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Environmental assessment and monitoring of lake Burullus, Egypt with special reference to sediment and water quality

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ABSTRACT. Some characteristics of Lake Burullus, North Egypt, were monitored over a period of one year. Data from sediment core analysis showed that, pesticides were detected in the surface of the lake. The maximum concentration of Zn (6.2 ppm) and Cu (1.0 ppm) in sediment were recorded at 6.0 cm and 26.5 cm sediment depth, respectively. The highest concentration Pb (7.5 ppm) was found at 0.5 cm depth. Levels of nutrients measured were all significantly higher than those found in previous years. The major species of aquatic macrophytes were observed in the lake, two species of emergent aquatic plants (*Typha australis* Schum & Thomn and *Eleocharis olivacea* Torr.), and three species of submerged aquatic plants (*Potomogeton pectinatus* L., *Ceratophyllum demersum* L. and *Najas armata* Lindb.F.). Seasonal differences in the quantitative and qualitative composition of the phytoplankton communities in lake Burullus were marked. The maximum crop density was recorded in spring, whereas lowest values occurred in winter. The total crop densities were mainly a reflection of the trends in counts of *Chlorophyceae*. Six algal groups were recorded during the investigation: *Bacillariophyceae, Chlorophyceae, Cyanophyceae, Chrysophyta, Euglenophyceae* and *Dinophyceae*. Fifty-eight species were identified. *Crucigenia, Monoraphidium, Scenedesmus, Cyclotella,* and *Rhadominas* were found to be the dominant genera. Generally, the species data suggests that the water of lake Burullus can he considered as eutrophic. Generally, chemical contamination and eutrophication is increasing in Lake Burullus.

Key words: Burullus Lake; Phytoplankton; Water chemistry.

Introduction

Water chemistry exhibit variable physical and chemical characteristics and consequently variable planktonic compositions. These variations depend mainly on the type and nature of the water area itself as well as on the manmade additions or runoff of minerals and chemicals from agriculture soils (Ahmed *et al.*, 1986).

Wetland lakes and marshes are sensitive to disturbance yet they often support high value ecosystems, not only in terms of biological diversity and productivity but also because of direct and indirect economic benefits (Flower, 2001). Lake Burullus is one of the principal lakes in the coastal zone of the Nile Delta. It is notable because it is subjected to huge inputs of terrigenous material and anthropogenic nutrients from drains discharge, sewage and agricultural runoff as well as reclamation programs. These conditions make the lake biologically productive (Kobhia, 1982; Osfor *et al.*, 1998; Fathi *et al.*, 2001; Aly & Yahya, 2002), however several years ago, Lake Burullus was classified among oligotrophic lakes (Fathi *et al.*, 2001; Aly & Yahya, 2002). Due to high inputs of nutrient-rich effluents at its eastern section, the lake has become hypertrophic (Fathi *et al.*, 2001). The later condition is marked by extensive growths of the macrophyte *Phragmites communis* (L.) Tin and *Typha australis* Schumt and Thoron as well as decreased water quality.

Many studies were conducted on the hydrography, chemical and biological characteristics of North Egyptian Lakes (Badawy *et al.*, 1995; El-Naggar *et al.*, 1997; 1998; Osfor *et al.*, 1998; Fathi *et al.*, 2001; Abhassy *et al.*, 2003; Aly & Yahya, 2002; Fathi & Abdelzhaer, 2003). The study aims to follow variations in physico-chemical characteristics, phytoplankton and macrophyre, and to determine the sort of pollutants such as heavy metals that are affecting the Burullus Lake.

Site Description

Lake Burullus is one of the largest Nile Delta brackish water lakes . It occupies more or less the central position of northern Delta along the Mediterranean coast of Egypt between longitudes 30^0 30 and $31^0$10 E and latitudes $31^0$21 and $31^0$35 N (Figure1). The water depth in the lake is subjected to strong fluctuation variations from day to day, so that the depth varies annually from 50 to 160 cm. Generally the depth increases from east to west and from south to north. In the northeast, the lake is permanently connected to the Mediterranean Sea by an opening (El Boughaz) 50-60m width. The lake receives its water from two main sources the drains and lake-sea connection. Drain water is discharged through seven drains and Brembal canal, which connects the lake to Rosetta estuary. The in flow of seawater and the drainage water play a predominant role in the hydrographic and chemical conditions of the lake. The salinity of the lake water varies markedly according to different localities and seasons. It is, in general higher in the area of the Lake-sea connection and lower in area near the drains. The macroflora is represented by aerial, floating and submerged plants. The hydrophyte *Potamogeton* sp. represents about 90% to 95% by weight of submerged plants. They grow forming a plant belt along the southern shores. Lake Burullus was designated as a Protected Area in 1998.

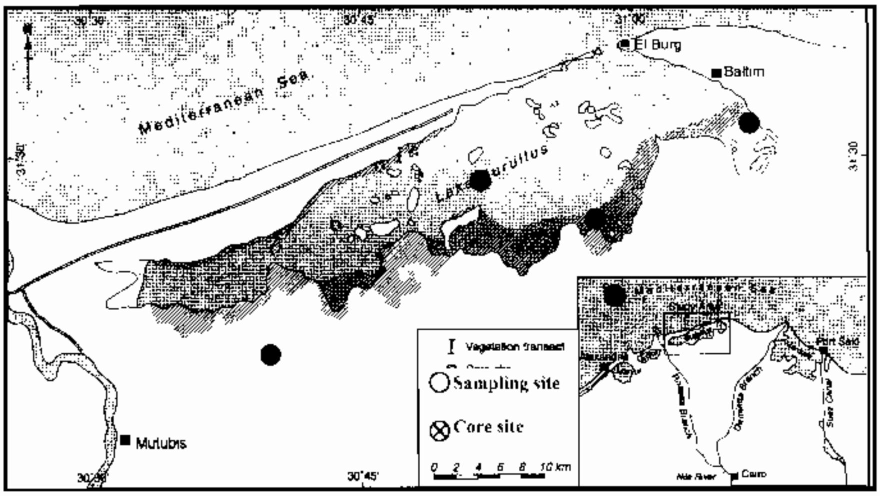


Fig. (1). Map of the study area and sampling sites.

Table (1). Some hydrographical characteristics of Lake Burullus (Fathi and Abdelzaher, 2000).

Location	North of the Nile Delta. Longitudes 30° 30 and 31°10 E and latitude 31° 30 N.
Area (Km^2)	570
Long Km	56
Wide Km	10
Average depth of water (m)	0.5 to 1.60
Depth (m)	1.5
Main Drains	- Nasser Drain. - Burulins Drain. - Drain 7,8,9 and 11.
In flow drain (m^3/ year)	3800 x 10^6
Connection with Mediterrian Sea	- Burullus Strait.
Evaporation (m)	741 x 10^6
Number of islands	73
Water budget (m^3)	256.3 x 10^6
Sediment types	***Complex type, sand -silt-clay with calcareous shells.***

Materials and Methods

Sediment studies

One sediment core was retrieved from the lake (Figure 1) using a technique of Berglund *et al.* (1986). The core was sectioned as 2 cm interval and each 2 cm section sample was placed in a Whirlpak bag for temporary storage in a cold room at 4°C. Heavy metals and pesticides were analyzed after sediment dissolution.

Sampling

Regular visits were made monitor the lake over a period of one-year (January, April, July and October 2003). Subsurface water samples were taken from the lake on each visit from 5 sites within the lake (Figure 1). Two-liter samples for water chemistry analyses were collected. One liter was used for measurements of pH, conductivity and alkalinity measurements and the other was filtered through a Whatman GF/C filter and was used for analysis of major ions. After tightly capping, samples were returned to laboratory and kept in the dark at 4 °C until further analysis.

Physical & Chemical characteristics

Temperature and pH of the lake water were measured in the field by Hg thermometer graduated to 0.1 °C and digital pH-meter (Lutron, pH 204), respectively. The secchi disc depth was also measured. Conductivity was measured using a calibrated Conductivity meter. Dissolved oxygen was measured according to the Winkler method (Strickland & Parsons, 1972). Total alkalinity was measured according to Methods for the examination of waters and associated materials (1981). Phosphate-P, nitrate-N, chloride, silicate and major cations were measured in the lake water according to Adams (1991). Sodium and potassium concentrations in water samples were determined photometrically by flame emission according to Golterman & Clymo (1971). Trace metals analyses were performed by atomic absorption spectrophotometer according to Adams (1991). The results are calculated as mean values of triplicate measurements at each of the five sampling stations.

Macrophyte

Some plants could not be identified in the field using standard floras thus samples were collected and preserved for future identification. The Egyptian flora was identified according to the following references, Tackholm (1974) and Loutfy & El-Hadidi (1984).

Quantitative and qualitative analysis of phytoplankton:

For phytoplankton analysis, 1.5 Liter water samples were fixed in the filed with acid Lugol's solution (1 ml l^{-1} sample). Samples were then allowed to settle for at least 36 hours, where after the supernatant was siphoned off and the remaining volume was adjusted to 100 ml. This 100 ml sample was kept at 4 °C until analysis. Phytoplankton counts were done using a Wild inverted microscope following the Utermöhl technique (Utermöhl, 1936). For counting, the simplified methods described by Willen (1976) and Hobro and Willen (1977) were followed. The counts of phytoplanktonic algae (unicellular, colonial or filamentous) were expressed as cells per ml. The algal taxa were identified according to standard references, including Smith (1950), Fott (1972), Bourelly (1981) and Prescott (1987). The appropriate statistic in Brillouin's index (Pielou, 1966) was used for quantitative analysis of species diversity of the phytoplankton.

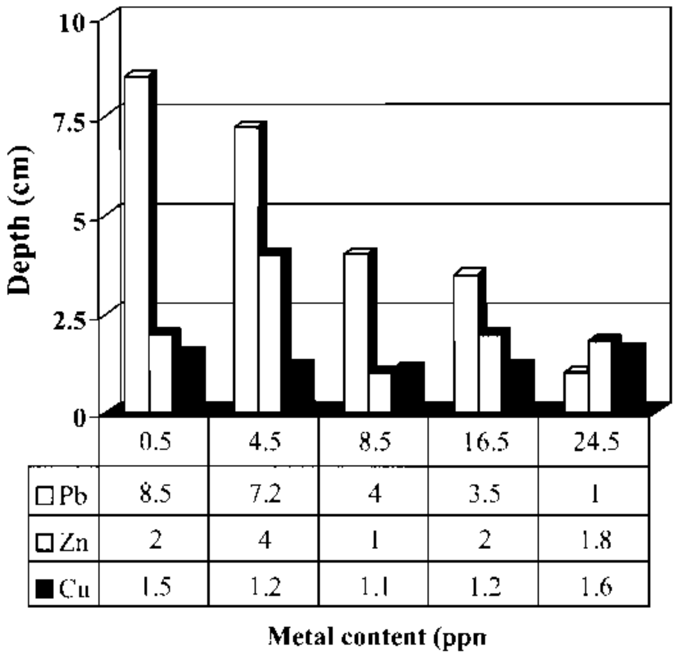
Results and Discussion

The biotic variables used to describe different freshwater areas are often related to environmental factors such as climate, chemistry and pollution. A consideration of these factors lead to a better understanding of the biology of aquatic habitats. The present study was carried out in Lake Burullus, this lake is shallow body water with depth ranging between 50 and 160 cm, and an average depth of about 1m.

Sediment core

The results of heavy metals stratigraphy from Burullus Lake are shown in Figure 2. The data revealed that the maximum content of Zn (6.2 ppm) and Cu (1.0 ppm) in sediment were recorded at 6.0 cm and 26.5 cm depth, respectively. Noteworthy is that the highest value of Pb was 7.5 ppm at 0.5 cm depth. Establishment of metal levels in sediments can play an important role in detecting sources of pollution in aquatic systems (El-Sammak & El-Sabrouti, 1995; Peters *et al.*, 2001). Accordingly, the highest value of Pb in the sediment at 0.5 cm depth is a clear indicator of recent lake pollution by this sediment. Shakweer *et al.*, (1993) reported that Cu and Zn concentration in the fish flesh were found to be lower than the levels allowable for the human consumption, while those of Pb were higher than the tolerable concentration for man. This pollution was thought to be associated with the input from different drains.

The gamma isomer of HCH (Hexachlorocyclohexane) and the primary DDT (Dichlorodiphenyltrichloroethane) metabolite, *pp*-DDE, were found in Burullus Lake sediment. Concentrations of both pesticides tended to exhibit surface or near surface maxima (Figure 3). El-Gendy *et al.*, (1991) report concentrations of 120 and 62 ng g^{-1} of g-HCH and *pp*-DDE, respectively, in sediment from Rosetta on the Rosetta branch of river Nile near to its discharge into the Mediterranean Sea. They also report that pp-DDT was detected at 76, suggestive of relatively recent usage of DDT. This is in accordance with results obtained by some other authors (Abou-Arab *et al.*, 1995; Peters *et al.*, 2001).



	0.5	4.5	8.5	16.5	24.5
□Pb	8.5	7.2	4	3.5	1
□Zn	2	4	1	2	1.8
■Cu	1.5	1.2	1.1	1.2	1.6

Fig. (2). Heavy metals stratigraphy from Brullus Lake.

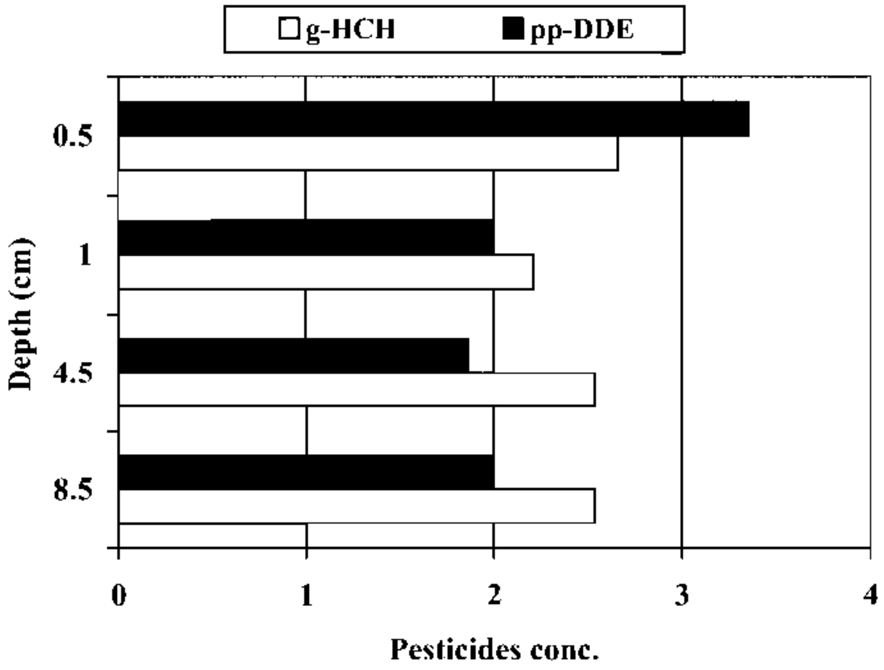


Fig. (3). Pesticides concentrations (ng.g^{-1} dry weight) in Burullus Lake surface sediment.

Physical & Chemical characteristics

It is well known that, the physical & chemical characteristics controlling life in aquatic habitats, either saline or brackish water, lead to the appearance of special types of biota (Fathi & El-Shahed 1998; Fathi & Kobbia, 2000; Fathi *et al.*, 2001). The physical- and chemicals characteristics of Brullus Lake water are shown in Figure (4) and Tables (2 & 3).

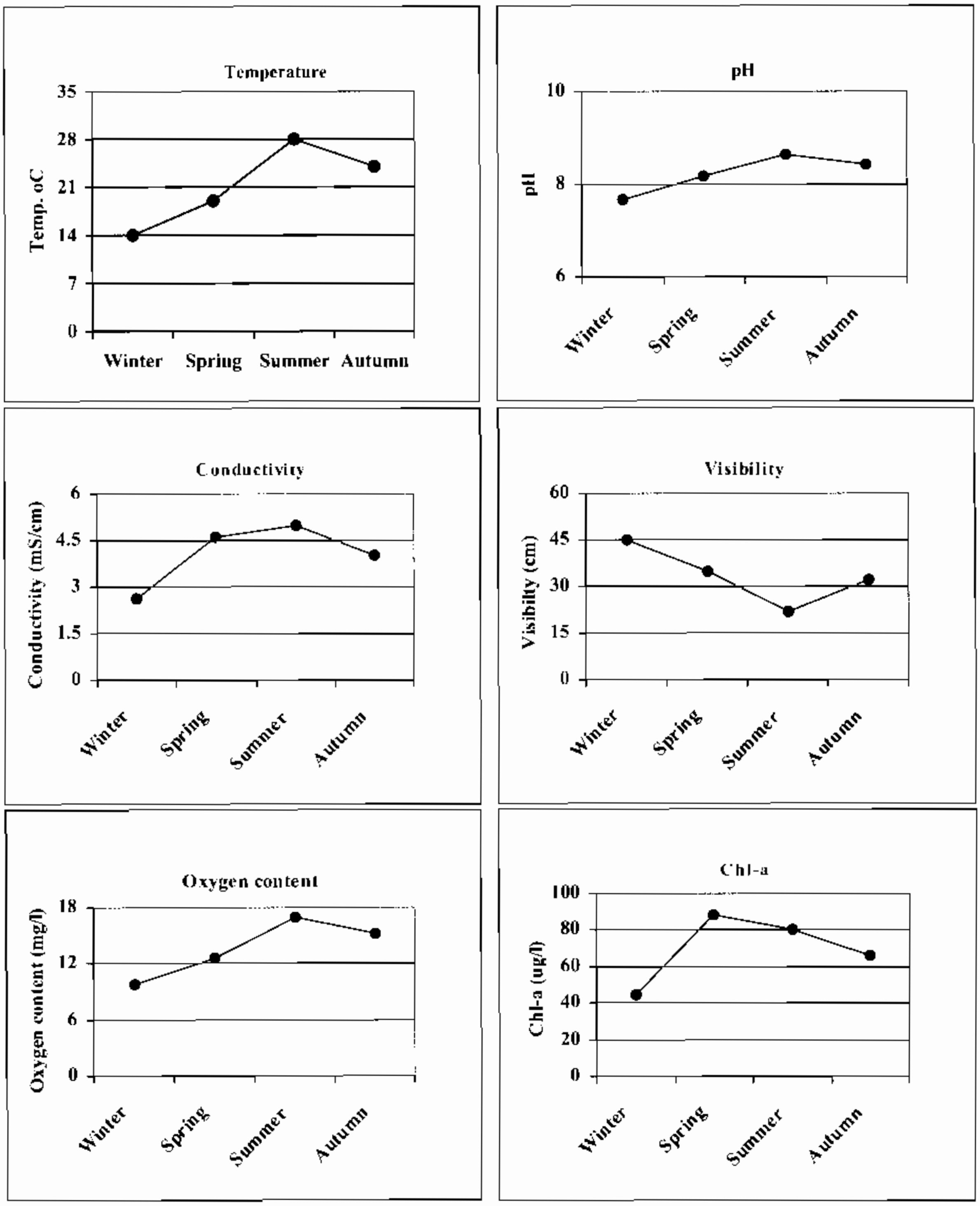


Fig. (4). Seasonal variations of temperature, pH, conductivity, visibility, oxygen content and Chl-*a* content in Burullus Lake during 2003.

Table (2). Chemical composition of the Brullus Lake water during the year 2003.

Parameters		Winter	Spring	Summer	Autumn
Total alkalinity	**mg/l**	260 ± 1.20	180 ± 0.20	120 ± 0.20	200 ± 1.00
Sodium	**mg/l**	1400 ± 0.00	820 ± 0.00	600 ± 0.00	1100 ± 0.00
Potassium	**mg/l**	20.00 ± 0.00	30.00 ± 0.00	30.00 ± 0.00	31.00 ± 0.00
Magnesium	**mg/l**	7.22 ± 0.10	44 ± 0.20.	15.81 ± 0.15	16.00 ± 0.20
Calcium	**mg/l**	60.05 ± 0.30	55.5 ± 0.20	54.00 ± 0.20	52 ± 0.20
Chloride	**mg/l**	1012 ± 1.00	700 ± 0.00	720 ± 1.20	906 ± 0..5
Nitrate-N	**μg/l**	1025 ± 1.00	880 ± 0.50	167 ± 0.20	550 ± 0.15
Phospahate-P	**μg/l**	440 ± 0.50	220 ± 0.15	110 ± 0.10	352 ± 0.20
Silicate	**mg/l**	3.85 ± 0.12	3.33 ± 0.20	3.00 ± 0.30	3.62 ± 0.15
COD	**mg/l**	25.00 ± 0.00	22.5 ± 0.10	28.0 ± 0.25	20.00 ± 0.12

Table (3). Trace metal compositions of Burullus lake water during the year 2003.

Metals	**Copper**	**Iron**	**Lead**	**Manganese**	**Zinc**
	$\mu g l^{-1}$	$\mu g l^{-1}$	$\mu g l^{-1}$	$\mu g l^{-1}$	$\mu g l^{-1}$
Winter	-	160	260	50	-
Spring	-	120	100	50	-
Summer	-	160	100	55	-
Autumn	-	160	150	50	-

The average water temperature of Lake Burullus was subjected to seasonal variations. The temperature of water reached its minimum in winter (14 °C) while the maximum (28 °C) was recorded in summer sample. The water temperature of Burullus Lake generally followed that of the air, due to the shallow depth and large expanse of surface as compared with the volume (Ruttner, 1963). In the present investigation the lake did not show proper thermal stratification, as it is extremely shallow (maximum depth 1.5 m). Allott (1986) reported that thermal stratification is weak in the shallowest lakes. Generally, it can be said that any increase or decrease in standing crop of phytoplankton at Burullus Lake seemed to be strongly correlated with fluctuation in water temperature. (Mohammed & Fathi, 1990; Fathi & Kobbia, 2000; Fathi *et al.*, 2001).

Change in pH value was always in the alkaline side. It fluctuated between 7.66 in winter and 8.62 in summer. Generally, this general tendency to the alkaline side may be due to the increased photosynthetic activity of planktonic algae, which was also previously recorded (El-Wakeel & Wahby, 1970; Kobbia *et al.*. 1995; Fathi & Kobbia, 2000, Fathi *et al.*, 2001). The lowest pH and alkalinity values recorded in Burullus Lake may be due to greater amount of inflowing agriculture water and also to the decomposition of plankton and organic matter (Badawy *et al.*, 1995; El-Naggar *et al.*, 1997; El-Naggar *et al.*, 1998; Fathi & Abdelzahar, 2003).

The conductivity of water was higher in summer (5.0 mS/cm) but dropped to a minimum level through spring and winter (2.62 mS/cm). The highest value of its electrical conductivity could be attributed mainly to the high pollutional levels in water, resulted from the high nutrient loads of wastewater (Kobbia 1982; Kobhia *et al.*, 1995, Fathi *et al.*, 2001). On the other hand Fathi *et al.*, (2001) and Flower *et al.*, (2001) reported that the fluctuations of salinity of North Egyptian Lakes from time to time, could be explained by the differences of the input amount of drainage water.

The visibility of water appeared to be not variable allover the study period, however in winter reached 45 cm. Generally, the visibility of the lake increased in winter and decreased in other seasons. The relatively low sighting depth may be due to the nature of the bottom sediments and high turbidity of lake water. Kobbia (1982) and Kobbia *et al.,* (1992) reported that low visibility could be attributed to vigorous phytoplankton growth rather than allochthonous factors.

Dissolved oxygen is an important parameter for identification of different water masses. The oxygen content of the investigated lake water tended to be higher in summer (17.0 mgl^{-1}) and lower in winter (9.86 mgl^{-1}). The relatively high concentrations of dissolved oxygen recorded in this study (summer) could be mainly attributed to light intensity rather than photosynthetic activity of phytoplankton.(Mohammed & Fathi 1990; Kobbia *et al.,* 1992). due to the increased photosynthetic activity of phytoplankton populations. In this respect, Talling (1976) noticed that oxygen super saturation due to photosynthetic activity is often encountered in regions with abundant phytoplankton. On the other hand Chlorophyll content in spring exceeded that recorded in other samples (Figure 4), which could be attributed to vigorous phytoplankton growth (Fathi & Kobbia, 2000; Fathi & Abdelzahar, 2003).

Total alkalinity of Burullus Lake water reached its minimum in summer (120 mgl^{-1}), whereas the maximum was recorded in winter (260 mgl^{-1}), this increase may be due to the bacterial decomposition of organic substrates (Abdel-Satar, 1998; Abdel-Satar & Elewa, 2001).

Monovalent and divalent cations play very important role in the productivity of inland water. Calcium and magnesium are reported to be of importance for phytoplankton production (Hussein 1989). In the present study the values of divalent (calcium and magnesium) and monovalent cations (sodium and potassium) were relatively high at all samples, irrespective of some minor fluctuations in seasonally readings. Levels of calcium and magnesium were found to fluctuate within the ranges of (52 - 60 mgl^{-1}) and (7.0 – 44 mgl^{-1}), respectively. On the other hand the concentrations of sodium were found to be higher throughout the study period, which exceeded those of calcium , magnesium and potassium in the lake water. It fluctuated from 1400 mgl^{-1} (in winter) to 600 mgl^{-1}(in summer). Generally, Burullus Lake water showed rather higher values of sodium content. Despite its major role in algal growth and photosynthesis, there are only a few instances of either magnesium deficiency or toxicity in lakes (Goldman, 1960). Magnesium is usually present in aquatic system in large amounts relative to plant needs. Both sodium and potassium play important role in the productivity of water (Cole, 1983 and Goldman & Horne, 1983). Talling & Talling (1965) suggested that the amounts of sodium, calcium, and chloride determine the species present rather than quantitative development of phytoplankton.

Chloride attained their maximum in winter (1012 mgl^{-}), and dropped to their minimum in spring (700 mgl^{-1}). The high concentrations of chloride recorded in this study (summer) could be mainly attributed to drain water discharge or to high summer temperature which accelerates evaporations. It seemed probable that ions play significant role in biomass and standing crop. Kobbia *et al.,* (1992), stated that chlorides appear to limit algal production directly in nature, but in the form of NaCl.

The maximum value of nitrate was found in winter (1025 mgl^{-1}) and the minimum value in summer (167 mgl^{-1}). The highest values of nitrate-N reflect the direct effect of the agriculture runoff, while the lowest values of nitrate-N are indicative of phytoplankton uptake (Gharib & Soliman 1998). On the other hand, phosphate and total phosphorous content tended to be high in summer and autumn, but lower in the other seasons. The recorded high phosphate values are probably due to the release of great amounts of adsorbed phosphate from the bottom sediments or to drainage water (Gharib & Soliman, 1998; Aly & Yahya, 2002; Fathi & Abdelzhaer, 2003). On the other hand the lowest values of phosphate concentrations could be attributed to the vigorous uptake by the heavy blooms of phytoplankton (Mohammed & Fathi, 1990; Fathi & Kobbia, 2000).

Silicate levels fluctuated between the seasons without any regular trend. The observed fluctuations in silicate concentrations were probably related to variation in silicate uptake by diatom (Stefansson, 1968) as well as to the input of drainage water to the lake. Such assumptions are consistent with the results obtained by Kobbia *et al.*, (1990) and Kobbia *et al.*, (1992).

The chemical oxygen demand was taken in the present study as a measure of the oxygenated state and additionally the amount of organic matter in water as well. The data of this study show that COD tended to be higher in summer (28 mgl^{-1}) and lowered in other seasons. The increase in COD could be attributed to the high organic matter content that produces about poor oxygenated state of water (Fathi & Zaki, 1999;; Fathi & Kobbia, 2000; Aly & Yahya, 2002; Fathi & Abdelzahar, 2003).

Concerning trace metals (Table 3), the most pronounced feature is the highest concentration of lead in Burullus Lake water (260 μgl^{-1}) in comparison to other metals. By comparing the data of this investigation and the metals content in fresh water in the absence of pollution (Bowen, 1979) it is obvious that lead represented the only metal that is considered to be more than the normal concentration in the fresh water. However the other elements are in the same range. Recently, Aly & Yahya (2002) reported that the heavy metals concentrations in Lake Burullus were low, except those for Cu, Zn, Al, Fe, Mn and Pb.

Macrophytes

Table (4) represents the major species of aquatic macrophytes observed in Lake Burullus during the investigation period, two species of emergent aquatic plants (*Typha australis* Schum & Thomn and *Eleocharis olivacea* Torr.), and three species of submerged aquatic plants (*Potomogeton pectinatus* L., *Ceratophyllum demersum* L. and *Najas armata* Lindb.F.). These species represent those aquatic plants having significant abundance and or/ distribution in Lake Burullus and are likely to be of great importance from the ecological-socio-economic viewpoint. A list of terrestrial and semi-aquatic plants (5 species), which occur in the area are presented also in table (4).

Table (4). Major species of aquatic macrophytes observed in Lake Burullus during 2003.

Emergent aquatic plants	**Submerged aquatic plants**	**Terrestrial and semi-aquatic plants**
Typha australis Schum & Thonn	*Potamogeton pectinatus* L	*Carex divisa* Huds
Eleocharis olivacea Torr.	*Ceratophyllum demersum* L	*Cyperus laevigatus* Roemer
	Najas armata Lindb.F	Cyperus rotundus
		Imperta cylindrica
		Juncus arabicus Adams

Some species also growing as weeds in the numerous waste and road-sides, these are: *Portulaca oleracea* L, *Stellaria pallida* Pire, *Amaranthus gracilis* Desf, *Fumaria densiflora* DC, *Brassica nigra* Koch; *Chenopodium album*; *Sonchus oleraceus* and *Plantago major* L. Many of the plants found in the study area are specifically adopted to the extreme habitats such as, *Typha australis* and *Ceratophyllum* (Ishak & El-Halawany 1989). Same authors also reported that *Typha* predominates in lower salinity. On the other hand *Eleocharis* is widely distributed throughout the lake but more distributed in some areas around the lake. As regards to the submerged aquatic plants, it was found that *Ceratophyllum* is abundant in all the regions heavily impacted by agriculture drainage. Ishak & El-Halawany (1989) and Fathi & Abdelzhaer (2003) showed the same trend of abundance and distributiou of submerged aquatic plants on Manzalla Lake (North Egypt).

Phytoplankton

It is well known that, the changes in physico-chemical eharacteristics of any water mass lead to concomitant qualitative and quantitative changes in phytoplanktonic organisms. (Mohammed *et al.*, 1986). The extensive large area of shallow water of the Burullus Lake; its connection to the sea and the huge amounts of fertile drainage water entering continuously it could be considered as main factors responsible for great variations in the community structure of the algal flora.

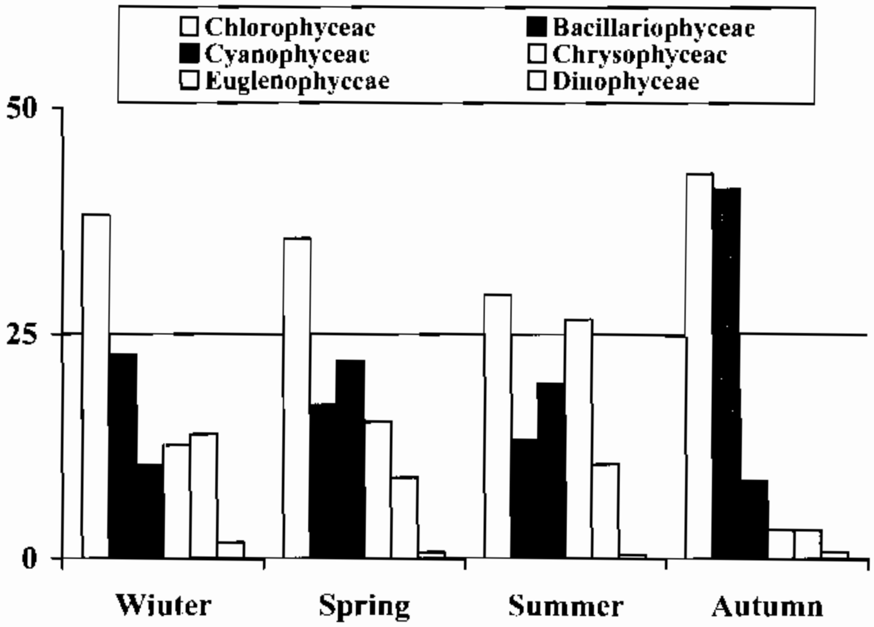


Fig. (5). The Percentage composition of the main algal groups recorded at Burullus Lake during 2003.

The data of this study shows that there are marked seasonal differences in the quantitative and qualitative composition of the phytoplankton communities in Lake Burullus (Table 5 and Figure 5). In terms of total cell number the maximum count (163 x 10^6 cell l^{-1}) was recorded in spring, whereas the lowest densities occurred in winter (11 x 10^6 cell l^{-1}). The changes in total algal counts throughout the investigation coincided closely with in Chlorophyceae abundance. It is worthy to mention that in summer sample Chrysophyceae was dominated, and some blue green algal genera were recorded in a high abundance (Figure 6).

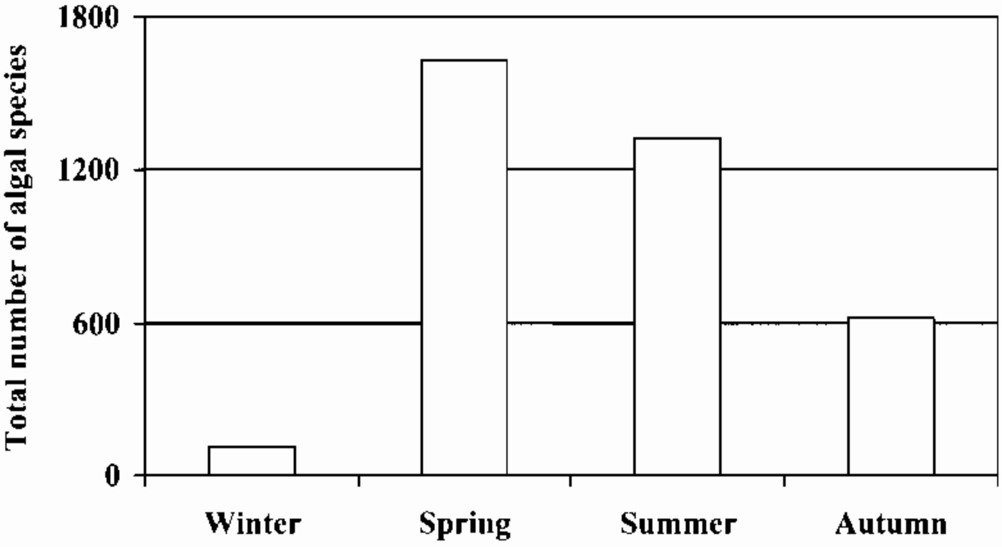


Fig. (6). Phytoplankton abundance (No. x $10^5 l^{-1}$) for Burullus Lake during 2003.

Six algal groups were recorded throughout the investigation period, *Bacillariophyceae, Chlorophyceae, Cyanophyceae, Chrysophyceae, Dinophyce*ae and *Euglenophyceae*. (Table 5 and Figure 5). The total percentage composition of the five main phytoplankton groups shows that *Chlorophyceae* dominated the phytoplankton of Lake Burullus throughout the study period. *Bacillariophyceae* ranked second. Ranking third were the *Cyanophyceae*, which were least abundant in the summer. *Chrysophyceae* ranked fourth in order of dominance and were always relatively common throughout the year. *Euglenophyta* ranked the fifth and *Dinophyceae* seventh.

The data included in Table (5) further revealed that a total of 58 species were identified allover the period of investigation. Out of these, 24 species belong to *Chlorophyta*, 16 belong to *Bacillariophyta*, 12 to *Cyanophyta*, 3 to *Euglenophyta*, 2 to *Dinophyceae* and one to *Chrysophyta*. The maximum number of phytoplankton taxa on any one sampling period (50 species) occurred in spring, while the minimum (37 species) was in winter. *Chlorella* sp., *Chlorococcus humicola, Scenedesmus bijuga* , *Cyclotella meneghiniana, Cylindrospermum* sp. and *Rhodominas ovalisd* were observed in a high rank of occurrence. Eleven algal species were moderately common (*Chlorophyceae* and *Bacillariophyceae*). On the other hand 26 species were frequently recovered, most of them belong to *Chlorophyceae*. The remaining recorded species were rarely recovered. Generally, the phytoplankton crop showed a remarkable increase as compared with the previous records (Fathi *et al.*, 2001) and the study indicated high level of eutrophication in Lake sector.

The data of Table (5) also shows that the maximum diversity index (2.08) was estimated on summer, while the minimum (0.66) was in winter. It should be noted that biological indices of species diversity, based mainly on the composition of phytoplankton have been proposed by Pielou (1966) and Nygaard (1978) may indicate the pollutional state of water. According to scales of Staub *et al.*, (1970), Lake Burullus indicates heavy pollution in autumn and winter (diversity from 0.0 to 1.0), and moderate pollution in spring and summer (diversity from 1.0 to 2.0). There are several numerical attempts to express degrees of oligotrophy and eutrophy from a consideration of species complements rather than from nutrient levels (Kobbia, 1982; Shabana *et al.*, 1985; Kobbia *et al.*, 1992). Some workers (Nosseir & Abou El-Kheir 1970; Soliman 1990; Fathi & Zaki, 1999; Fathi, *et al.*, 2001) believe that the biological estimation of the degree of eutrophication and pollution of aquatic ecosystems is probably more informative than chemical determinations. According to the phytoplankton diversity one could consider that the water of Lake Burullus is eutrophic.

Table (5). Relative occurrence of the phytoplankton on Burullus Lake during the study period (High=++++; Moderate =+++; Frequent = ++ Rare =+).

Algal Taxa	Winter	Spring	Summer	Autumn
Bacillariophyceae				
***Amphora ovalis* Kutz**	-		+	-
***Cocconies* sp.**	+	+	-	++
Cyclotella meneghiniana	+++	++	++	++
Cyclotella ocellata	-	++	+	++
Cymbella cistula	-	++	+	++
Diatoma sp.	-	+	+	-
Fragilaria capucina	-	+	-	++
Melosira granulata	-	-	+	-
Melosira italica	-	+	+	+
Navicula lanceolata	-	+	+	+
Navicula sp.	++	+	+	+
Nitzschia sp.	-	+	+	+
Stephanodiscus invisitatus	++	-	++	+
Surirella obonga	-	+	-	-
Synedra acus Kutz	+	+	+	+
Synedra ulna	++	++	+	++
Chlorophyceae				
Actinastrum hantzschii Lagerh.	-	+	-	+
Ankistrodesmus falcatus (Corda) Ralfs	+	+	++	+
Ankistrodesmus fusiformis Corda	-	-	+	-
Chlorella sp.	+++	++++	++++	++++
Chlorococcus humicola (Nag)	++	+++	++	++
Coelastrum combricum Archer	-	+	+	+
Crucigenia quadrata Morren	+	+	+	+
Crucigenia sp.	-	+	+	+
Dictyosphaerium pulchellum Wood	+	+	+	-
Gleocystis major Gerneck	+	+	-	+
Elakatothrix viridis (Kleb) G.M. Smith	-	-	-	+
Eudorina sp.	+	+	+	+
Gleocystis major Gerneck	+	-	-	-
Monoraphidium capricornutum Nygaard.	-	++	-	++
Monoraphidium contortum Komarava	-	++	+	+
Pandorina sp.	+	++	+	++
Pediastrum duplex	+	+	+	+
Pediastrum simplex Lemm	+	++	++	++
Scenedesmus acuminatus Chodat	+	+	++	++
Scenedesmus bijuga (Turp.) Lag.	-	+++	+	++
Scenedsmus quadriquda (Turp.)Brch.	+	+	+	++
Schroederia setigera Lemm.	-	+	-	++
Tetraedron muticum (A.Braun) Hansgirg	++	++	+	++
Tetrastrum sp.	+	-	-	-

Table (5). Continued

Algal Taxa	**Winter**	**Spring**	**Summer**	**Autumn**
Cyanphyceae				
Anabaena sp.	+	+++	+	+
Anabaenoipsis elenkinni Miller	-	+	+++	-
Chroococcus turgidus Nagel	+	++	+	+
Cylindrospermum sp.	+	+	+++	++
Lynghya contorta Lemmermann	-	+	+	+
Merismopedia elegans Braum	+	+	+	++
Merismopedia glauca (Ehrenb) Nagelei	-	+	+	+
Microcystis aeruginosa (Kleb.) Geitler	+	+	+	+
Microsystis flos-aquse	+	++	++	+
Euglena aeus <u>*Ehrenberg*</u>	-	++	+	+
Euglena promixa <u>*Dangeard*</u>	-	++	+	+
Phacus macrostigma Pachmann	-	+	-	+
Chrysophyceae				
Rhadomonas ovalis Nygaard	++	++++	++	++
Dinophyceae				
Peridinium bipes Stein	+	+	-	-
Peridinium sp.	-	-	-	+
Diversity index. (H)	**2.08**	**1.02**	**1.87**	**0.66**

In conclusion, the investigated lake area is contaminated with discharge waters enriched with chemical fertilizers in addition to domestic and industrial effluents. These are manifested by high amounts of organic matter, a high concentration of nutrients (causing eutrophication). We recommend minimizing the usage of fertilizers in agricultural lands to reach an optimum level, and prevent the discharge of domestic sewage into the lake and divert it to the sewerage system.

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References

Abbassy M.S., Ibrahim H.Z. and **Abdel Kader H.M.** (2003): Persistent organochlorine pollutants in the aquatic ecosystem of Lake Manzala, *Egypt. Bull Environ. Cont. Toxicol,* **70**(6): 1158-1164.

Abdel-Satar A.M. (1998): *Distribution of some chemical elements in River Nile at Great Cairo Region.* Ph..D. Thesis, Faculty of Science, Ciro Univ., p. 249.

Abdel-Satar A.M. and **Elewa, A.** (2001): *Water quality and Environmental assessments of the River Nile at Rosette branch.* The Second Conference and exhibition for life and Environment, Alexandria, 3-5 April 136-164.

Abou-Arab A.A.K., Gomaa M.N.E., Badawy, A. and **Naguib K.** (1995): Distribution of organochlorine pesticides in the Egyptian aquatic ecosystems. *Food Chem.,* **54:** 141-146.

Adams V.D. (1991). *Water and wastewater examination manual,* Lewis Publishers, INC. USA.pp 247.

Ahmed A.M., Ahmed A.M. and **Zeinab A.A.** (1986). Studies on Phytoplankton of the Nile System in Upper Egypt. *Limnologica (Berlin)* **17**(1): 99- 117.

Allott, N.A. (1986): Temperature, oxygen and heat-budgets of six small western Irish lakes. *Freshwater Biology,* **16:** 145-154.

Aly, M.M. and **Yahya, M.M.** (2002): Impacts of chemical and microbiological pollutants on water quality of natural protected area: Lake Burullus. *Engineering Research Journal,* **84:** 87-108.

Badawy, M.I., Wahaah, R.A. and **Abou Waly, H.F.** (1995): Petroleum and chlorinated hydrocarbons in water from Lake Manzala and associated canals. *Bull Environ. Cont. Toxicol,* **55**(2): 258-263.

Berglund, B.E. and **Ralska-Jasiewiczsowa M.** (1986): *Pollen analysis and pollen diagram.* In : Berglund, B.E. ed. Handbook of Holocene Palaeoecology and Palaeohydrology. Wiley, Chichester. Pp. 455-484.

Bourrelly, P. (1981). *Les algues d'eau douce.* Initiation a'la sestematique. Tome II: Chrysophyce'es,Phyeophyc'ee, Xanthopyce'es et diatome'es- Paris: N. Boube's & Co. 517.

Bowen, H.J.M. (1979). *Environmental Chemistry of the elements,* Academic press, London.

Cole, G.A. (1983). *Textbook of Limmnology.* C.V. Mosby Company,st. Louis-Toronto-London. 3rd Ed. 401 pp.

El-Gendy K.S., Abdalla, A.A., Aly H.A., Tantawy, G. and **El-Sebae, A.H.** (1991): Residue levels of chlorinated hydrocarbon compounds in water and sediment samples from Nile branches in the delta, *Egypt J. Envron. Sci. Health,* **B26:** 15-36.

El-Naggar M.E.E, Shaaban D.S.A., Abdel-Hamid M.I. and **Aly E.M.** (1997). Effect of treated sewage on the water quality and phytolankton populations of Lake Manzala (Egypt) with emphasis on biological assessment of water quality. *New Microbiol.,* **20**(3): 253-276.

El-Naggar, M.E.E., Shaaban, D.S.A., Abdel-Hamid, M.I. and **Aly, E.M.** (1998) Studies on the phytoplankton population and physico-chemical conditions of treated sewage discharged into Lake Manzala in Egypt. *Microbiologia (Pavia)* **21**(2): 183-196.

El-Sammak A.A. and **El-Sabrouti M.A.** (1995): Assessment of metals pollution in the sediments of Lake Burullus, S.E. Mediterranean, Egypt. *Qatar Univ. Sci. J.,* **15**(20): 451-455.

El- Wakeel, S.K. and **Wahby, S.D.** (1970). Hydrography and chemistry of Lake Manzala, Egypt., *Arch. Hydrobiol.,* **67:** 173-200.

Fathi, A.A. and **El-Shahed, A.M.** (1998). Response of Nile water Phytoplankton to some heavy metals and their interaction with carbonate, and **Fathi A.A.** and **Fatma El-Zahraa T.Z.** (1999) Effects of wastewater discharge into the river Nile on the water quality and phytoplankton communities at El-Minia, Egypt, *Bull. Fac. Sci. El-Minia University (Egypt)* **12:** 99-110 EDTA., *J.Union.Arab.Biol, Cairo,* **6(B):** Botany, 1-12.

Fathi A.A. & Zaki, F.T. (1999): Effects of wastewater disposal into the river Nile on the water quality and phytoplankton commmnities, at El-Minia , Egypt, **12**(2): 99-110.

Fathi A.A. and **Kobbia I.A.** (2000); Hydrobiological investigation of Abou-Median Lake, El-Minia, EGYPT. *Bull. Fac. Sci., Assiut Univ.,* **29**(1-D): 77-91.

Fathi A.A. and **Abdelzahar H.M.A.** (2000) *Site description for the Egyptian Lakes and results of water chemistry and phytoplankton for CASSARINA Lakes.* Unpublished Final Report to the EU Commission, University of El Minia.

Fathi, A.A, H.M. Abdelzaher, R. Flower, M. Ramdani, and **M. Kraiem,** (2001): Phytoplankton communities in North African wetland Lakes: the CASSARINA Project. *Aquatic Ecology,* **35**(3-4): 303-318.

Fathi A.A. and **Abdelzahaher H.M.** (2003). Limnological studies on wetland Lake El-Manzala, Egypt. *Bull. Fac. Sci., Assiut Univ.,* 215 - 233

Flower, R.J. (2001). Change, stress, sustainability and aquatic ecosystem resilience in North African wetland Lakes during the 20th century: an introduction to integrated biodiversity studies within the CASSARINA Project. *Aquatic Ecology,* **35**(3-4): 261-280.

Flower, R.J., S. Dobinson, M. Ramdani, M.M. Kraïem, C. Ben Hamza, A.A. Fathi, H.M.A. Abdelzaher, H.H. Birks, P.G. Appleby, J.A. Lees, E. Shilland, and **S.T. Patrick** (2001): *Recent environmental change in North African wetland lakes: diatom and other stratigraphic evidence from nine sites in the CASSARINA Project.*

Fott. B. (1972): *Das phytoplankton des SüBwassers.* 6-Chlorophyceae, Crdnung. Tetrasporalis. Stuttgart: 116pp.

Gharib S.M. and **Soliman A.M.** (1998). Some water characteristics and phyto-Zooplankton relationship in Lake Edku (Egypt) and Adjacent Sea., *Bull. Faci..Sci., Alex. Univ.,* **(38):** 1, 2, 25-44.

Goldman, C.R. (1960). Primary productivity and limiting factors in three lakes of the Alaskan peninsula. *Ecol. Monogr.* **30:** 207-270.

Goldman, C.R. and **Horne, A.J.** (1983). *Limnology.* Mc Graw - Hill Book Company, New York, 464 pp.

Golterman, H.L. and **Clymo, R.S.** (1971): *Methods for chemicals analysis of freshwaters.* Black well Scientific Publications, Oxford, 166.pp.

Hohro, R. and **E. Willen,** (1977): Phytoplankton counting. In tercalibration results and recommendations for routine work. *Int. Revue ges. Hydrobiol.,* **62:** 605-811.

Hussein A.B. (1989): *Ecological Studies in pond Ismaelia in El-Minia Province (Egypt).* M.Sc. Thesis, Zoology Department, Faculty of Science, El-Minia University, Egypt.

Imada, C., Sugimoto, Y., Makimura, T., Kobayashi, T., Hamada, N. and **Watanabe, E.** (2001): Isolation and characterisation of tyrosinase inhibitor-producing microorganisms from marine environment. *Fisheries Science,* **67:** 1151-1156.

Ishak, I.F. and **El-Halawany, E.F.** (1989): Aquatic and terrestrial flora of Lake Manzala, Egypt. *Egypt. J. Bot.,* **32**(1-2): 95-107.

Kobbia, I.A. (1982): The standing crop and primary production of phytoplankton in Lkae Brollus. *Egypt. J. Bot.,* **25:** 109-128.

Kobbia, I.A., S.K.M. Hassan, and **M.A. Shoulkamy,** (1990): Standing crop and distribution of phytoplankton in relation to nutritional status of polluted drain at Minia province (Upper Egypt). *Bull. Fac. Sci. Assiut Uinv.,* **19**(2-D): 247-264.

Kobbia, I.A.; Zaki, M.A. and **Mona, Y.G.** (1992). Ecology of phytoplankton in Estuarine regions of Abuo Tarfaia drain in Lake Qarnn (Egypt).

Kobbia, I.M., Metwali, R.M. and **El-Adel H.M.** (1995): Influence of water effluents of soap and oil factory at Benha on Nile Phytoplankton Communities., *Egypt. J. Bot.,* **35**(1): 45-57.

Loutfy B. and **M. El-Hadidi** (1984): *The Wed Flora of Egypt.* The American University in Cairo press, Cairo, Egypt, pp. 178.

Methods for the examination of waters and associated materials (1981): 37pp: HMSO London.

Mohammed A.A., Ahmed A.H. and **Ahmed Z.A.** (1986): Studies on Phytoplankton of the Nile System in Upper Egypt. *Limnologica* (Berlin) **17**(1): 99- 117.

Mohammed A.A. and **Fathi A.A.** (1990). The condition of the Nile in the years 1968-1978. *Bull.Fac.Sci.,Assiut Univ.,* **19**(1-D): 141-164.

Nosseir, M.A. and **W.S. Abou El-Kheir,** (1970): Effect of dissolved nutrients on the distribution of algal flora in selected lakes of U.A.R., I- Lake Qarun. *Ann. rev. Univ. Coll. Girls. Ain Shams Univ. U.A.R.* **6:** 15-24.

Nygaard, G. (1978): Freshwater phytoplankton from the Narssaq Area, *South Greenland. Bot. Tidsskrift bd.* 73**:** 3-4.

Osfor M.M.H., El Dessouky S.A., El-Sayed A. and **Higazy R.A.** (1998). Relationship between environmental pollution in Manzala Lake and health profile of fishermen, *Nahrung,* **42**(1): 42-45.

Peters, A.J., Jones, K.C., Flower, R., Appleby, P.G., Ramdani, M., Kraiem, M.M. and **Fathi, A.A.** (2001): Recent environmental change in North African wetland Lakes: a baseline study of organochlorine contaminant residues in sediments from nine sites in the CASSARINA Project. *Aquatic Ecology,* **35**(3-4): 449-459.

Pielou, E.C. (1966): The measurement of diversity in different types of biological collections. *J. Theor. Biol.,* **13:** 131-144.

Prescott, G.W. (1987). *How to know the fresh water algae.* Wm.C. Brown Company Publishers Dubuque lowe., and 293pp.

Ruttner, F. (1963): *Fundamental of Limnology.* English translation by D.G. Frey and F.E.J. Fry. Toranto University press, Canada. 307pp.

Sabae, S.Z. and **S.A. Rabeh,** (2000): Bacterial indices of sewage pollution in Lake Qarun, El-Fayoum, Egypt. *Egypt. J. Aquat. Biol. Fish.,* **4**(3): 103-116.

Shaaban, A.S., A.A. Badawi, and **A.A. El-Awamry,** (1985): Studies on the diatoms of Bahr Youssef Irrigated canal and its branches in El-Fayoum depression (ARE), Moshtohor. *Ann. of Agri. Sci.,* **24**(1): 7-33.

Shakweer. L.M.; Abbas M. and **Alsayes A.** (1993). Heavy metals content of some fishes in Lake Edku. *Bull.Fac. Sci., Alex. Univ.,* **33**(A): 130-164.

Smith, G.M. (1950): *The fresh water algae of the united states.* 2nd. ed. - New York, MacGraw Hill book Co., 719.

Soliman, A.M. (1983): *Quantitative and qualitative studies of the plankton of Lake Edku in relation to the local environmental conditions and to fish food.* M.Sc. Thesis, Faculty of Science, Alexandria University, 220P.

Soliman, G.F. (1990). *Observations on some Physical conditions of Lake Qarun,* Regional Symp. Environ. Stud. (UNARC), Alexandra: 588-601.

Staub, R., J.W. Appling, A.M. Hofstetter, and **I.J. Haas,** (1970): The effects of industrial wastes of Memphis and Shelby on primary planktonic producers. *Bioscience,* **20:** 905-912.

Stefansson, U. (1968). Dissolved nutrients, oxygen and water masses in the northern Irwinger Sea. *Deep Sea Research,* **15:** 541-575.

Strickland , J.D.H. and **Parsons, T.R.** (1972). A practical handbook of sea water analysis. *Fish. Res. Ed. Canada, Bull.* **167:** 2nd ed., 310pp.

Tackhlom V. (1974): *Students flora of Egypt.* Cairo University, Cooperative Printing Company, and Beirut.

Talling, J.F. (1976): *Water Characteristics.* In: Rzoska.,J. (ed.): The Nile, biology of an Ancient River. Junk. The Hague.

Talling, J.F. and **Talling, I.P.** (1965). The chemical composition of Africa Lake waters. Int. Review ges. *Hydrobiologia.*, **50:** 421-463.

Utermohl, H. (1936): *Quantitative Methoden Utersuchung des Nannoplankton in Adderheldens*. Handbuch der Biolog-Arb-Methoden Abt.IX (1).

Willen, E. (1976): A simplified method of phytoplankton counting. *Br. phycol.J.*, **II:** 265-278.

التقييم البيئي لبحيرة البرلس ، جمهورية مصر العربية ، مع التعرض للقاع ونوعية المياه

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المستخلص. تم في هذا البحث إجراء دراسة موسمية للخصائص الكيميائية والفيزيائية والبيولوجية لبحيرة البرلس خلال عام ٢٠٠٣ . وقد أظهرت النتائج التي تم الحصول عليها من تحليل قطاعات من تربة قاع البحيرة أن التركيز الأقصى لعنصر الزنك هو ٦,٢ جزء في المليون ، والنحاس ١,٠ جزء في المليون عند أعماق ٦ و ٢٦,٥ سم بينما كان التركيز الأقصى للرصاص ٧,٥ جزء في المليون عن عمق نصف سم.

من جهة الفلورا النباتية المائية فقد سجل خلال فترة الدراسة إثنى عشر جنسا منها اثنان من النباتات المغمورة و ثلاثة من النباتات شبه المغمورة وسبعة أرضية شبه مائية.

بالنسبة لنوعية المياه فقد أوضحت الدراسة وجود تغيرات هامة وجلية في تركيز معظم العناصر الكيميائية المقدرة وخاصة العناصر الغذائية. كما لوحظ أيضاً تغيرات وصفية وكمية في الهائمات النباتية والتي ربما تعود إلى التغيرات التي حدثت في الخصائص الكيميائية لمياه البحيرة . ولقد سجل أعلى إنتاج طحلبي خلال فصل الربيع بينما كان أقل إنتاج خلال فصل الشتاء. وقد أوضحت الدراسة وجود ستة أنواع طحلبية في مياه البحيرة كان أكثرها وجودا الطحالب الخضراء. ولقد تم تسجيل ثمانية وخمسين جنسا طحلبيا خلال فترة الدراسة . وقد أظهرت الكائنات الهائمة التي تم جمعها أن البحيرة تنتمي إلى البحيرات ثرية التغذية وكان مستوى العناصر الغذائية التي تم تقديرها أعلى من الأعوام السابقة.