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BIODIVERSITY OF PHYTOPLANKTON STRUCTURE IN LAKE QARUN (EL-FAYOUM, EGYPT) AND ITS USE AS INDECATOR FOR ENVIRONMINTAL POLLUTION

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Abstract

Seasonal structure of phytoplankton in Lake Qarun was estimated. A total of 50 algal taxa related to 4 classes were identified: Bacillariophyceae (36 taxa), Dinophyceae (9 taxa), Cyanophyceae (3 taxa) and Chlorophyceae (2 taxa). It was dominated by only 5 spp of diatoms (*Cyclotella glomerata*, *C. kutizingiana*, *Nitzschia closterium*, *N. fonticola*. and *N. frustulum* var. *perpusilla*) constituting about 89.44% from the diatoms density and 5 spp of dinoflagellates (*Exuvaiella apora*, *Gymnodinium orientalis*, *G. smile*, *Peridinium incospicum* and *Prorocentrum micans*) forming about 96.7% from the dinoflagellates density.

Different diversity indexes were applied to estimate species diversity, richness, evenness, redundancy and the dominance for the predominant species. The results were compared with the previous data and discussed with the effect of accumulated pollutants drained into the lake. Biodiversity studies indicated that the lake biota is affected by the destructive action of these pollutants, and some of the dominant species are known as one of toxin-producing phytoplankton.

Key wards: phytoplankton, systematic, biodiversity, lakes, Qarun.

Introduction

Phytoplankton classification according to taxonomic affinities might reflect a degree of resemblance among samples but, since they are based on species counts alone, they do not provide information for making inferences about the underlying communities (Ignatiades et al., 1992). In any community description, even the best possible based on a single criterion, can capture only a part of the total variation (Gauch, 1989).

One of the most pressing problems facing the biologist concerned with water pollution is presenting the interpretation of biological data clearly and concisely (Brck, 1955). The most common form of data to which numerical classification techniques are applied is the use of species as entities with their abundance or presence as attributes (Pielou, 1984). Comparisons of phytoplankton samples should not be limited to taxonomic relationships but they should be extended to diversity estimators (Ignatiades *et al.*, 1992). Attention has been focused on the diversity in populations of organisms as a measure of pollution, on the principle that in a clear water community diversity is high, while in one polluted water the diversity is low (Wilhm, 1967). Patten (1962) developed mathematical expression of diversity from information theory to determine changes in the structure of populations, and claimed that since accurate identification of the species was

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unnecessary, the method was suitable for use by persons with a limited background in taxonomy.

The structure of phytoplankton inhabiting Lake Qarun was illustrated systematically (Abd El-Monem, 1991 and Anonymous, 1997). But, studies of biological diversity will give an impression about the affect of biota by pollutants or the stress of the new environmental conditions on the different regoins of the lake.

The main objective of this work is to illustrate the seasonal structure and density of phytoplankton inhabiting the different regions of Lake Qarun during a year. Comparing the recent data with the previous results to clear the effect of pollutants on the biotic changes of the lake. Various diversity indexes were applied to provide an insight on the resemblance structure of phytoplankton communities with changes on the drastic environmental variables.

Side location and description

Lake Qarun is a closed saline lake, located in subtropical arid region in the deepest part of El-fayoum depression at the western desert, far about 83 km NW from Cairo-Egypt. It's area is about 228 km^2, extends about 45 km from east to west with about 5.7 km main width and about 4.2 m mean depth (Abd El-Monem, 1991). It is surrounded by vast desert at the northern shore and cultivated lands at the south. It is used as a reservoir for the drainage water of El-Fayoum province. The drainage water drained into the lake via two main drains, El-Bats at the most eastern part (drains about 207.6 million m^3/year) and El-Wadi (drains about 103.03 million m^3/year) at the middle of the southern side, and some bumping stations expanded along the eastern shore of the southern side (see Fig 1).

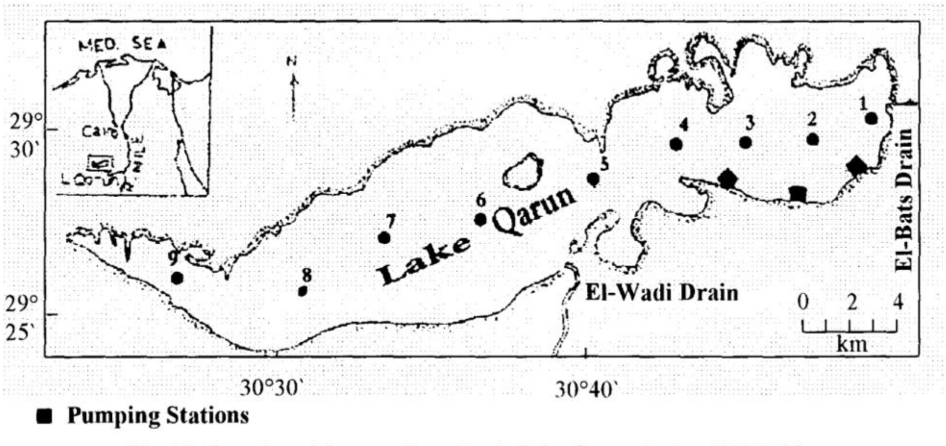

Fig. (1): Location of the sampling sites in Lake Qarun during 1999-2000

Mullet fish fries are transplanted to the lake from the Mediterranean sea. More recent details on physical, chemical, and biological conditions were discussed in Anonymous (1997). Some important meteorological parameters of the lake were illustrated in Table 1.

Table (I): Meteorological variables of Lake Qarun, the seasonal maximum and minimum values with its recording time during 1996. Wind direction, north west (NW) and north east (NE). as reported in Anonymous; (1997).

Meteorological parameters	Maximum		Minimum	
	Value	Season	Value	Season
Net radiation Wm^{-2}.	241.9	Summer	53.1	Winter
Air pressure mb.	1022	Winter	1012	Summer
Wind speed $msec^{-1}$. (direction)	5.4 (NW)	Summer	2.11 (NE)	Winter
Wind gust $msec^{-1}$.	8.89	Summer	3.7	Winter
Evaporation rate cm $month^{-1}$	28.4	Summer	4.1	Winter
Salinity ‰	45.31	Autumn	37.64	Spring

The annual average of primary productivity for the lake water was amounted to 105.48 $mgCm^{-3}h^{-1}$ and phytoplankton biomass as represented by Chl *a* was 26.38 mg m^{-3}. There was a relationship between its productivity and Chl *a* with linear regression. It has an assimilation rate value of 3.75 mgC/mgChl/h. Temperature was the most effective factor on productivity (Abd El-Monem, 2001). Rabeh (2001) studied the seasonal variation of bacteria involved in carbon and sulphur cycles in the lake for the same samples. He reported that there is a notable decrease in bacterial content in the lake, which may represent a warning sign to some adverse ecological changes, especially high salinity, that may threat the biota of the lake. Nosseir and Abou-El-Kheir (1970) studied the effect of dissolved nutrients on the distribution of algal flora in the lake, and recorded 85 species.

The lake water suffered drastic chemical changes during the last years. Its salinity increases progressively which affects greatly the lake biota (Elewa, 1994). He measured some heavy metals in the lake sediments and reported that, the highest concentrations (Mn>Zn>Cu>Pb) were found in El-Bats drain (1804, 720, 595and 32 ppm, respectively) comparing with the other locations of the lake. But in the lake water, Fe was the most dominant metal followed by Co and Zn (Anonymous, 1997). He reported that salinity is considered to be the main factor responsible for the deterioration of the environmental conditions of the lake (its annual average values for the last ten years are shown in fig. 2). The abnormal increasing rate of salinity represents dangerous effects on biological productivity and fish production in the present time and perhaps in the near future. The same author attributed these fatal changes in salinity not for meteorological variation but for discharges of the brine water from AMISAL salt company. In addition, the drainage waters are loaded with sewage, pesticides, heavy metals and nutrients (mainly nitrogen and phosphorus). These pollutants are accumulated in stock lake water or sediment. It is well known that lake biota are more sensitive for any changing in environmental variables.

Material and methods

The different ecological habits of the lake water were covered by nine sampling stations (Fig.1). Four successive seasonal sampling program were done. Started from summer 1999 to spring 2000. A composite water sample was collected from different depths at each station using Ruttner sampler. For phytoplankton examination, one litter sample was preserved with Lugols iodine immediately. In the laboratory, these samples are transferred into a glass cylinder and left 5 days for settling. About 90% of the supernatant siphoned off using plastic tubes covered with plankton net (5µ), and adjusted to a fixed volume. Lugol-preserved subsamples were prepared for species identification and enumeration using inverted . Each sample was examined and counted (reported as $\log_{10}$ cells/l) using a drop method (APHA, 1995). The main references used in identification were; Krammer and Lang-Bertalot (1991), Mizuno (1990), Popovsky and Pfiester (1990), Tikkanen (1986), Hannford and Britton (1952) and Huber and Pestalozzi (1942).

Some physical parameters (water depth and Secchi-depth, air and water temperature, pH, and electrical conductivity) were measured in the field immediately. Some chemical analysis for the same sampling station were done by the Chemical Laboratory (Ali, 2001) (salinity, CO_3, HCO_3, NH_3, PO_4 ant total phosphorus) and variables were measured for the same sampling. The results of these variables were averaged seasonally for the lake water.

Comparison of various diversity indexes

The following indices of diversity were applied on the results obtained for species structure and density:

$$\text{Simpson's Index } S.I = \sum_{i=1}^{m} \pi i^2 \quad \text{(Duffy, 1968),}$$

where πi is the proportion of the i th species in the sample

$$\text{Margalef's Index} = S - 1 / \ln N \quad \text{(Wilhm, 1967),}$$

where S is the number of species, and N is the total number of individuals in the sample.

Univariate method (Ludwig and Reynolds, 1988) were performed on species abundance data as follows:

Species richness (R) after Menhinick's (1964) Index: $R = S/(N^{1/2})$, (Wilhm, 1967),

Species diversity (H') after Shannon-Weaver's (1949) index:

$$H' = -\sum_{i=1}^{S} [(Ni/N)/\ln (Ni/N)]$$

where Ni is the number of individuals belonging to the ith of S species in the samples and N is the total number of individuals.

Species evenness (E) after Pielou's (1977) index: $E = H' / \ln (S)$,

Species redundancy (R') after Patten (1962) index: $R' = (H'_{max} - H')/(H'_{max} - H'_{min})$, where $H'_{max} = \ln S$ and $H'_{min} = -[\ln N - (N - S + 1/N)]$.

Species dominance (D) after McNaughton (1967): $D = 100 (N_1 + N_2)/N$, which is equal to the percentage of the two most abundant species (N_1 and N_2) to the total number of individuals (N).

Results

Physico-chemical variables:

The seasonal average values of the main physical and chemical variables were shown in Table (II). The lake water reached its highest level in winter with a maximum depth of 3.83 m and the lowest in autumn with a minimum depth of 2.61 m. The changing in water temperature followed the corresponding values of air temperature with highest temperatures of 30.1 and 32.9°C during summer, and lowest of 15.7 and 17.2°C during winter. The lake water was turbid as indicated by low transparency, which represented by Secchi-depth readings. Its values fluctuated from 83 cm in summer to 36 cm in spring. The pH values always lies in the alkaline side with a highest record of 8.69 in autumn and decreased gradually to 7.58 in summer. Water salinity ranged from 41.04 to 45.79 ‰ in spring and autumn, respectively.

Water alkalinity was found to be dominated by bicarbonate contents while carbonates were low through the year. The lowest contents of HCO_3 and CO_3 were 281.5 and 41.1 mg.l^{-1}, respectively, and observed in summer where as the highest values of both were recorded in spring and autumn and represented by 324.9 and 113.7 mg.l^{-1}, respectively. NH_3 concentrations varied from 0.14 to 0.66 mgl^{-1} in spring and summer, respectively. PO_4 contents ranged between 53.03 and 89.5 µgl^{-1}, while TP values ranged from 247.0 to 370.8 µgl^{-1}.

Table (II): Physical and chemical variable (seasonal average) for lake Qarun during the sampling seasons through 1999-2000.

Parameters	Autumn	Winter	Spring	Summer
	1999		2000	
Depth m	2.61	3.83	3.33	3.44
Air temperature °C	23.1	17.2	28.5	32.9
Water temperature °C	21.2	15.7	26.1	30.1
Transparency cm	64	56	36	83
PH	8.69	8.40	8.36	7.58
Chemical variables as reported in Ali (2001).				
Salinity ‰	45.79	43.55	41.04	42.42
CO_3 mg.l^{-1}	113.7	90.8	64.0	41.1
HCO_3 mg.l^{-1}	302.4	294.9	324.9	281.5
NH_3 mg.l^{-1}	0.29	0.37	0.14	0.66
PO_4 µg.l^{-1}	76.19	53.03	83.55	89.50
TP µg.l^{-1}	247.0	273.1	360.5	370.8

Phytoplankton examination

The temporal and spatial examination of phytoplankton samples in Lake Qarun resulted in, a total of 50 species were identified (table IV) during the year, related to 4 main classes, Bacillariophyceae (36 taxa), Dinophyceae (9 taxa), Cyanophyceae (3 taxa) and Chlorophyceae (2 taxa). The annual average of phytoplankton density was dominated by diatoms, followed by dinoflagellates and constituted about 76.82 and 22.42% from the total count, respectively. While blue-greens and greens were scarce forming about 0.64 and 0.12%, respectively (Fig.3).

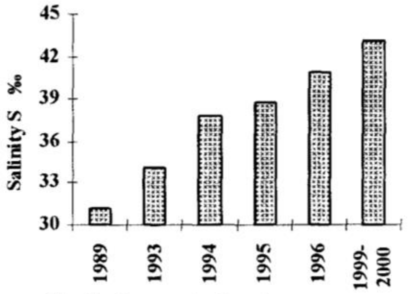

Fig. 2: Accumulative changes in salinity of Lake Qarun.

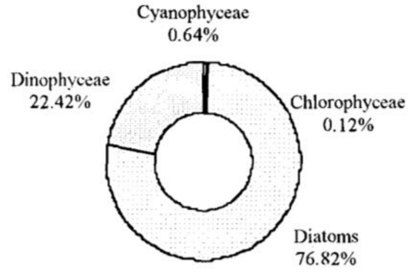

Fig. 3: Annual changes in phytoplankton Classes ratio in Lake Qarun.

Its seasonal structure cleared that; the highest population density was recorded during summer (seasonal average of $\log_{10}$ 3.428 cells/l) with a maximal of $\log_{10}$ 3.845 cells/l in St.1. The lowest density was observed during autumn (seasonal average of $\log_{10}$ 2.75 cells/l) with a minimal of $\log_{10}$ 2.477 cells/l in St.9 (see Fig. 4).

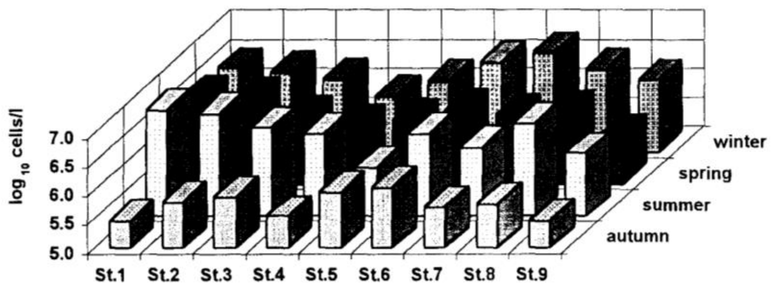

Fig. 4: Temporal and spatial density of phytoplankton in Lake Qarun.

Diatoms, which was the predominant class during the year, flourished in autumn constituting about 88.53% and decreased gradually to about 68.8% from the total population in summer. In contrary with diatoms, dinoflagellates ratio was maximized in summer and minimized in autumn forming about 29.57 and 11.47%, respectively. Blue-greens was represented in spring and summer only by about 0.19 and 1.47%, respectively. While greens recorded only in summer and composed about 0.175% from the total density (Fig. 5).

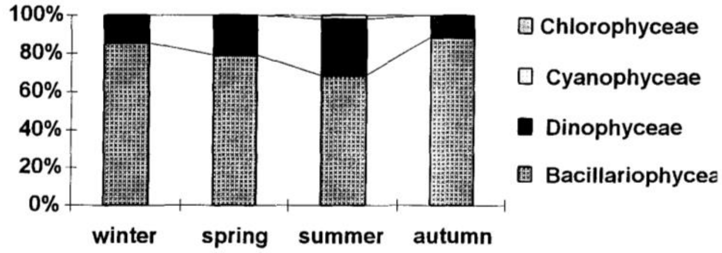

Fig. 5: Seasonal changes in phytoplankton classes ratio in Lake Qarun.

Taxonomic structure of phytoplankton in the lake revealed that, diatoms were dominated by 5 species from the total of 36 taxa. Those species were named, *Cyclotella glomerata, C. kutizingiana, Nitzschia closterium, N. fonticola* and *N. frustulum* var. *perpusilla,* and constituted about 89.44% from the total density of diatoms. While dinoflagellates were dominated by 5 spp also from the total of 9 taxa and formed about 96.7% from its annual density and were named; *Exuvaiella apora, Gymnodinium orientalis, G. smile, Peridinium incospicum* and *Prorocentrum micans*. Fig (6 and 7) showed distribution of the annual population for the dominant spp of diatoms and dinoflagellates in the different locations along the lake.

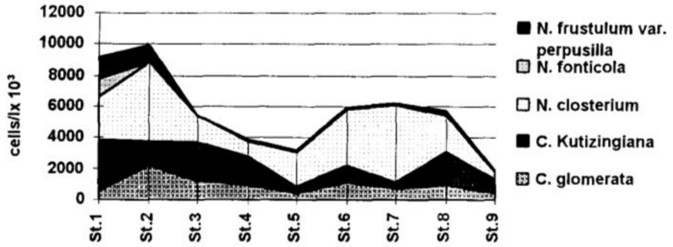

Fig. 6: Annual distribution for the dominant species of diatoms in Lake Qarun.

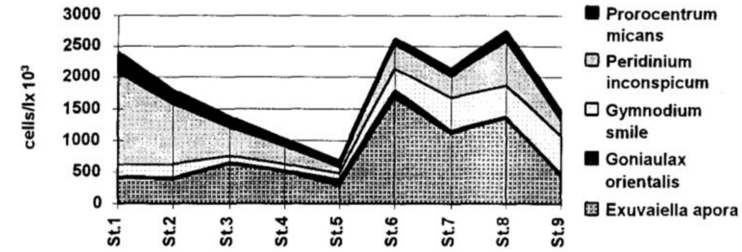

Fig. 7: Annual distribution for the dominant species of dinophyceae in Lake Qarun.

The annual spatial distribution of phytoplankton species revealed that the highest number of species (33 spp.) was recorded at the most eastern side of the lake (st1) with a gradual decreasing to the lowest of 18 spp at st 4, while its distribution was irregular in the western part.

Table (III) shows the various species diversity variables in the different locations of the lake water during the investigated year. The indexes of diversity for each station cleared that; Simpson's Index for phytoplankton species fluctuated between 0.356 at st 7 and 0.115 at st 9, Margalef's Index values changed from 3.367 to 1.99 at st 1 and st 4, respectively. Menhinick's Index, which represent species richness, varied from 0.409 at st 9 to 0.227 at st 6. The species diversity recorded abnormal peak of 1.764 at st 7, while the other values were changed from 0.853 at st 5 to 0.454 at st 9.

Species evenness fluctuated in limited values between 0.139 at st 9 and 0.375 at st 7. The lake had a very low species redundancy, the maximal value was 0.026 at st 5 and decreased to 0.005 at st 6. The lake has a moderate dominance for the two highest density species. It varied between 36.54 and 69.66% at st 9 and st 7, respectively.

Diversity values were highly positive correlated with Simpson's Index Simpson's Index (r =0.92), evenness (r =0.95) and dominance (r =0.902). The calculated data revealed that the lake had irregular variations in the ratio between diatoms and dinoflagellates with different locations. This ratio realized that the population density of diatoms was high in the eastern part comparing with the western side, the highest ratio was 5.94 at st 5, while the lowest was 1.65 at st 9.

Table III: Results of examined phytoplankton seasonal samples in Lake Qarun during 1999-2000 and its specices biodiversty parameters. Species (spp.), total cells {$\log_{10}$(cells+1)/l} and dominance (%).

Parameters	East ◄—— Sampling stations ——► West								
	St 9	St 8	St 7	St 6	St 5	St 4	St 3	St 2	St 1
Number of spp. *S*	26	26	23	22	26	18	25	28	33
Total cells *N.*	3.607	3.966	3.944	3.973	3.668	3.71	3.881	4.091	4.127
Simpson' Index. *S.I.*	0.115	0.161	0.356	0.210	0.265	0.215	0.195	0.233	0.142
Margalef,s Index	2.010	2.738	2.422	2.295	2.960	1.990	2.685	2.866	3.367
Diversity. *H'.*	0.454	0.544	1.764	0.664	0.853	0.667	0.616	0.723	0.508
Richness. *H.*	0.409	0.270	0.245	0.277	0.381	0.251	0.287	0.252	0.285
Evenness,.*E'.*	0.139	0.167	0.375	0.215	0.262	0.231	0.191	0.217	0.145
Redundancy. *R'.*	0.019	0.012	0.017	0.005	0.026	0.020	0.016	0.012	0.009
Dominance. *D'.*	36.54	48.59	69.66	56.06	58.04	56.92	55.72	58.91	45.37
Diatom : Flagellate.	1.65	2.24	2.97	2.41	5.94	4.03	4.26	5.65	4.25

Table (IV): Phytoplankton species recorded in Lake Qarun and its seasonal appearance during 1999-2000, sp. recorded in one season (+), two seasons (++), three seasons (+++) and four seasons (++++).

	East ← Sampling stations → West								
Parameters	St 1	St 2	St 3	St 4	St 5	St 6	St 7	St 8	St 9
I- *Diatomphyceae*									
Amphora coffeaeformis Agardh.							+		+
Amphiprora paludosa W. Sm.	+				+				
Aulacoseira granulata Her. Simon.	++	+++	+++	++	++	+++	+++	+++	+++
A. moniliforms (Muller) Agardh.	+								
Chaectoceros subtilis Cleve	+	+	+		+	+		+	
Cocconeis lineatus (Ehr.) Cleve.	+								
C. placentula Ehr.	+								
C. diminuta Pant.			+				+		
Cosinodiscus granii Gough.	+	+++	+	++	++	+	+	+	
C. lineatus Ehr.					+				
Cyclotella glomerata Bach.	++++	++++	++++	++++	++++	++++	++++	++++	++++
C. Kuetzingiana Thwaites.	++++	++++	++++	++++	++++	++++	++++	++++	++++
C. meneghiniana Kutz.	++	+					+	+	++
C. ocellata Pant.	+								
Diploneis interrupta Ehr.		+			+				
Hanzschia amphioxys Ehr.					+				
Navicula hungarica Grun.					+			+	+
Nitzschia acicularis W. Sm.	+	+							
N. apiculata (Greg.) Grun.	+								
*N. closterium(*Ehr.) W. Sm.	++++	++++	++++	++++	++++	++++	++++	++++	++++
N. fonticula Grun	++	+							
N. frustulum (Kutz.) Grun.	+++	++	++++	++	++	+		+	
N. frustulum var. perpusillai Hust.	++	++++	+	+++	++++	++++	++++	++++	++++
N. kutzingiana Hilse					+				
N. longissima. (Breb.) Ralfs.									+
N. palea (Kutz.) W. Sm.	+++	+++	+++	+	+			+	++
N. sigma (Kutz.) W. Sm.	+++	+++	+++	+++	+++	+++	++	++	++
N. thermalis Ehr.	+	+							+
N. tropica Hust.			+						
Opephora martyi Herib.	++	++	++++	++	++	++	++	+	+
Stephanodiscus aegyptiacus Ehr.		+	++	+	+++	+	+	++	
S. astraea Grun.	+		+		+				
Syndera ulna Ehr.						+			+
Thalassionema nitzschiodes Kutz.	++	++	+	++	++	+	+	+	++
Thalassiothrix frauenfeldii Grun.									++
Triceratium untediluvianum Herib	++	++	+	+	+	+		++	+
II – *Dinophyceae*									
Diplopsalis lenticula Bergh.	+	+				+	+	+	++
Exuvaiella apora Schiller.	++++	++++	++++	++++	++++	++++	++++	++++	++++

Table (IV): continued.

	East ◄			Sampling stations				► West	
Parameters	St 1	St 2	St 3	St 4	St 5	St 6	St 7	St 8	St 9
Gonyaulax apiculata (Pend.) Entz.	+						+		
G. orientalis Lind.	+	+	++	+++	++	+++	++	+	++
Gymnodinium smile Skuja	+++	++	+++	++++	++	++++	++++	++++	++
Hermecium adriaticum Entz.	+	++	+			++	+	+	
Peridinium inconspicumi Lemm.	+++	++++	++++	++++	++	++++	++++	++++	+++
Prorocentrum micans Ehr.	++	+++	++++	++++	+++	++++	+++	+++	+++
Gomnolax monocantha Entz.								+	
III – *Cyanophyceae*									
Oscillatoria agardhii Gomont.						+	+	+	+
O. sp.									+
Phormidium retzii (Agardh) Gomont.			+				+		+
V- *Chlorophyceae*									
Scenedesmus quadricauda (Turp.) Breb	+	+							
Euglena sp.		+	+					+	

Discussion

The phytoplankton species, which are endemic in Lake Qarun, are exogenous. It has two sources, the first is freshwater origin and the other is saline. The saline source species were coming into the lake through transportation of fish fries from the Mediterranean. While, the freshwater source species is coming with the drainage water, which beginning from the Nile and drained into the lake. For the conformation of this respect, some of the epidemic species in the lake (e.g. *Aulacoseira granulata, Cyclotella glomerata, C. Kuetzingiana. Nitzschia frustulum, and N. palea*) have been recorded in the Nile water (Abd El-Monem; 1995 and Abd El-Karim; 1999). Also, the highest number of species were located in front of the Drain (st1 at El-Bats Drain) and decreased gradually towards inside, as the result of stress conditions such as salinity or pollution load which are increased progressively. Greater number of sensitive species are eliminated, whereas, at extremely high stress conditions the tolerant species are survive. A few of the tolerant species are found in a great numbers. In the present investigation, the spatial distribution for some species introduced the two opposite species (sensitive and tolerant), the first is *Nitzschia fonticola* and *N. frustulum* var. *perpusilla,* as sensitive species, while the second is *N. closterium* as tolerant one.

The drainage water discharging into the lake, increases dissolved inorganic carbon and nutrients in the lake water. Its availability in natural waters has become a fraught question of lake as has direct relevance to the problems of eutrophication. Whether or not phosphorus or carbon as the major limiting factor for phytoplankton growth in eutrophic waters is beyond the scope of this review, but it seems clear that both dissolved and atmospheric source of carbon can contribute to carbon available for photosynthesis (Harris, 1978). Different species of phytoplankton have different abilities when it comes to taking up dissolved inorganic carbon from water (Talling, 1976). On the other hand, phytoplankton taxonomic composition and species diversity change with increasing nutrient levels (Smith 1990) and these changes are related to differences among taxa in nutrient uptake, storage, growth, and loss rates (Kalff and Knoechel 1978, Reynolds 1984). There is a well established positive relationship between nutrient loading and productivity in lakes (e.g. Schindler 1978). Growth of phytoplankton may be limited by one of several nutrients (e.g. phosphorus, nitrogen carbon, silica) in a manner that has been related to cellular stochiometric ratio (e,g, Hecky and Kilham 1988, Susan *et al*, 1997). Numerous studies have shown that phytoplankton taxonomic composition and species diversity change with increasing nutrient levels (e,g, Lazerte and Watson 1981, and Smith 1990). Moderate enrichment results in higher and more seasonally variable levels of phytoplankton biomass, along with increased taxonomic diversity (Sommer *et al.* 1986). Eutrophic and hypereutrophic lakes sustain very high average algal biomass often dominated by very few taxa, usually Cyanobacteria, diatoms, or in some water-bodies, Chlrococcales or dinoflagellates (e.g. Padisak and Doklil 1994; Jensen *et al.* 1994).

The examined indexes related to species diversity (richness, diversity, evenness, redundancy and dominance) showed considerable differences as far as the scaling of their values in relation to taxonomic changes. This due to the fact that the different indexes measured different aspects of the partition of abundance between species. Thus, species evenness, redundancy and dominance varied more widely and, therefore, they were more sensitive and powerful discriminators than richness and diversity for sample comparisons.

The presence of low diversity with a high dominance ratio for a certain species in the lake, is the typical form of eutrophic and hypereutrophic lakes. The lake has a low diversity, low evenness, very low redundancy and moderate dominance. These observations on the phytoplankton association in Lake Qarun prompted the following hypothesis of community structure in relation to pollution.

Diversity of communities in clean water is generally high and can be therefore very variable, covering the whole range of diversity. Or it can emphasis that the lake water lies under a heavily polluted environments. Long term changes on phytoplankton structure inhabiting lake Qarun during the last ten years revealed a severe drop in number of species. Nosseir Abou-El-Kheir (1970) recorded 85 species in one season. In 1989, 119 taxa were recorded through seasonal investigation (Abd El-Monem; 1991), while the monthly examination during 1996 recorded 101 taxa (Anonymous; 1997), and decreased to 50 taxa in the present work. Drop in species composition reflects the severe impact of the pollution load environments on the lake conditions. This finding coincided with that of Rabeh, (2001), who studied the bacterial activity of the same samples and reported that there is a notable decrease in bacterial content in the lake, which may represent a warning sign to some adverse ecological changes, especially high salinity, that may threat the biota of the lake.

The waste drained from both El-Bats Drain and pumping stations (on the eastern side) were loaded with pollutants (Anonymous; 1997) including sewage and agriculture nutrient wastes. While the western part was affected by El-Wadi drainage water, which are loaded with chemical salts pollutants, wasted from the salt Production Company (AMISAL). Also, Rabeh, (2001) stated that the two drains maintained the highest counts of aerobic heterotrophic bacteria and a gradual decrease from east to west. In this respect, the drains water contained highest counts of total and faecal coliform bacterial comparing with the lake water (Sabae and Rabeh, 2000). The presence of coliforms bacteria is one of the most useful indicators of sewage pollution (Sabae and Rabeh 2000). Sewage contains many kinds of organic material together with products formed from their partial, preliminary decomposition. In addition, the phosphates from detergents and small amounts of other wastes will be present. The relative effect on algae of each constituent in the complex mixture has not been determined (Campbell, 1973).

Phytoplankton species may be affected by pollution in a number of ways: a) they may be discouraged from growing as a result of being deprived of sunlight; b) the substances may be toxic or may ecologically modify the physical or chemical environment sufficiently to retard or prevent growth; c) they may suddenly have competition with additional organisms; d) certain phytoplankton may be stimulated to increased growth and multiplication; e) a change may also occur in the individual types or the groups of organisms that predominate; f) some phytoplankton may form blooms, the total algal population may be increased or decreased; g) oxygen production and utilization of nutrient substances by algae may be greatly modified; h) and the color, odor, and taste of the water may be changed by the algae (Mervin, 1980).

However environmental factors other than pollution can also affect the structure of the community, resulting in some associatiowith low diversities. The temporal fluctuations of diatoms ratio was biologically regulated. The summer decreasing in this ratio can be ascribed to the grazing pressure of zooplankton. In this respect, El-Sabrawy and Taha, (1999) stated that zooplankton in lake Qarun play a major role in regulation of phytoplankton in summer, when *Brachionus plicatilis* was the most predominant zooplankter which feeds mainly on *Nitzschia sigma* and *N. frustulum* var. *perpusilla*. However zooplankton grazing is not an important overall regulator of phytoplankton assemblage of the lake in winter and spring when nauplius larvae (Copepoda), *Tintinnopsis strigosa* (Protozoa) were the most abundant zooplankton.

Diversity in itself, therefore, is not a reliable estimator of water quality. One cannot predict with any certainly the degree of pollution at any particular diversity value. High diversity values can represent any condition from clean water to mild enrichment, values in the middle of the scale anything from clean to moderately polluted water, while low diversity can represent communities from either clean or heavy polluted water (Archibald; 1972).

Some of phytoplankton dominant species in the lake are bloomed in some locations under a certain condition. *Prorocentrum micans* is one of the nuisance species intimidate the lake. Premazzi and Laura, (1993) recorded it in toxin-producing phytoplankton. They reported that, algal blooms associated with nutrient enrichment from municipals and industrial activities. In the spreading of algal blooms other human activities are involved, such as, ballast water, shellfish transport and aquaculture activities. Pollution and especially domestic pollution, has often been considered as an amplifying factor with regard to coloured waters. Nevertheless no correlation has been clearly established between the global level of pollution, and toxic dinoflagellate bloom. Some authors think that disequilibrium in the ratio N/P/Si, caused by eutrophication processes, could be at the origin of these noxious blooms. There are good reasons to believed that the persistent recurrence of flagellate bloom is related to changed nutrient conditions due to eutrophication, especially the input of inorganic nitrogen compounds. Phytoplankton bloom formation depends not only the supply of nutrients, but also on a variety of other environmental factors such as the availability of light and the absence or the ineffectiveness of grazers.

Conclusion and recommenditions

The lake biota are greatly affected by the destructive action of the pollutants which are drained into the lake. The abnormal increasing in accumulation rate of salinity represents dangerous effects on the lake environments.

It is recommended that, monitoring studies must be done to study the impact of the different pollutants and the effect of its accumulation on the lake biota. Toxicity test for the dominant phytoplankton species must be tested especially during the bloom to detect its level and types. It is must be stopped the draining of the brine water into the lake.

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التنـوع البيولوجى لمكونـات الهائمـات النبـاتية فى بحـيرة قـارون (الفيـوم-مصـر) واستخـدامها كدليـل للتلـوث البيئـي

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تم تقييم التكوين الموسمي للهائمات النباتية لبحيرة قارون. أجمالي ما تم تعريفة ٥٠وحدة تقسيمية تنتمى الى ٤ عائلات وهى الدياتومات (٣٦ وحدة تقسيمية)، السوطيات (٣٦ وحدة تقسيمية)، والطحالب الخضراء المزرقة (٣ وحدات تقسيمية) وأخيرا الطحالب الخضراء (وحدتين تقسيمية). وقد أظهرت النتائج المعملية تسيد ٥ وحدات تقسيمية فقط من الدياتومات (سيكلوتيلا جلوميراتا، سيكلوتيلا كوتزنيانا، نتشيا كلوستيريم، نتشيا فونتكولا و نتشيا فرستيولم بيربوزيلا) شكلت نسبة ٨٩,٤٤% من كثافتها وكذلك خمسة أجناس من السوطيات (اجزوفيلا أبورا، جيمنودينيم أورينتالز، جيمنودينيم سميل، بيريدينيم انكونسبيكم و برورروسنترم ميكانز) شكلت نسبة ٩٦,٧% من كثافتها.

وقد استخدمت معادلات التنوع البيولوجى لتقييم مدى تنوع ألأجناس، الثراء ، التوازن، الوفرة وكذلك نسبة السيادة لأكثر وحدة تقسيمية ين كثافة فى البحيرة. وقد قورنت هذه النتائج بالدراسات السابقة ونوقشت مع التأثير التراكمى للملوثات التي تصب في البحيرة. وقد ابرزت نتائج تطبيق هذه المعادلات مدى تأثر الحياة البيولوجية فى البحيرة بالتفاعلات المدمرة لهذه الملوثات. وقد أشارت الدراسة الى ان بعض من الأجناس السائدة فى البحيرة من الأنواع التي لها القدرة على إفراز السموم الطحلبية.