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COMPARATIVE STUDY ON THE PLANT LIFE OF TWO MEDITERRANEAN DELTAIC LAKES IN EGYPT

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ABSTRACT :

The terrestrial and aquatic flora of the two largest natural lakes of Egypt (Lake Manzala and Lake Burollos) were studied. Lake Manzala is located on the eastern side of Damietta branch of the Nile, whereas, Lake Burollos lies on the eastern side of Rosetta branch of the Nile, occupying the central position along the Mediterranean coast of the Nile delta .

Despite the two times larger area of Lake Manzala compared with Lake Burollos and physiographic similarity, Lake Burollos is floristically rich (135 species, 41 families) as compared with Lake Manzala (102 species, 36 families). Both lakes have many floristic differences. Lake Burollos is characterized with lower number of euhydrophytes (7 species) compared to 16 species recorded in Lake Manzala. The highest number of species are belonging to Gramineae and Chenopodiaceae, respectively in both lakes. The life form spectrum of both lakes showed that therophytes are highly represented followed by geophytes .

The islands in both lakes are floristically rich. However, islands of Lake Burollos seem to be suitable habitat for some plant species absent from the islands of Lake Manzala e.g. *Lycium schweinfurthii, Pancratium maritimum, Allium roseum, Silene succulenta, Asparagus stipularis* and *several annuals*, some plant species recorded in one site in Lake Burollos, are considered as rare species such as *Ipomoea imperati* and *Limonium narbonense* which are threatened and need protection .

In the present paper, the authors compared the floristic composition of the different habitats of both lakes.

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INTRODUCTION :

The Mediterranean coast of Egypt is characterized by 5 natural lakes, namely : Mariut (in the western section), Idku, Burollos and Manzala (in the middle deltaic section) and Bardawil (in the eastern section), Fig.1. The three delatic lakes receive the main bulk of the drainage water from the Nile Delta. They are connected with the Mediterranean Sea by outlets through strips of land fringing them. These outlets (straits) are either remarks of the mouths of old deltaic branches or marsh gaps in weak sections of the bars known as tidal inlets [1,2] . The area of these lakes are affected by several factors such as continuous degradation and deposition, the accumulation of the remains of vegetation, the blowing of sand and man-made desiccation e.g. closing of some irrigation canals and construction of levees. Accordingly,[3] reported that the areas of Lake Manzala and Lake Burollos decreased since 1799 to 1970 as follow : from 470.000 and 270.000 feddan (1799) to 300.000 and 130.000 feddan in 1970. Nowadays, these areas are greatly reduced due to land reclamation [4,5].

Due to the uncontrolled man's inter-erence, great environmental changes part-icularly in the water and soil characteristics of these lakes occurred. These are associated with variation in biotic composition of the lakes. The flora of Lake Manzala had been studied intensively two times: by Montasir [6] then after 50 years by Khedr [7]. However, Lake Burollos received little attention with respect to its vascular flora.

In this paper the authors are describing the similarities and differences in the floristic composition of the two lakes as being affected by the surrounding environmental factors of both lakes. It will help to view the facts necessary to protect the rare species in each lake which are under intensive pressure mainly due to human activities.

EXPERIMENTAL :

Methods :

Presence-absence data for vascular plant species were collected from more than 20 islands in each lake and from about 100 and 80 line transects along the shores (from north to south and from east to west) of Lake Manzala and Lake Burollos respectively. Notes were taken about the floristic composition and distribution pattern of plant species in the different habitats prevailing in the study area : islands inside the lakes, along the shores and also along the mouths of the canals and drains which discharge in each lake .

Species were classified in terms of life-forms [8]. Grouping the sum total of species into life forms was done to establish a biological spectrum of the vegetation of the study area. The number of species within each life form was expressed as a percentage of the total number of species in each lake .

plant species were regularly collected for identification. Analysis of phytogeographical affinities was carried out. Nomenclature and identification of the plant species followed [9-14].

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Plant species collection are kept in the Herbarium of the Department of Botany, Faculty of Science at Damietta, Mansoura University .

Fig. (1) : Map of the Nile Deta showing the sudied lakes .

Study area :

Lake Manzala :

Lake Manzala (31°-31° 30′ N and 31° 50′-32°20′E; Fig. 1) is the largest natural lake in Egypt, with an area of ca. 1200 km^2. It is bounded by the Mediterranean Sea to the north, the Suez Canal to the east, and the deltaic province to the south-west. The lake is very shallow (depth 0.4–1.5 m). It is connected with Mediterranean Sea by two straights and reaches the Suez Canal through a small canal. Along its south and west coasts, many inlets are found through which large amounts of water drains from the nearby provinces.

Lake Burollos :

Lake Burollos lies on the eastern side of Rosetta branch of the Nile, occupying a central position along the Mediterranean cost of the Nile delta. It extends between longitudes 30°,30′ and 31° 10′E and Latitudes 31°21′ and 31°35'N. It is considered the second largest natural lake in Egypt, with an area of about 452 km^2 in 1991 [5]. The lake is roughly rectangular in shape. Its shorelines show much irregularities particularly along the southern margin. Its maximum length reaches about 70 km and its width varies between 6 km across Dechimi island and 16 km across the lake-sea connection (Fig. 1). This lake is separated from the Mediterranean along its north margin by a narrow stretch of low land covered with sand. The width of this strip increases gradually towards the west direction. The lake is connected with the sea at its northeastern side through El-Burollos outlet, which is about 250 m long, 5 m wide and 5 m depth .

The climate :

The climatic averages of 15 years [15], at two meteorological stations (Damietta & Baltim) adjacent to Lake Manzala and Burollos respectively, were compared. The total annual rainfall was relatively high in Lake Burollos (175.2 mm/yr.) in comparison with Lake Manzala (102.3 mm/yr.). The rainy months are January, February and December. For the rest of the year there is virtually no rainfall. The humidity in the deltaic Mediter-ranean coast of Egypt is higher in winter than is summer months. The presence of numerous water bodies e.g. lakes, river Nile, Mediter-ranean sea as well as the thick transpiring vegetation playing an important role in increasing this climatic element [16]. The mean annual relative humidity, evaporation and maximum temperature were comp-aratively high in Lake Manzala (84.9%, 4.6 mm/day and 27.1°C respectively) than in Lake Burollos (96%, 3.7 mm/day, and 24°C respectively). Cloudy days are rare and occur in winter only.

RESULTS :

Floristic analysis :

In spite of plant life similarity in different sites on islands and along the shores of both lakes, the floristic composition and vegetation structure show major variation. 135 species belonging to 41 families were recorded in Lake Burollos compared with 102 species belong 1o 36 families in Lake Manzala. The most impressive feature of the data is the restriction

of 7 aquatic plants to Lake Manzala that are totally absent from Lake Burollos. These species (*Epilobium hirsutum, Myriophyllum spicatum, Nymphaea caerulea, Nymphaea lotus, Persicaria lapathifolia, Pistia stratiotes and Saccharum spontaneum*) are restricted to the western section of Lake Manzala. On the other , there are 26 species recorded in Lake Burollos, but totally absent in Lake Manzala (Table 1), out of these, 18 species are psammophytes and the remaining 8 species are halophytes.

Life-form :

The floristic relationship of the life form is demonstrated in Fig.2 . Therophytes are best represented in both lakes followed by geophytes. In comparison, Lake Manzala showed higher percentage of hydrophytes, geophytes hemicryptophytes and helophytes. On the other hand, Lake Burollos is represented by relatively high percentage of therophytes, phanerophytes, chamaephytes and parasites.

Phytogeography :

The phytogeographical grouping of the flora of the two lakes is given in Fig. 3. The flora is mostly Mediterranean, with relatively higher number in Lake Burollos (72 species) than, Lake Manzala (49 species). The plant species of Lake Manzala showed, relatively, higher representation of Cosmopolitan, Palaeotropical, Sudano-Zambezian and Neotropical elements in comparison with Lake Burollos.

DISCUSSION :

The flora of Egypt comprises 2094 native and naturalized species [18] which is very close figure to the 2080 species in [9,17]. El-Hadidi and Fayed (1995) estimated that the number of the weed species recorded in the Nile Delta ranges between 248-252 species including aquatics, swampy, revarian and weed flora. The flora of Lake Burollos and Lake Manzala includes 142 species which is about 7% of Egypt's flora. Floristically, the richest part of Egypt appears to be the area west Alexandria, comprising about 800 species, probably due to the regular winter rains followed by appearance of large number of annual plant species each year [18].

Mashaly [11] has suggested a general successional pattern for the evolution of vegetation types along the deltaic coast. This pattern suggested a general trend from saline to less saline and fertile non-cultivated land communities with modification in the sequence caused by topography and soil physio-chemical parameters.

The coastal Mediterranean deltaic these lakes are of characteristic features of the old branches of the Nile. The flora of these are interesting where some aquatic plants e.g. Najas armata is restricted to these lakes but absent else where in other water bodies in Egypt such as River Nile [19] or irrigation and drainage canals [20]. It is also interested in terms of reporting the recent invasion of species never been before in the lakes such as the exotic fern Azolla filiculoides and some submerged

macrophytes e.g. Myriophyllum spicatum which is recorded in Lake Manzala. The latter spices was totally absent in the Nile Delta in the last decade {2}

Table (1):Occurreance and life from spectrum of plant species restricted to Lake Manzala (LM) or Lake Burollus (LB) or common to both lakes. (+ or ++ or +++ indicate that the plant species is recorded in one or two or more than three sites in each or both of the two lakes respectively.

Life-forms:Ph=Phanerophytes, Ch=Chamaephytes, H=Hemicryp-tophytes, G=Geophytes, He= Helophytes, Hy=hydrophytes, P= Parasites, Th=therophytes.

Plant species	Life-Form	LM	LB	LM+LB
Epilobium hirsutum L.	G	++	-	-
Myriophyllum spicatum L.	Hy	+	-	-
Nymphaea caerulea Savigny	Hy	++	-	-
Nymphaea lotus L.	Hy	+	-	-
Persicaria lapathifolia (L) Gary	G	+	-	-
Pistia stratiotes L.	HY	+	-	-
Saccharum spontaneum L.	G	+++	-	-
Adonis dentata Delile.	Th	-	++	-
Alhagi graeccrum Boiss.	H	-	+++	-
Allium roseum L.	G	-	++	-
Asparagus stipularis Forssk.	G	-	++	-
Atriplex farinosa Forssk.	Ch	-	+++	-
Atriplex halimus L.	Ph	-	+++	-
Calligonum polygonoides L.	Ph	-	+	-
Cynomorium coccineum L	P	-	++	-
Cyperus capitatus Vand.	G	-	++	-
Cyperus conglomeratus Rottb.	G	-	++	-
Daucus syrticus Murb.	Th	-	++	-
Echinops spinosissimus Turra	H	-	++	-
Elymus farctus (Viv) Runemark ex Melderis	G	-	++	-
Emex spinosa (L) Campd.	Th	-	++	-
Heliotropium curassavicuml L.	Ch	-	+++	-
Ifloga spicata (Forssk) Sch. Bip.	Th	-	++	-
Ipomoea imperati (Vahl) Griseb	G	-	+	-
Limoniastrum monopetalum (L) Bioss.	Ch	-	+++	-
Limonium narbonense Mill.	H	-	+	-
Lolium temulentum L.	Th	-	++	-
Lotus halophilus Boiss. & Spruner	Th	-	+++	-
Lycium schweinfurthii Dammer	Ph	-	++	-
Medicago intertexta (L) Mill.	Th	-	++	-
Medicago polymorpha L.	Th	-	++	-
Pancratium maritimum L.	G	-	++	-
Paronychia arabica (L) Dc.	Th	-	++	-
Plantago squarrosa Muray.	Th	-	+++	-
Rumex pictus Forssk.	Th	-	++	-
Silene rubella L.	Th	-	++	-
Silene succulenta Forssk .	H	-	++	-
Sporobolus pungens (Schreb) Kunth	G	-	++	-

Stipagrostis lanata (Forssk) de Winter	G	-	+	-
Aeluropus lagopoides (L) Trin. ex Thwaites	G	-	-	+++
Alternanthera sessilis (L) DC.	He	-	-	+++
Arthrocnemum macrostachym (Moric) K.Kock	Ch	-	-	+++

Table (1). Cont.

Plant species	Life-Form	LM	LB	LM+LB
Aster squamatus (spreng) Hieron	Ch	-	-	+++
Atriplex portulacoides L.	Ch	-	-	+++
Avena fatua L.	Th	-	-	+++
Azolla filiculoides Lem.	Hy	-	-	+++
Bassia indica (Wight)A.J. Scoot	Th	-	-	+++
Beta vulgaris L.	Th	-	-	+++
Brassica nigra (L) Koch	Th	-	-	+++
Brassica tournefortii Gouan	Th	-	-	+++
Bromus diandrus Roth	Th	-	-	+++
Cakile maritima Scop	Th	-	-	+++
Capsella bursa-pastoris (L) Medik	Th	-	-	+++
Carex extensa Good	G	-	-	++
Centaurea calcitrapa L.	Th	-	-	++
Chenopodium ambrosiodes L.	Th	-	-	+++
Cichorium endivia L.	Th	-	-	+++
Cistanche phelypaea (L) P. Court	P	-	-	++
Conyza bonariensis (L) Cronquist	Th	-	-	+++
Corchorus olitorius L.	Th	-	-	++
Cressa cretica L.	H	-	-	++
Cutandia memphitica (Spreng) K. Richt	Th	-	-	+++
Cynanchum acutum L.	Ph	-	-	+++
Cynodon dactylon (L) Pers	G	-	-	+++
Cyperus articulatus L.	He	-	-	+++
Cyperus difformis L.	Th	-	-	++
Cyperus laevigatus L.	G	-	-	+++
Cyperus rotundus L.	G	-	-	+++
Dactyloctenium aegyptium (L) Willd	Th	-	-	+++
Echinochloa colona (L) Link	Th	-	-	+++
Echinochloa crusgalli (L) P.B. Beauv	Th	-	-	+++
Echinochloa stagnina (Retz) P. Beauv	He	-	-	+++
Eichhornia crassipes (C. Mart) Solms	Hy	-	-	+++
Eleusine indica (L) Gaertn	Th	-	-	++
Frankenia hirsuta L.	H	-	-	++
Frankenia Pulverulenta L.	Th	-	-	++
Halocnemum strobilaceum (Pell) M. Bieb	Ch	-	-	+++
Hordeum marinum Huds	Th	-	-	++
Imperata cylindrica (L) Raeuch	H	-	-	+++
Inula crithmoides L.	Ch	-	-	+++
Ipomoea carnea Jacq	Ch	-	-	++
Juncus acutus L.	He	-	-	+++
Juncus bufonius L.	Th	-	-	+++
Juncus rigidus Desf	G	-	-	+++
Juncus subulatus Forssk	G	-	-	+++
Lamium amplexicaule L.	Th	-	-	++

Leersia hexanda Sw	He	-	-	+++
Lemna gibba L.	Hy	-	-	+++
Leptochola fusca (L) Kunth	G	-	-	++

Table (1). Cont.

Plant species	Life-Form	LM	LB	LM+LB
Limonium pruinosum (L) Chaz	H	-	-	+++
Lobularia arabica (Boiss) Muschl	Th	-	-	++
Lolium rigidum Gaudin	Th	-	-	++
Ludwigia stolonifera (Guill.& Perr) P.H.Raven	He	-	-	+++
Malva parviflora L.	Th	-	-	+++
Melilotus indicus (L) All	Th	-	-	+++
Mesembryanthemum crystallinum L.	Th	-	-	+++
Mesembryanthemum nodiflorum L.	Th	-	-	+++
Najas marina H. Lindb	Hy	-	-	+++
Orobanche cernnua Loefl	P	-	-	+
Panicum repens L.	G	-	-	+++
Parapholis incurva (L) C.E. Hubb	Th	-	-	+++
Paspalidium geminatum (Forssk) Stapf	He	-	-	+++
Perscaria saticifolia (Willd) Assenov	G	-	-	++
Phalaris minor Retz	Th	-	-	+++
Phoenix dactylifera L.	Ph	-	-	+++
Phragmites australis (Cav) Trin. exsteud	He	-	-	+++
Plantago crassifolia Forssk	H	-	-	+
Pluchea dioscoridis (L) DC	Ph	-	-	+++
Poa annu L.	Th	-	-	++
Polygonum equisetiforme Sm	G	-	-	+++
Polypogon monspeliensis (L) Desf	Th	-	-	+++
Portulaca oleracea L.	Th	-	-	+++
Potamogeton crispus L.	Hy	-	-	++
Potamogeton pectinatus L.	Hy	-	-	+++
Ranunculus scleratus L.	Th	-	-	+++
Rorippa palustris (L) Besser	Th	-	-	+++
Rumex dentatus L.	Th	-	-	+++
Ruppia maritima L.	Hy	-	-	++
Salsola kali L.	Th	-	-	++
Schismus barbatus (L) Thell	Th	-	-	++
Scirpus litoralis Schrad.	G	-	-	+++
Scirpus maritimus L.	G	-	-	+++
Senecio glaucus L.	Th	-	-	+++
Senecio vulgaris L.	Th	-	-	+++
Setaria verticillata (L) P.Beauv	Th	-	-	++
Solanum nigrum L.	Th	-	-	+++
Sonchus oleraceus L.	Th	-	-	+++
Spergularia marina (L) Griseb	Th	-	-	+++
Sphenopus divaricatus (Gouan) Rchb	Th	-	-	+++
Suaeda maritima (L) Dumort	Th	-	-	+++
Suaeda vera Forssk ex. J. F. Gmel	Ch	-	-	+++
Tamarix nilotica (Ehrenb) Bunge	Ph	-	-	+++
Typha domingensis (pers) Poir. ex Steud	He	-	-	+++
Urospermum picroides (L) F. W. Schmidt	Th	-	-	+++

Urtica urens L.	Th	-	-	++
Zygophyllum aegyptium Hosny	Ch	-	-	+++

Fig.(2) : Life forms of Lake Burollos and Lake Manzata flora, in percentage of total of species .

Fig.(3) : Pytogeographical grouping of the flora of Lake Burollos and Lake Manzala. COSM=Cosmopoltian, PAN=Palaeotropical, ME=Mediterranean, ER-SR=Euro-Siberian, SA-SI=Saharo Sindian, IR-TR =Irano-Turanian, S-Z=Sudano-Zambezian .

other submerged macrophytes e.g. *Myriophyllum spicatum* which is recorded in Lake Manzala. The latter species was totally absent in the Nile Delta in the last decade[2].

Montasir [6] found 27 species of the common halophytes in Lake Manzala. This number has been reduced to 22 [7]. Some of the halophytic species which were reported by Montasir [6], such as *Lemoniastrum monopetalum, Halopeplis perfoliata, Atriplex farinosa, Suaeda vermiculata* and *Limonium raddianum* are absent nowadays [22, 23]. The floristic list of Lake Burollos [24] includes some of the extinct species in Lake Manzala.

The local variation in topography and their impact on soil depth created within community heterogeneity, appearing as microsites, probably increasing species richness. The phytogeographical distribution of the majority of plant species in both lakes indicates that the intrusion of plant species with non-Mediterranean distribution is not the main reason for the high species richness.

The life form of a species refers to the vegetative form of the plant and its assumed to be a result of morphological adjustment to the environment [25,26]. Analysis of the two deltaic lakes demonstrated higher percentages of life forms resistant to water stress: annuals (48.09-44.12%) and geophytes (18.32-18.63%) in Lake Burollos and Lake Manzala, respectively. Each of the above life forms has its own unique adaptation to Mediterranean climate. The development of an annual flora in the study area may be related to the predicted seasonal rainfall [18,27]. However, in cultivated crops, the predominance of annuals (>70%) in the weed communities in the Nile Delta is mainly related to the niche coincidence of both weeds and host crops [28]. The relatively high percentage of geophytes in both lakes is the scale of geophytes percentages in hot deserts and in arid shrublands, recorded as 9-18% by Werger [29]. The main advantage of being annual or geophyte is to have high degree of plasticity in growth rate, size and phenology and to be completely absent in years of extreme climate.

Lake Burollos has low percentage of hydrophytes (5.34%), compared with Lake Manzala (9.80%). It is suggested that this life form is more sensitive to saline water and turbidity. These factors are relatively high in Lake Burollos than Lake Manzala.

The existence of some rare species along Lake Burollos shores indicates that during the observation period the shores were relatively undisturbed. However, the recent development in the area may result in decreasing population or even disappearance of rare species.

Concluding remarks :

Comparison of the flora of Lake Burollos and Lake Manzala habitats leads to the following conclusions :

1- There are differences in the composition of aquatic flora between both lakes with higher proportion in Lake Manzala as compared to

Lake Burollos which was related to eutrophication [30].

2- Flora of Lake Burollos comprises higher proportion of psammophytes and theroph-ytes. This may be attributed to the high sand formation and the relatively increase in rainfall (175.2 mm/yr.) when compared with that of Lake Manzala (102.3 mm/yr.)
3- Evidence of the disappearance of some salt marsh communities in Lake Manzala during the period of 1937-1989.
4- Evidence of the invasion of exotic species and species which are not common to the northern lakes or even in the Nile Delta.
5- The flora of the deltaic lakes needs to be updated to document the recent changes due to invasion or extinction of some species, particularly, those having localized dist-ribution.

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دراسة مقارنة على حياة النبات فى اثنين من بحيرات الدلتا ـ مصر المطلة على ساحل البحر الأبيض المتوسط

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لقد تم فى هذا البحث دراسة الفلورا الأرضية والمائية لكل من بحيرة المنزلة وبحيرة البرولس واللتان تطل على ساحل البحر الأبيض المتوسط حيث تقع بحيرة المنزلة على الجانب الشرقى لفرع دمياط من نهر النيل ، بينما تقع بحيرة البرولس على الجانب الشرقى لفرع رشيد من نهر النيل .

ولقد وجد أن بحيرة البرولس غنية بالنباتات (١٣٥ نوع ، ٤١ عائلة نباتية) بالمقارنة لبحيرة المنزلة (١٠٢ نوع ، ٣٦ عائلة نباتية) كذلك تتميز بحيرة البرولس بوجود عدد قليل من النباتات المائية الحقيقية (٧ أنواع) أما بحيرة المنزلة فيوجد بها عدد أكبر (١٦ نوعاً) وغالبية هذه النباتات المائية تنتسب إلى العائلة النجيلية والعائلة الكينوبودية . هذا وتمثل الجزر فى كل من هاتين البحيرتين مناطق غنية بالنباتات ، ولكن مع تباين فى الأنواع يتباين الجزر والبحيرة . من أمثلة هذه النباتات والتى توجد فى بحيرة البرولس هى : ***Lycium schweinfurthii, Pancratium maritimum,*** ***Allium roseum, Silene succulenta, Asparagus stipularis*** **and** ***several annuals*** وبعض الحوليات ومنها ما هو نادر مثل : ***Ipomoea imperati*** **and** ***Limonium narbonense*** وهذه النباتات مهددة بالإنقراض لذلك وجبت المحافظة عليها .

وإنتهت الدراسة إلى عمل مقارنة بين فلورا كل من البحيرتين لأن كل منهما يمثل نظاماً بيئياً معيناً .