical and chemical properties of the soil samples were determined. The results indicated that 25 species of 22 genera and linked to 12 families were documented. These species include 10 annual species (40 %) and 15 perennial species (60 %). Therophytes (35.71%) and Pluri-regional taxa (36%) were dominant. Four vegetation groups were segregated after the application of TWINSpan. Among soil factors, sand, silt, saturation capacity, moisture content, soil salinity, cadmium and magnesium were the utmost effective factors.

keywords: Lake Manzala, flora, classification, ordination, soil analysis.

1. Introduction

The wetlands in Egypt are considered as one of the most prominent aquatic ecosystems, which are widely distributed all over the country. Lakes are the most conspicuous wetland habitat in Egypt [1].

The Egyptian Government launched on May 2017 the national project to develop Egypt's lakes, at a cost of 100 billion Egyptian pounds, while "Al-Manzala" is at the top of the list of lakes after nearly a century of neglect that caused its area to shrink from 750,000 acres to only 125,000 acres, in addition to its transformation from the most fertile and most wonderful lakes in the world to drug den and a pollution source because it receives 12 million cubic meters of sanitation and industrial wastewater on a daily basis. All the weeds and more than 4,100 cases of unlicensed nests, buildings and farms were removed. The state announced concerted efforts to stop the dumping of sewage in the lake, as well as the start of the implementation of a triple treatment for wastewater in preparation for its use in desert cultivation, in addition to dredging and

removing 80 million tons of sediments, extraction and utilization in 49 industries.

The present study aimed to determine and analyze the floristic composition occurring in two islands of Lake Manzala. The ultimate aim of this study was to identify the threatened plant species and communities and to assess the environmental factors controlling the vegetation and plant diversity.

2. Materials and methods

1. Study area

Lake Manzala is a rhombohedral shape located on the northern Mediterranean coast of Egypt between 31° 00' and 31° 35' N and 31° 45' and 32° 15' E (Fig. 1). The lake is isolated from the sea in the north by a narrow sand bar. It is bounded by Suez Canal to the east, Damietta to the northwest and Dakahlia to the southwest.

The lagoon is 56 km long, from Damietta to the Suez Canal, and 28 km wide, but reduce to just 15.6 km in the middle, covering a total area of 1575 km² [2]. The climate is semi-arid with annual rainfall varies between 64-102 mm. In

Manzala Lagoon, 1022 islands were recorded throughout history, representing only 9 percent of the area of the lagoon; only 304 islands are remaining [2]. Ebn Salam and Tinnis, the subject matter of the present research, are among these islands.

In general, the lake is shallow because more than half of its area is lower than 1.0 m [3]. As a result of the disposal the drainage water in the lake, aquatic vegetation has bloomed dramatically [4]. The water body is inhabited by fresh and brackish water vegetation such as *Zygophyllum aegyptium*, *Phragmites australis*, *Juncus* spp., *Arthrocnemum macrostachyum*, etc. [5].

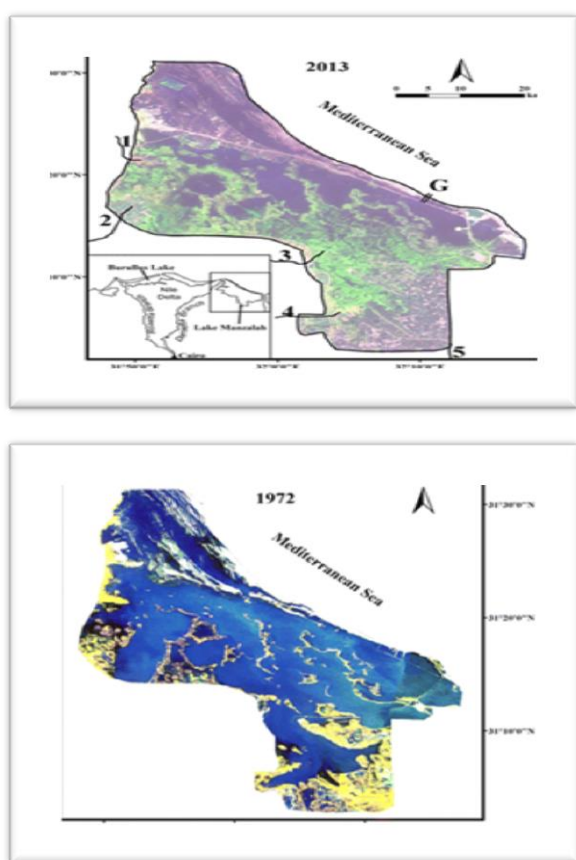


Fig. (1) Lake Manzala, as seen in the March 2013 image of the Landsat OLI. The numbers apply to 1 El-Inaniya, 2 El-Serw, 3 Hadous, 4 Ramses and 5 Bahr El-Baqar as the positions of agricultural drains ending at the lake. G refers to the lake opening of El-Gamil in the Mediterranean Sea. The right picture shows the lake with a lower distribution of aquatic vegetation in 1972 relative to its status in 2013

Lake Manzala has witnessed a change in its aquatic vegetation. Owing to freshwater from agriculture drainage [6], the salinity of the lake

has decreased significantly, leading to a reduction of salt-marsh vegetation, as shown by pollen examination [7]. On the other hand, considerable increases in freshwater plant pollen grains, such as *Typha* and *Phragmites* plants have been observed by [8]. Figure (1) clearly displays the lake with low aquatic vegetation coverage in 1972, just after the operation of the High Dam compared to 2013, where the bulk of the lake area is occupied by aquatic vegetation, which is compatible with previous findings of [8]. One of the main factors of lake depletion is the shrinking of the water bodies with sediments from agricultural land, drying practices for agriculture and weed and swamp vegetation abundance, while the other factor includes the erosion of the coastal sand bars [9].

2. Vegetation analysis

A total of 24 stands have been selected for the sampling of vegetation on 2 islands of Lake Manzala. The sampled stands were distributed in both Ebn-Salam and Tinnis Islands (Table 1). Each stand is obtained as a sum of four quadrates (area 2 m² each). Life-forms were performed according to [10, 11]. Identification and nomenclature of species were according to [12, 13]. In each plot, perennial and annual species were recorded. The relative values of density and plant cover of each species were estimated in each stand [14,15]

3. Soil analysis

Soil samples at a depth of 0–50 cm, were air-dried by air and packaged for physical and chemical analyses. Soil texture, porosity, moisture and saturation capacity were estimated according to [16], [17]; [18] and [19] respectively. Calcium carbonate and organic carbon were carried out using air dry soil samples according to [17] and [19] respectively. Soil pH and electrical conductivity (EC) were determined in an aqueous solution (1:5 w/v) using a digital pH-meter and conductivity meter (Model Corning, NY 14831 USA). From the soil extracts some chemical variables were analyzed. Chlorides and sulphates were carried out according to Jackson [17] and [19], respectively. Carbonates and bicarbonates were performed according to

[20]. Total dissolved phosphorus was determined following the method of [21]. Total

dissolved nitrogen was determined using the micro-Kjeldahl method. Na, K, Ca and Mg (flame photometry). The available heavy metals: zinc, lead, nickel and cadmium were analyzed using an atomic absorption spectrophotometer; model of VARIAN specter AA. 2

Table (1): List of stands location and coordinat

Stands No.	Locality	Governo rate	Coordinate
1	Ebn-Salam Island	El Dakahlia	31° 10' 48" N 32° 05' 06" E
2			31° 10' 50" N 32° 12' 09" E
3			31° 10' 51" N 32° 05' 10" E
4			31° 10' 48" N 32° 05' 11" E
5			31° 10' 46" N 32° 05' 12" E
6			31° 10' 55" N 32° 05' 08" E
7			31° 10' 57" N 32° 05' 07" E
8	Tinnis Island	Port Said	31° 11' 98" N 32° 13' 76" E
9			31° 12' 25" N 32° 13' 71" E
10			31° 12' 25" N 32° 13' 70" E
11			31° 12' 26" N 32° 13' 70" E
12			31° 12' 23" N 32° 13' 67" E
13			31° 12' 19" N 32° 13' 64" E
14			31° 12' 05" N 32° 13' 71" E
15			31° 12' 02" N 32° 13' 73" E
16			31° 11' 97" N 32° 13' 76" E
17			31° 11' 95" N 32° 13' 78" E
18			31° 11' 94" N 32° 13' 80" E
19			31° 11' 91" N 32° 13' 82" E
20			31° 11' 86" N 32° 13' 86" E
21			31° 12' 64" N 32° 13' 59" E
22			31° 12' 65" N 32° 13' 61" E
23			31° 12' 65" N 32° 13' 57" E
24			31° 12' 66" N 32° 13' 58" E

4.Data analysis

TWINSPAN (Two-Way Indicator Species Analysis, [22]) was used for classification of 25 species in 24 stands, while the ordination of Detrended Correspondence Analysis (DCA) and the Canonical Correspondence Analysis (CCA) using CANOCO [23, 24, 25]. Therelationship between groups and soil variables is indicated by CCA. The statistical treatment in the present study was according to [26, 27].

3. Results and Discussion

1.Floristic Analysis

Floristically, 25 species, belonging to 22 genera and 12 families of the vascular plants were recorded. Chenopodiaceae comprises 7 species (28 % of the total number of recorded plant species), followed by family Asteraceae with 5 species (20 %), then Poaceae, Cyperaceae and Aizoaceae comprise 2 species each (8 %). The remaining families which include Juncaceae, Polygonaceae, Zygophyllaceae, Asclepiadaceae, Ruunculaceae, Tamaricaceae and Typhaceae were represented by only one species each (4 %) (Table 2).

The recorded species includes 10 annual (40 %) and 15 perennial species (60 %) (Figure 2).

The life-forms of the flora of the study area were grouped under six types [10] as follows: therophytes (35.71 %), followed by chamaephytes (21.43 %), then geophytes and helophytes which attained a value of 14.29 % each, and nanophanerophytes (10.71 %). The lowest value of life forms was recorded as hemicryptophytes (3.57 %). It is clear that the life-form varies among habitats (Figure 3).

Chorological analysis of the vegetation in the study area (Table 2) displayed that, 9 species (36 %) are Pluriregional taxa with 6 species (24 %) are Cosmopolitan, 6 species (24 %) are Biregional taxa, 2 species (8 %) are Pantropical, one species (4 %) is Mediterranean and one species (4 %) is Neotropical.

2.Vegetation analysis

TWINSPAN depending on the importance values of 25 species in 24 stands released 4 groups, (Table 3 and Figure 4).

Group A was the smallest group, located in Tinnis Island. It comprised 6 species recorded in 2 stands and dominated by *Mesembryanthemum nodiflorum* which attained the highest importance value (IV = 89.42). Some common species that attained high importance value include *Mesembryanthemum forsskalii* (IV = 37.09) and *Senecio glaucus* (IV = 34.01). There are no indicator species in this group. The stands of this group

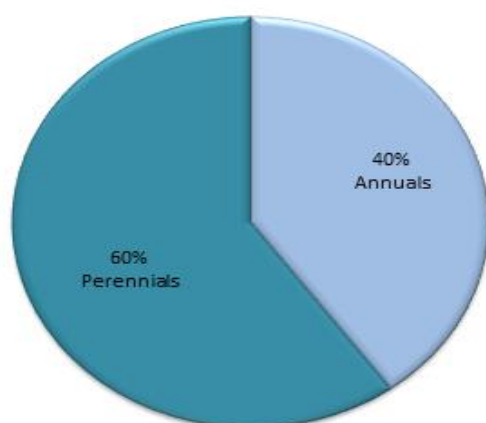


Fig. (2): Plant life-span spectra of the study area

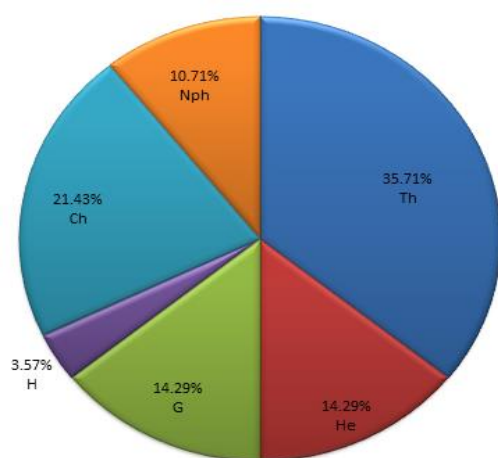


Fig. (3): Plant life-form spectra of the study area. See abbreviations in Table 2

preferred soil with the highest level of sand and pH (Table 4).

Group B consisted of 9 species inhabiting 8 stands (number 3: 7) were located in Ebn-Salam Island. Three other stands number 9, 13 and 14 located in Tinnis Island were separated in this group. The dominant species is *Arthrocnemum macrostachyum* (IV = 62.96). The other important species are *Halocnemum strobilaceum* (IV = 42.89), *Phragmites australis* (IV = 35.75) and *Juncus rigidus* (IV = 34.86).

The indicator species are *Tamarix nilotica* (IV = 8.9), *Limbarda crithmoides* (IV = 7.23) and *Atriplex portulacoides* (IV = 5.51). Soil is characterized by high percentages of soil salinity (EC), chlorides, sulphates, cations and total dissolved phosphorus (Table 4).

Group C comprised 12 species recorded in 11 stands separated into two groups: a) stands No. 1 and 2 were located in Ebn-Salam Island and b) stands No. 8, 10, 12 and 15: 20 were located in Tinnis Island. This group is dominated by *Juncus rigidus* (IV = 45.58). The other important species are *Phragmites australis* (IV = 40.47), *Arthrocnemum macrostachyum* (IV = 34.15) and *Tamarix nilotica* (IV = 18.61). The identified indicator species are *Limbarda crithmoides* (IV = 11.54) and *Cynanchum acutum* (IV = 1.3). Stands were found on soil rich in soil porosity, moisture content, saturation capacity, calcium carbonates, organic carbon and bicarbonates (Table 4).

Group D comprised 16 species in 3 stands number 11, 23 and 24. These stands were located on Tinnis Island. This group is dominated by *Limbarda crithmoides* (IV = 41.28). Two other important species are *Cyperus articulatus* (IV = 32.44) and *Atriplex prostrata* (IV = 24.23). There are no indicator species in this group. Elevated percentages of silt, clay, total nitrogen and heavy metals define the soil of this group (Table 4).

1. DCA of the surveyed stands in the study area is shown in Figure 5. It is clear that the vegetation groups A and D are markedly different on the ordination planes. Groups B and C are superimposed

2. Vegetation-Soil Relationships

The variation of soil variables of the four vegetation groups is displayed in Table (3). The soil texture in all groups was formed mainly of fine fractions (silt and clay) and partly of coarse fractions (sand). The percentages of soil porosity, moisture content and saturation capacity were relatively high (52.55, 53.16 and 69.69 %, respectively) in group C. The soil samples of group C also attained the highest values of calcium carbonates and organic carbon (42.25 and 2.06 %, respectively). The pH values indicated that the soil is slightly alkaline in all groups, where they varied from

7.29 to 7.84. Electrical conductivity, chlorides and sulphates content attained the highest values in group B (24.32 mmhos/cm, 4.01 % and 2.19 %, respectively). The soluble carbonates and bicarbonates were detected in very low content in all vegetation groups. The highest concentrations of monovalent cations sodium and potassium were estimated in group B (64.34 meq/100 g soil and 5.43 meq/100 g soil, respectively). The highest concentrations of divalent cations calcium and magnesium

(20.1 meq/100 g soil and 15.89 meq/100 g soil, respectively) were also obtained in group B.

The soil samples of group D attained the highest values of total nitrogen content (74.98 ppm), while the highest value of total dissolved phosphorus (11.24 ppm) was attained in group B. The heavy metals (Zn^{2+} , Pb^{2+} , Ni^{2+} and Cd^{2+}) attained the highest values in group D (0.92 ppm, 6.87 ppm, 2.68 ppm and 0.92 ppm, respectively)

Table (2): Floristic composition of the recorded species in the study area. Life span: Per. = Perennials, Ann. = Annuals; Life form: Th. = Therophytes, H. = Hemicryptophytes, G.= Geophytes, He.= Helophytes, Nph. = Nanophanerophytes, Ch. = Chamaephytes; Floristic Category: COSM = Cosmopolitan, PAN = Pantropical, NEO= Neotropical, ME= Mediterranean, SA-SI = Saharo-Sindian, ERSR = Euro-Siberian, IR-TR = Irano-Turanian, S-Z = Sudano-Zambe

No	Taxon	Family	Life-span	Life-form	Floristic category
1	<i>Arthrocnemum macrostachyum</i> (Moric.) k. koch	Chenopodiaceae	Per.	Ch.	ME + SA-SI
2	<i>Aster squamatus</i> (Spreng.) Hieron.	Asteraceae	Per.	Ch.	NEO
3	<i>Atriplex portulacoides</i> L.	Chenopodiaceae	Per.	Ch.	ME + ER-SR + IR-TR
4	<i>Atriplex prostrata</i> DC.	Chenopodiaceae	Ann.	Th.	ME + ER-SR+ IR-TR
5	<i>Bolbochoenus glaucus</i> (Lam.) S. G. Smith	Cyperaceae	Per.	G.	COSM
6	<i>Cynanchum acutum</i> L.	Asclepiadaceae	Per.	H.	ME + IR-TR
7	<i>Cyperus articulatus</i> L.	Cyperaceae	Per.	G, He.	PAN
8	<i>Halocnemum strobilaceum</i> (Pallas) M. Bieb.	Chenopodiaceae	Per.	Ch.	ME + IR-TR + SA-SR
9	<i>Juncus rigidus</i> Desf.	Juncaceae	Per.	G, He.	ME + IR-TR+ SA-SI
10	<i>Limbarda crithmoides</i> (L.) Dumort.	Asteraceae	Per.	Ch.	ME + ER-SR+ SA-SI
11	<i>Mesembryanthemum forsskalii</i> Hochst. ex Boiss.	Aizoaceae	Ann.	Th.	SA-SI + S-Z
12	<i>Mesembryanthemum nodiflorum</i> L.	Aizoaceae	Ann.	Th.	ME + ER-SR+ SA-SI
13	<i>Phragmites australis</i> (Cav.) Trin. ex Steud.	Poaceae	Per.	G, He.	COSM
14	<i>Pluchea dioscoridis</i> (L.) DC.	Asteraceae	Per.	Nph.	SA-SI + S-Z
15	<i>Polypogon monspeliensis</i> (L.) DC.	Poaceae	Ann.	Th.	COSM
16	<i>Ranunculus sceleratus</i> L.	Rununculaceae	Ann.	Th.	ME + ER-SR+ IR-TR
17	<i>Rumex dentatus</i> L.	Polygonaceae	Ann.	Th.	ME + ER-SR+ IR-TR
18	<i>Salsola kali</i> L.	Chenopodiaceae	Ann.	Th.	COSM
19	<i>Senecio glaucus</i> L.	Asteraceae	Ann.	Th.	ME + IR-TR+ SA-SI
20	<i>Sonchus oleraceus</i> L.	Asteraceae	Ann.	Th.	COSM
22	<i>Suaeda maritima</i> (L.) Dumort.	Chenopodiaceae	Ann.	Th.	COSM
21	<i>Suaeda vera</i> Forssk. ex J.F.Gmel.	Chenopodiaceae	Per.	Nph.	ME + ER-SR
23	<i>Tamarix nilotica</i> (Ehrenb.) Bunge	Tamaricaceae	Per.	Nph.	SA-SI + S-Z
24	<i>Typha domingensis</i> (Pers.) Poir. ex Steud.	Typhaceae	Per.	He.	PAN
25	<i>Zygophyllum aegyptium</i> Hosny	Zygophyllaceae	Per.	Ch.	ME

ziaGroup A is dominated by *Mesembryanthemum nodiflorum* and segregated at the left side of the DCA diagram. Group D is dominated by *Limbarda crithmoides* and separated at the middle part of

the DCA diagram. Groups B and C dominated by *Arthrocnemum macrostachyum* and *Juncus rigidus*, respectively and are superimposed at the right side of the DCA diagram.

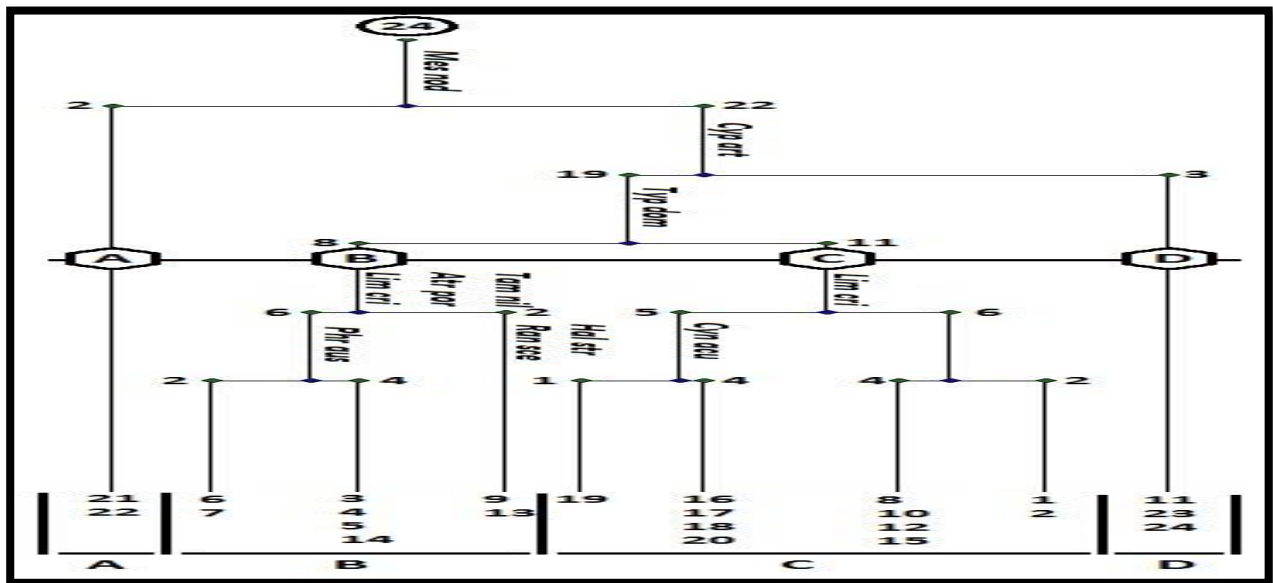


Fig. (4). TWINSpan dendrogram recognizing four groups (A, B, C and D) at the third level. The indicator species are abbreviated by the first three letters of genus and species, respectively. The indicator species are coded as follow: Mes nod = *Mesembryanthemum nodiflorum*, Cyp art = *Cyperus articulatus*, Typ dom = *Typha domingensis*, Lim cri = *Limbarda crithmoides*, Tam nil = *Tamarix nilotica*, Atr por = *Atriplex portulacoides*, Cyn acu = *Cynanchum acutum*, Hal str = *Halocnemum strobilaceum*, Ran sce = *Ranunculus sceleratus*, Phr aus = *Phragmites australis*

Table (3): Mean value and coefficient of variation (value between brackets) of the importance value of the recorded plants in the different vegetation groups resulting from TWINSpan classification of the study area.

No	Species	Vegetation group			
		A	B	C	D
1	<i>Arthrocnemum macrostachyum</i> (Moric.) k. koch	.....	62.96(0.35)	34.15(0.49)	6.93(0.92)
2	<i>Aster squamatus</i> (Spreng.) Hieron.	.....	0.59(2.81)	.....	.....
3	<i>Atriplex portulacoides</i> L.	.....	5.51(1.89)	8.13(1.67)	11.77(0.9)
4	<i>Atriplex prostrata</i> DC.	.....	.....	.....	24.23(1.73)
5	<i>Bolbochoenus glaucus</i> (Lam.) S. G. Smith	.....	.....	1.4(3.31)	.....
6	<i>Cynanchum acutum</i> L.	.....	.....	1.3(3.32)	5.76(0.93)
7	<i>Cyperus articulatus</i> L.	.....	.....	.....	32.44(0.87)
8	<i>Halocnemum strobilaceum</i> (Pallas) M. Bieb.	.....	42.89(0.39)	.....	.....
9	<i>Juncus rigidus</i> Desf.	.....	34.86(1.15)	45.58(0.78)	3.59(1.73)
10	<i>Limbarda crithmoides</i> (L.) Dumort.	.....	7.23(1.85)	11.54(1.47)	41.28(0.5)
11	<i>Mesembryanthemum forsskalii</i> Hochst. ex Boiss.	37.09(1.41)	.....	.....	.....
12	<i>Mesembryanthemum nodiflorum</i> L.	89.42(0.1)	.....	.....	.....
13	<i>Phragmites australis</i> (Cav.) Trin. ex Steud.	.....	35.75(0.67)	40.47(0.49)	16.51(1.06)
14	<i>Pluchea dioscoridis</i> (L.) DC.	.....	.....	.....	4.9(1.73)
15	<i>Polypogon monspeliensis</i> (L.) DC.	.....	.....	4.86(2.24)	9.74(1.73)
16	<i>Ranunculus sceleratus</i> L.	.....	.....	14.19(1.7)	19.17(0.83)
17	<i>Rumex dentatus</i> L.	.....	.....	.....	9.89(1.02)
18	<i>Salsola kali</i> L.	13.28(0.35)	.....	.....	.....
19	<i>Senecio glaucus</i> L.	34.01(0.73)	.....	.....	.....
20	<i>Sonchus oleraceus</i> L.	4.82(1.41)	.....	.....	.....
21	<i>Suaeda maritima</i> (L.)Dumort.	.....	.....	1.47(3.33)	2.67(1.73)
22	<i>Suaeda vera</i> Forssk. ex J.F.Gmel.	.....	.....	.....	3.53(1.73)
23	<i>Tamarix nilotica</i> (Ehrenb.) Bunge	.....	8.9(2.07)	18.61(1.81)	2.11(1.73)
24	<i>Typha domingensis</i> (Pers.) Poir. ex Steud.	.....	1.21(2.83)	15.7(1.47)	5.39(1.73)
25	<i>Zygophyllum aegyptium</i> Hosny	21.56(1.41)	.....	.....	.....

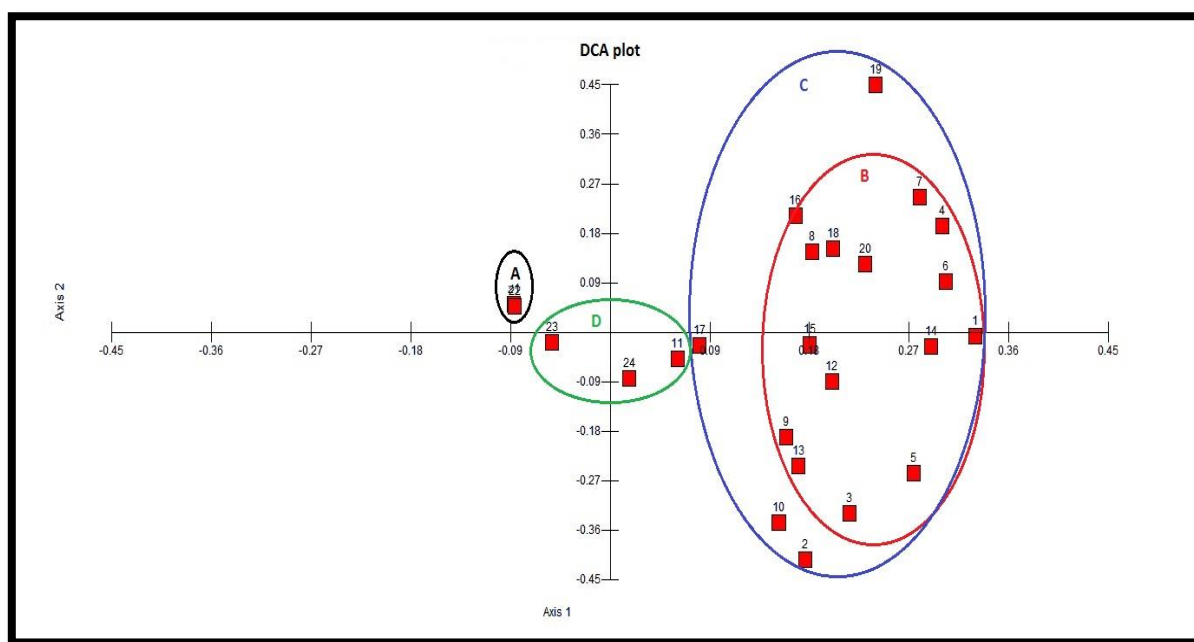


Fig. (5): DCA ordination diagram of the four vegetation groups; identified by TWINSpan classification

Table (4). Mean value and standard error of the different soil variables in the sampled stands representing the different vegetation groups obtained by TWINSpan classification of the different habitats in the study area.

Soil variable	Vegetation group			
	A	B	C	D
Sand %	74.42 ± 0.46	41.43 ± 2.45	33.97 ± 3.53	21.76 ± 1.11
Silt %	13.19 ± 0.03	37.33 ± 1.76	36.76 ± 1.9	42.22 ± 6.78
Clay %	12.39 ± 0.43	21.24 ± 1.38	28.74 ± 4.07	36.01 ± 7.56
Porosity %	31.7 ± 2.3	48.94 ± 2.61	52.55 ± 1.91	42.93 ± 6.29
Moisture content %	0.52 ± 2.3	35.09 ± 3.88	53.16 ± 7.1	39.32 ± 6.57
S.C. %	22.17 ± 0.76	55.96 ± 3.59	69.69 ± 4.82	51.93 ± 8.41
CaCO ₃ %	3.84 ± 1.5	31.25 ± 5.61	42.25 ± 5.23	27.23 ± 20.22
O.C. %	0.27 ± 0.09	1.6 ± 0.37	2.06 ± 0.29	1.26 ± 0.25
pH	7.84 ± 0.04	7.5 ± 0.17	7.57 ± 0.12	7.29 ± 0.08
E.C mmhos/cm	0.25 ± 0.08	24.32 ± 4.75	11.68 ± 1.46	3.31 ± 1.55
Cl ⁻ %	0.05 ± 0.00	4.01 ± 1.04	1.51 ± 0.23	0.41 ± 0.23
SO ₄ ²⁻ %	0.04 ± 0.004	2.19 ± 0.36	1.04 ± 0.16	0.26 ± 0.08
CO ₃ ²⁻ %	0.00 ± 0.00	0.005 ± 0.004	0.00 ± 0.00	0.00 ± 0.00
HCO ₃ ⁻ %	0.13 ± 0.01	0.12 ± 0.01	0.17 ± 0.03	0.1 ± 0.02
Na ⁺ meq/100g soil	1.84 ± 0.01	64.34 ± 12.2	34.74 ± 3.28	10.88 ± 4.58
K ⁺ meq/100g soil	0.3 ± 0.00	5.43 ± 1.03	2.93 ± 0.03	0.93 ± 0.37
Ca ²⁺ meq/100g soil	0.62 ± 0.004	20.1 ± 4.16	11.58 ± 1.07	3.64 ± 1.52
Mg ²⁺ meq/100g soil	0.45 ± 0.01	15.89 ± 3.13	9.12 ± 0.82	2.73 ± 1.14
TN (ppm)	51.72 ± 0.11	56.9 ± 3.21	64.39 ± 1.91	74.98 ± 2.75
TDP (ppm)	5.19 ± 0.02	11.24 ± 0.34	6.94 ± 0.72	8.3 ± 0.74
Zn ²⁺ (ppm)	0.37 ± 0.004	0.5 ± 0.05	0.68 ± 0.05	0.92 ± 0.09
Pb ²⁺ (ppm)	3.78 ± 0.04	4.37 ± 0.28	5.24 ± 0.33	6.87 ± 0.35
Ni ²⁺ (ppm)	1.5 ± 0.03	1.71 ± 0.12	2.01 ± 0.12	2.68 ± 0.16
Cd ²⁺ (ppm)	0.4 ± 0.004	0.55 ± 0.04	0.68 ± 0.05	0.06

The correlation between vegetation and soil characteristics was produced by Canonical Correspondence Analysis (CCA). It is clear that the sand, silt, saturation capacity, soil porosity, soil moisture, cadmium and magnesium were the most effective soil variables, which showed

highly significant correlations with the first and second axes of the CCA ordination diagram (Figure 6). On the right side of the CCA diagram, stand numbers 21 & 22 belonging to group A which is dominated by *Mesembryanthemum nodiflorum* in addition to

Mesembryanthemum forsskalii and *Senecio glaucus* which attained relatively high importance value in this group is obviously showed a close relationship with sand and pH. While in the upper left side, 3 stands (number 11, 23 & 24) belonging to group D which is dominated by *Limbarda crithmoides* in addition to *Cyperus articulatus* and *Atriplex prostrata* as important species and stand number 17 belonging to group C showed distinct relationships with silt, moisture, cadmium, zinc,

species in the same group as well as *Arthrocnemum macrostachyum* which is important species in group C showed close relationships with saturation capacity, soil porosity, calcium carbonates, magnesium, electrical conductivity, sulphates and organic carbon.

Discussion

The natural plant wealth in the two islands of the present study is composed of 25 species belonging to 22 genera and 12 families. Out of these families, Chenopodiaceae (7 species), Asteraceae (5 species), Poaceae, Cyperaceae and Aizoaceae (2 species each) are considered the major families.

This agrees with the findings of many authors e.g. [28] on the shoreline and aquatic vegetation of El-Salam Canal, Egypt, [29] on the aquatic macrophyte distribution in Lake Manzala, Egypt, [30] on the plant life in two Mediterranean Lakes; [31] on the vegetation-environment relationships along EL-Salam Canal, Egypt and [32] on ecophysiology and vegetation of terrestrial habitats in Lake Manzala, Egypt. The dominance of the perennials may be attributed to the nature of the habitat in the study area (salt-affected lands) in which saline soils have a salinity level of more than 4 dS/m. These results were accommodated with [33, 34, 35, 36], where they concluded that the growth and abundance of both annuals and biennials were constrained by reproductive ability, ecological, morphological and genetic plasticity. The life-forms of the plant genetic resources in the present study are grouped under therophytes, geophytes, helophytes, hemicryptophytes, chamaephytes, and nanophanerophytes. The bulk of the recorded species were therophytes (35.71 %), followed by chamaephytes (21.43 %), then geophytes

T.D.N, T.D.P, lead and nickel. The lower left side comprises stands (number 1: 10, 12: 16 & 18:20). *Arthrocnemum macrostachyum* and *Juncus rigidus* which are the dominant species in groups B& C, respectively, *Phragmites australis* which is the important species in the two groups, *Limbarda crithmoides* which is indicator species in these two groups, *Halocnemum strobilaceum* which is Important species in group B, *Tamarix nilotica*, and *Atriplex portulacoides* which are indicator and helophytes which attained a value of 14.29 % each, and nanophanerophytes (10.71 %). The lowest value of life forms was recorded as hemicryptophytes (3.57 %). These results were in agreement with [37, 38, 39, 40, 41, 42, 43]. From the floristic point of view, Egypt includes four phytogeographical regions: African Sudano- Zambesian, the Asiatic Irano-Turanian, the Afro-Asiatic Sahro- Sindian and the Euro-Afro-Asiatic Mediterranean [44]. The floristic analysis of the study area revealed that, 9 species (36 %) of the total recorded species are Pluriregional taxa, 6 species (24 %) are Cosmopolitan, 6 species (24 %) are Biregional taxa, 2 species (8 %) are Pantropical, one species (4 %) is Mediterranean and one species (4 %) is Neotropical. These agree with [30] who reported that the flora of Lake Manzala is mainly influenced by the Pluriregional chorotype, especially of Mediterranean combination.

[45] stressed upon the importance of description of vegetation to give a picture to an area with its vegetation, and to allow a comparison among different vegetation units. In the present study, the phytosociological analysis revealed that the vegetation structure is classified by TWINSpan into four groups. The vegetation groups identified in the present study are comparable / more or less to those recognized by [28] on the shoreline and aquatic vegetation of El-Salam Canal, Egypt, [29] on the aquatic macrophyte distribution in Lake Manzala, Egypt, [46] on the floristic diversity of the islands of Burullus Lake, [1] on the vegetation soil relationships in Lake Burullus protected area, [32] on ecophysiology and vegetation of terrestrial habitats in Lake Manzala, Egypt and [47] on the plant communities associated with genus *Atriplex* in Nile Delta coast, Egypt.

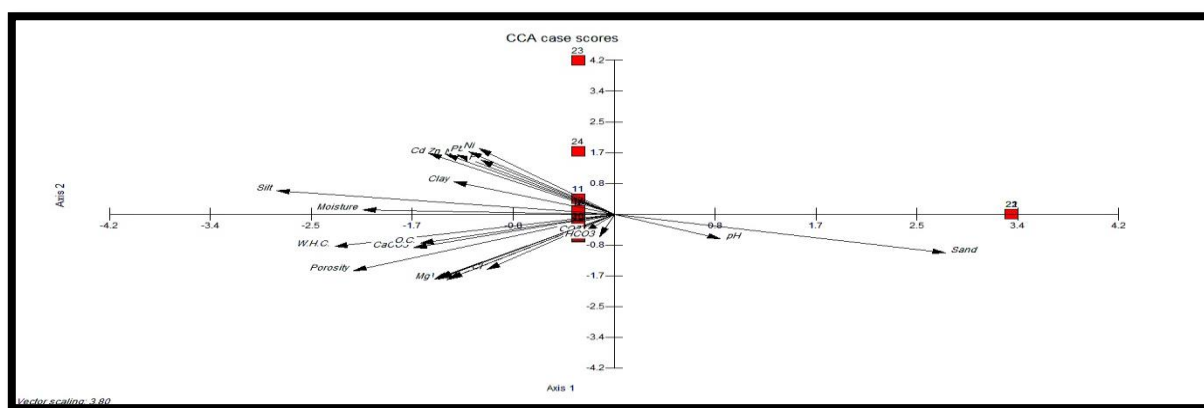


Fig. (6): CCA-ordination biplot of the sampled stands and soil variables in the study area.

The application of the Detrended Correspondence Analysis (DCA) indicated that the vegetation groups had a clear pattern of distinction along planes. Group A is separated on the left side of the DCA diagram. Group D is separated at the middle part of the DCA diagram. These two groups showed distinct separation from groups B and C which are superimposed; this may be attributed to the dissimilarity between the floristic structures of the sampled stands of these groups.

Plant communities are affected by several factors as farm management practices [48], crop type [49], season [50] and soil characteristics [51]. CCA showed that the most relevant soil variables correlated with the occurrence and distribution of the floristic elements in the vegetation of the Ebn-Salam and Tinnis Islands in Lake Manzala are: soil texture, saturation capacity, moisture content, calcium, magnesium, sulphates, soil salinity (EC), calcium carbonates, organic carbon, total nitrogen, and heavy metals. These results were more or less in accordance with the findings of [52, 53, 28, 46]. They recognized that the most important soil gradient related to the distribution of vegetation are soil salinity, moisture, soil fertility (organic carbon, phosphorus and nitrogen contents), soil texture, calcium carbonates, sulphate content. Out of all environmental factors, salinity appears to be one of the most important factors affecting the distribution of most plant communities in the swampy and salt marsh habitats. Some species are restricted to the more saline parts, while others occur more abundantly in fewer saline parts. The relationship between specific conductance (salinity) and plant distribution in the present study indicated that the relatively

high soil salinity values in the soils of groups B and C representing reed swamp and salt marsh habitats may be related to the evaporation processes of more saline water content. While the soil of groups A and D have low salt content.

Conclusion

The present study concluded that the salt marsh vegetation of Lake Manzala is threatened because of the rising drain water discharge that has altered the lake from saline to a relatively freshwater basin, with a significant increase in the nutrient levels. Water and soil salinity influence the distribution of most plant communities in Lake Manzala. The threat of genetic erosion in Lake Manzala as a result of desalination could lead to the extinction of many neglected and underutilized plant genetic resources. So, National Gene Banks in collaboration with other national partners have to be enhanced the conservation of the threatened and unique biodiversity of Lake Manzala in order to protect that biodiversity from extinction. Human economics' activities are associated with the sustainability of Lake Manzala's biodiversity.

Eventually, there is no one-factor act alone, while all environmental variables (factors) affect vegetation distribution, growth and the physiological mechanism that are able the living organisms to withstand the drastic conditions; salinity and drought

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