Bull. Nat. Inst. Oceanogr. & Fish. ARE, 15,(2), 1989: **101 - 118**

ECOLOGY OF BACILLARIOPHYCEAE IN LAKE BUROLLUS, EGYPT

ZEINAB M. El-SHERIF, AMIN A. SAMAAN AND RAMSIS R. ABDALLAH

National Institute of Oceanography and Fisheries, Alexandria, Egypt.

ABSTRACT

The ecology of diatoms in Lake Burollus was estimated monthly during the Years 1978 and 1979. Bacillariophyceae ranked as the second important component of phytoplankton in the Lake after Chlorophyceae and it contributed about 26.8 % of their counts (average 842 thousand cells/l). It included 59 species within 23 genera and 6 families. The dominant diatoms were **Nitzschia** spp. (67.6 % of the total diatom counts) and **Cyclotella meneghiniana** (13.4 %), while **Melosira** spp., **Synedra** spp. and **Cocconeis placentula** appeared as frequent forms. The other diatoms remained infrequent or rare. Most of the diatoms inhabiting the Lake are littoral, oligohalobous halophilous species, while few are mesohalobous or euhalobous diatoms.

The maximum persistence of diatoms in the Lake was in general around the southern margins nearby the land drains, particularly in the middle and western sectors. Their numbers were subjected to irrgular monthly fluctuations within the three sectors of the Lake. They showed a general increase in 1979, compared with their densities during 1978. Lake Burollus is considered as an eutrophic lake with a mixed chlorococcal-diatom type of phytoplankton.

INTRODUCTION

Lake Burollus represents the second important Nile Delta lake (Egypt) as regards to its total area which covers 48,000 hectars. The Lake is a shallow brackish water lake, with an average depth of about 120 cm. It lies at the north of the Nile Delta along the Mediterranean coast between longitudes 30° 30′ and 31° 10′ E and latitude 31° 35′ N. The main sources of water supply are five main drains that open at the southern margin of the Lake, beside Brimbal Canal which is situated at its western extrimity and Burollus Drain at its north eastern side (Fig. 1). The amount of water discharged into the Lake varies from one year to the other and it averages about 2.6 milliard cubic meters per year. The surplus water flows constantly from the Lake into the sea through a small opening called Boughaz El-Bourg. Sea water may on rare occasions invade the Boughaz region as well as the eastern Lake particularly during winter.

The phytoplankton community in Lake Burollus is rich, both in density and number of species. Chlorophyceae contributed about 53.0 % of the total phytoplankton counts while Bacillariophyceae amounted to 26.8 %. Members of Cyanophyceae were less frequent and they constituted collectively about 18.7 % of the total phytoplankton. Results of the quantitative estimation of chlorophytes in the Lake were previously given by Samaan et al (1989). The present paper deals with the distribution and seasonal variations of diatoms in correlation with the prevailing environmental conditions in the Lake.

MATERIAL AND METHODS

Quantitative estimation of diatoms in the Lake was carried out, using the sedimentation technique. One litre of water sample was collected from the different stations with a Ruttner water sampler and the sample was fixed with 40 % neutral formalin solution. In the laboratory, the samples were transferred to graduated cylinders of one liter capacity. Few drops of ligol's solution were added and the samples were left to sediment for 48 hours. The supernatant layer was then siphoned slowly until the sample was concentrated to exactly 100 cc. Subsamples or 1 cc were transferred into a counting cell and each plankter was counted separately under a research microscope.

Eighteen stations were selected as representing the differnt parts in the Lake as shown in Figure 1. These stations were further grouped into three sectors, namely, eastern lake (stations 1-6), middle lake (Stations 7-12) and western lake (Stations 13-18).

Sampling was carried out monthly during the period from January, 1978 to December, 1979.

RESULTS

Community composition of Bacillariophyceae:

Diatoms, as a whole, contributed about 22.5 % and 31.1 % of the total phytoplankton counts in Lake Burollus during 1978 and 1979 respectively (average annuals 618,200 and 1,066,500 cells/l). They were represented by 59 species included in 23 genera within 10 families. Nitzschia Hassal and to a less extent Cyclotella kutz. were the most dominant genera in the Lake, while Melosira Agardh., Synedra Ehr. and Cocconeis Ehr. appeared frequently. The other diatoms persisted as infrequent or rare forms.

The systematic positions of the different diatom species recorded in the Lake are given in the following list.

Class: Bacillariophyceae
Order: Centrales
Suborder: Coscinodiscineae
Family: Coscinodiscaceae

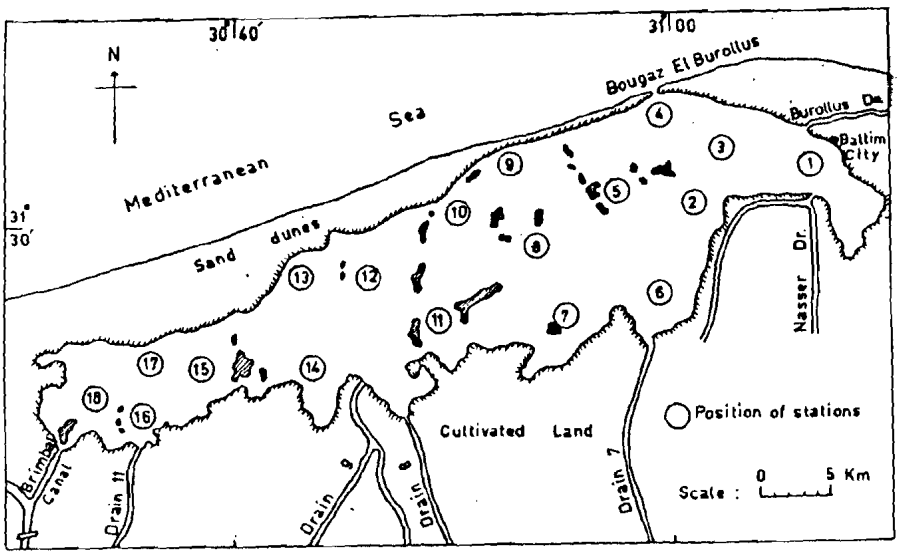

FIG. 1
Morphometry of Lake Burollus and position of stations

- Melosira granulata (Ehr.) Ralfs.
- M. varians Ag.
- Cyclotella meneghiniana Kutz
- Hyalodiscus laevis Ehr.
- Podosira montagnei Kutz

Suborder: Biddulphineae
Family: Chaetoceraceae
- Chaetoceros compressus Lauder.

Family: Biddulphiaceae
- Biddulphia laevis Ehr.

Order: Pennales
Suborder: Fragilarineae
Family: Fragilariaceae
- Synedra ulna Ehr.
- Synedra tabulata Kutz.
- Synedra reumpens Kutz.

Suborder: Achnanthineae
Family: Achnanthaceae
- Rhoicosphenia Grun.
- Cocconeis placentula Ehr.

Suborder: Naviculineae
Family: Naviculaceae
- Mastogloia elliptica (Ag.) Cleve.
- Mastogloia smithii Thw.
- Mastogloia braunii Grun.
- Amphiprora paludosa Sm.
- Caloneis silicula Cleve

- Pleurosigma macrum W. Sm.
- Pleurosigma elongatum Sm.
- Pleurosigma decorum Sm.
- Navicula cryptocephala Kutz.
- Navicula gregaria Donk.
- Navicula yarrensis Grun.
- Navicula cuspidata Kutz.
- Navicula humerosa Breb
- Navicula viridula Kutz.
- Navicula gracilis Ehr.
- Diploneis didyma Ehr.

Family: Gomphonemataceae

- Gomphonema subclavatum Grun.
- Gomphonema gracile Ehr.
- Gomphonema olivacum Kutz.
- Gomphonema constrictum Ehr.
- Gomphonema intriactum Kutz.

Family: Cymbillaceae

- Cymbella affinis Kutz.
- Amphora coffeoformis Ag.
- Amphora ovalis Kutz.
- Epithemia zebra (Ehr.) Kutz.
- Epithemia sorex. Kutz.
- Rhopalodia gibba (Ehr.) O. Miller.
- Rhopalodia gibberula (Ehr.) O. Miller.

Suborder: Surirellineae

Family: Nitzschiaceae

- Nitzschia palea (Kutz). W. Sm.
- Nitzschia microcephala Grun.
- Nitzschia reversa W. Sm.
- Nitzschia sigma (Kutz.) Sm.
- Nitzschia punctata (Sm.) Grun.
- Nitzschia frustulum (Kutz.) Grun.
- Nitzschia apiculata (Greg.) Grun.
- Nitzschia closterium Sm.
- Nitzschia longissima (Breb.) Ralfs.
- Nitzschia amphibia Grun.
- Nitzschia obtusa W. Sm.
- Nitzschia panduriformis Grun.
- Nitzschia circumsuta (Baily) Grun.
- Nitzschia acuminata (W. Sm.) Grun.
- Bacillaria paradoxa Gmel.

Family: Surirellaceae.

- Surirell striatula Turp.
- Surirell ovalis var. angusta Kutz.
- Campylodiscus echeneis Ehr.
- Campylodiscus clypeus Ehr.

Distribution and seasonal variations:

The horizontal distribution of diatoms in the Lake is illustrated in Fig 2. During 1978, the diatoms appeared more dense at the southern margins of the lake particularly in the middle sector and they decreased gradually northwards. The average numbers of diatoms were nearly doubled in 1979 at both the eastern and western sectors, mainly due to the increased numbers of Nitzschia, Cyclotella and Melosira.

The total number of diatoms showed irregular monthly fluctuations in the three sectors. The eastern Lake harboured higher counts in January of both years and in spring and late summer of 1978 and 1979 respectively (Fig 3). The higher counts of diatoms in the middle lake were in August, 1978 and during June and September, 1979. The western Lake sustained conspicuious high peaks in the summer and autumn of 1979, otherwise they remained at more or less constant lower values throughout the rest of the investigation period.

The following is a summary on the distribution and seasonal variations of the different genera given according to their frequencies.

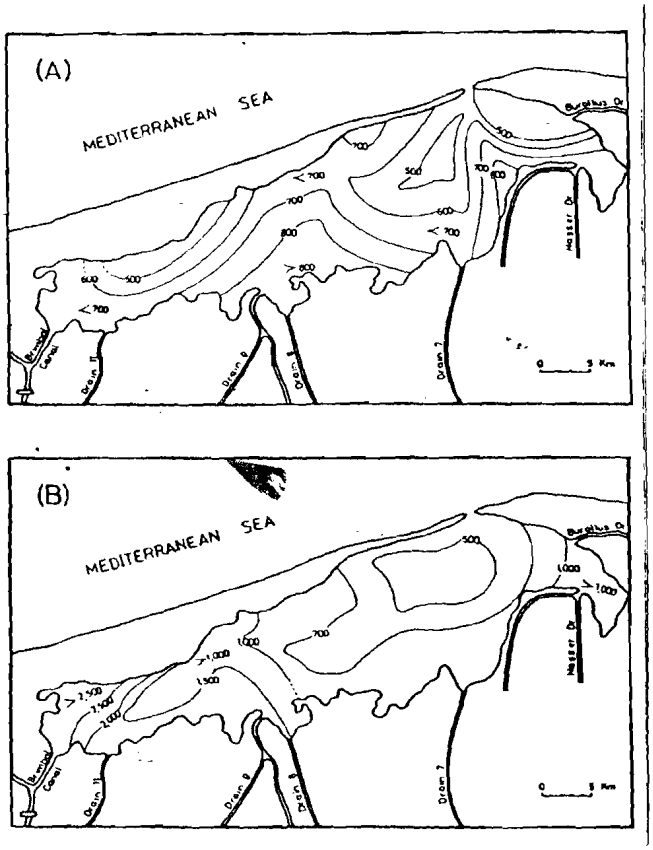

FIG. 2
Horizontal distribution of diatoms (thousand cells/l) in Lake Burollus.
(A) average of 1978 ; (B) Average of 1979.

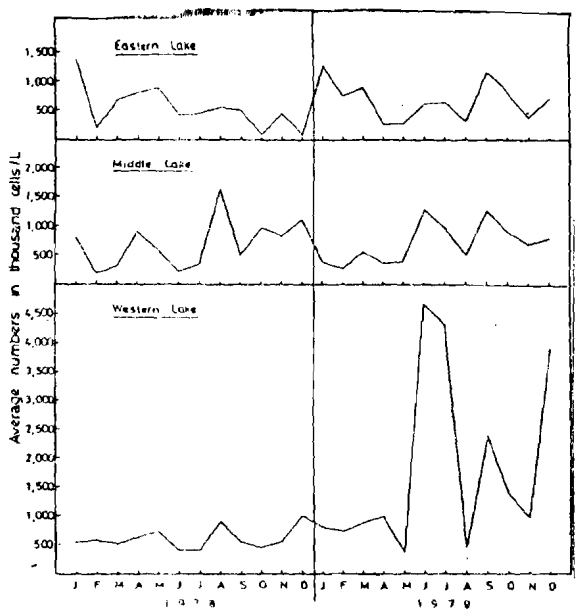

FIG. 3
Seasonal variations of diatoms in Lake Burollus.

1- **Nitzschia** Hassal

Nitzschia appeared as the most dominant diatom in Lake Burollus as it contributed numerically about 64.6 % (399,100 cells/l) and 70.5 % (751,400 cells/l) of the total diatoms during 1978 and 1979 respectively. Its horizontal distribution in 1978 showed highest density in the middle Lake while this was shifted to the western sector in 1979 particularly due to the increased numbers of N. palea (fig. 4). The genus was represented by 14 species of which **N. Palea, N. microcephala** and **N. reversa** were dominant while the others persisted as infrequant or rare forms as shown in Table 1.

Nitzschia spp. appeared all the year round. Their numbers in the eastern Lake tended to increase in January and May, 1978 as well as during the period January-March, 1979 (Fig. 5). The middle sector sustained high peaks in the summer and autumn of the successive years. The maximum persistence of **Nitzschia** in the western Lake appeared also in the summer and autumn of 1979.

Nitzschia palea was more dense in the middle and western Lake, showing highest counts during the summer and early autumn. The species is of wide distribution in the Egyptian

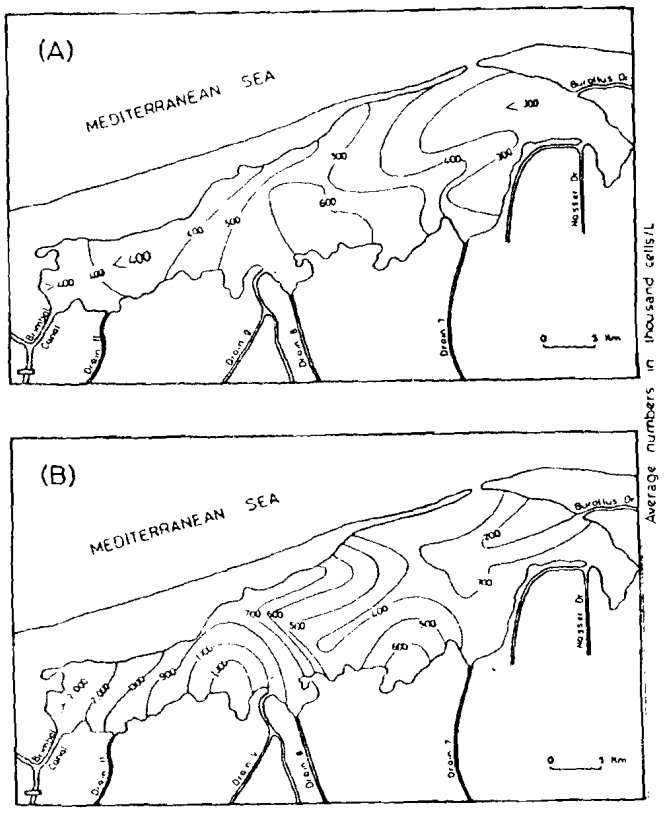

FIG. 4
Horizontal distribution of **Nitzschia** spp. (thousand cells/l) in Lake Burollus.
(A) average of 1978 ; (B) Average of 1979.

Delta lakes and Nile River (Soliman 1983 and Zaghloul, 1976), it is regarded as oligohalobous halophilous diatom which is usually favoured by high temperatures (Venkateswarlu, 1970).

Nitzschia microcephala was more dominant in the western Lake, decreased gradually eastwards. The peaks appeared mostly in the summer and autumn. It is considered as an oligohalobous halophilous species (Salah, 1960) alkaliphilous (Foged, 1948). It was previously recorded in the Egyptian Delta lakes.

Nitzschia reversa was frequently recorded in the eastern and middle sectors of the Lake, showing maximum persistence in early winter. It is regarded as mesohalobous euryhaline species.

Table 1
Average annual counts of the different species of Nitzschia (cells/l) recorded in Lake Burollus during 1978 and 1979 and their ecological affinities.

Species	average annual (cells/l)		Habitat
	9781	1979	
- N. microcephala	155,300	239,800	Oligohalobous, halophilous, littoral.
- N. palea	139,000	322,000	Oligohalobous, halophilous, littoral.
- N. reversa	39,600	122,000	Euhalobous, littoral.
- N. frustulum	12,100	24,200	Oligohalobous, halophilous,
- N. punctata	11,600	11,000	Oligohalobous, halophilous; littoral.
- N. longissima	10,100	9,200	Euhalobous, littoral.
- N. apiculata	7,300	8,300	Oligohalobous, halophilous; littoral.
- N. sigma	10,600	8,900	Mesohalobous, littoral.
- N. closterium	6,200	4,700	Mesohalobous, euryhaline, neretic.
- N. amphibia	5,900	400	Oligohalobous indifferent, littoral.
- N. obtusa	very rare	very rare	Mesohalobous
- N. panduriformis	" "	" "	Euhalobous, neretic.
- N. circumsuta	" "	" "	Euryhalinc, neretic.
- N. acuminata	" "	" "	Euryhalinc, littoral.

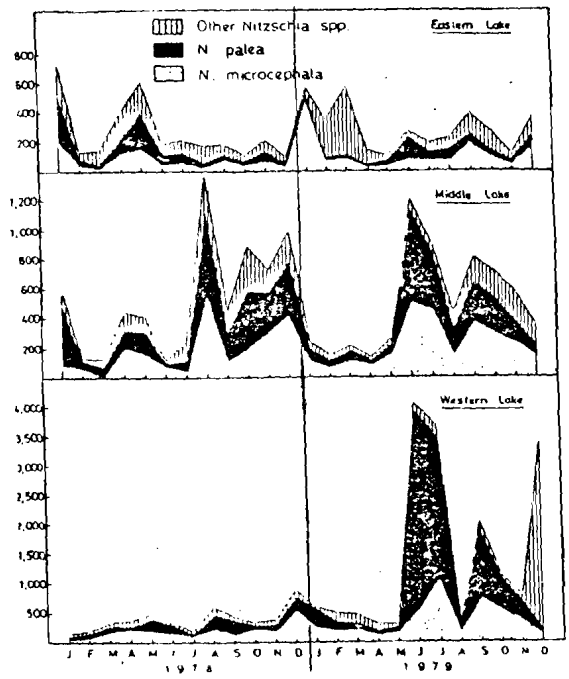

FIG. 5
Seasonal variations of **Nitzschia** spp.
in Lake Burollus.

Most of the other **Nitzschia** spp. recorded in the Lake are regarded as oligohalobous halophilous diatoms except for **N. longissima, N. panduriformis** which are euhalobous marine diatoms and **N. sigma, N. closterium** and **N. obtusa** which are regarded as mesohalobous diatoms (Foged, 1949 and Salah, 1960).

2- **Cyclotella** Kutz

Cyclotella meneghiniana represented the second important diatom in the Lake and it contributed about 15.3 % (94,600 cells/l) and 11.4 % (121,500 cells/l) of the total diatoms during 1978 and 1979 respectively. Its maximum frequency was noticed in the western Lake during 1978 and at both the eastern and western sectors in 1979 (Fig. 6).

Cyclotella meneghiniana appeared all the year round, showing higher densities in winter and or early spring. Relatively high counts were also observed in the autumn of 1979 (Fig. 7).

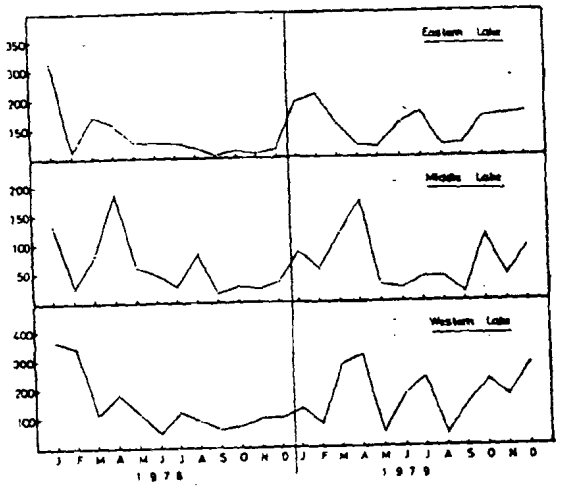

FIG. 7
Seasonal variations of Cyclotella sp. in Lake Burollus.

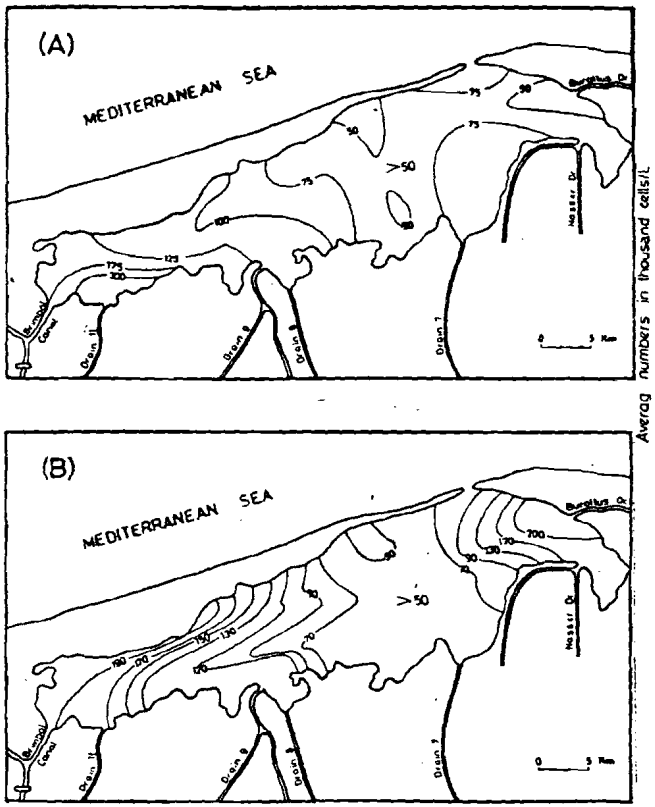

FIG. 6
Horizontal distribution of Cyclotella sp. (thousand cells/l) in Lake Burollus.
(A) average of 1978 ; (B) Average of 1979.

The species is known to favour both high and low chlorosity values (Foged, 1948 and Kopczynska, 1980). Peterson (1943) regarded it as a halophilous form. It is considered as a littoral diatom, occusionally found in the plankton. Cyclotella meneghiniana is of wide distribution in the Egyptian Delta lakes (Aleem and Samaan, 1969 and Samaan, 1974), along the Mediterranean Coast (Gergis, 1983) as well as in the Nile River (Zaghloul, 1976).

3- **Melosira** Agardh

Melosira was infrequently recorded in the Lake during 1978, forming numerically about 1.1 % of the total diatoms (6,500 cells/l). This value increased to 53,700 cells/l in 1979 with a percentage frequency of 5 %. The genus was represented by **M. granulata** and **M. varians**. The two species appeared more frequent along the southern margins of the Lake, nearby to the influx of land drains.

As shownm in Fig 8 the distribution of **Melosira** during 1978 was confined to the winter in the eastern lake and in April and May in the middle and western sectors respectively. It appeared more common in 1979, particularly in the western sector showing scattered peakes.

The two species are characteristic diatoms of the Nile River (El-Nayal, 1936). They appeared also in big numbers in land drains (Soliman, 1983) and the Egyptian Delta Lakes (Salah, 1961). They are considered as oligohalobous diatoms.

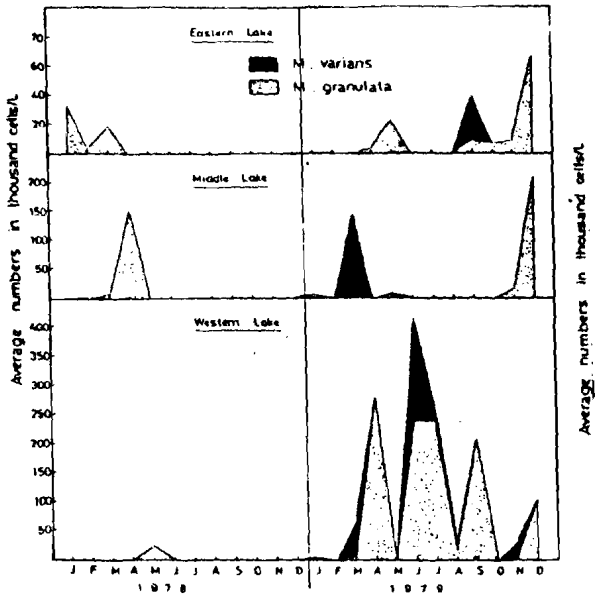

FIG. 8
Seasonal variations of Melosira spp. in Lake Burollus.

4- Synedra Ehr

Synedra spp. contributed numerically about 4.0 % (24,900 cells/l) and 2.7 % (28,500 cells/l) of the total diatoms during 1978 and 1979 respectively. The genus was represented by 3 species, namely, **S. ulna, S. tabulata** and **S. rumpens**, the former one appeared more common.

Synedra ulna was more abundant in the middle Lake, showing higher counts during the spring and autumn of 1978 as well as in the winter and autumn of 1979 (Fig. 9). The species is regarded as indifferent form (Peterson, 1943).

Synedra tabulata appeared mostly in the middle and eastern Lake during winter and autumn while it persisted as a rare diatom in the western sector. Peterson (1943) considered it as a halophilous diatom while it was regarded by Salah (1960) as mesohalobous species.

Synedra rumpens was rarely observed in spring and early summer. It is regarded as indifferent form (Peterson, 1943).

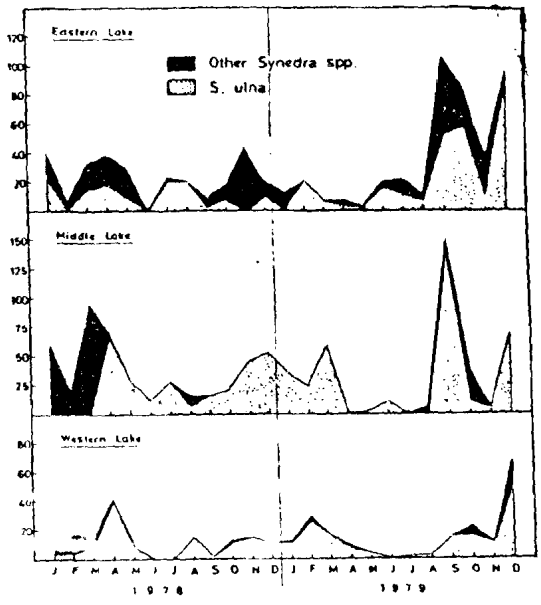

FIG. 9
Seasonal variations of **Synedra** spp. in Lake Burollus.

The three species were previously recorded in the Egyptian Delta lakes (Salah, 1960, and Soliman, 1983). Synedra ulna and S. tabulata was also observed along the Mediterranean Coast of Egypt (Dowidar, 1974).

5- Cocconeis Ehr

Cocconeis placentula was frequently recorded in the eastern Lake, while it remained rare in the other two sectors. Its average annual values for the whole Lake amounted to 22,500 cells/l (3.6 % of the total diatoms) and 31,500 cells/l (3.0 %) during 1978 and 1979 respectively.

The species is a littoral diatom. It grows both epiphytic on submerged hydrophytes and in the plankton. This may explain its maximum abundance in the eastern Lake which harbours a dense growth of Potamogeton pectinatus.

Cocconeis placentula appeared all the year round, showing maximum distribution during March, 1978 and January, 1979 in the eastern Lake. It remained low in the other two sectors throughout most of the investigation period, except of relatively higher counts recorded in the middle Lake during spring of 1978 and in September, 1979, (Fig. 10).

The species was frequently recorded in the Egyptian Delta lakes (Salah, 1961 and Soliman, 1983), and scarcely along the Mediterranean Coast of Egypt (Dowidar, 1974). It is considered as oligohalobous halophilous diatom (Salah, 1960).

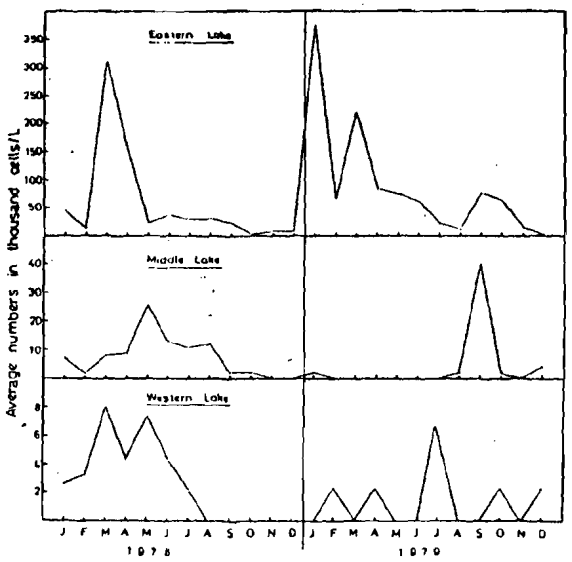

FIG. 10
Seasonal variations of Cocconeis sp.
in Lake Burollus.

species but were mainly represented by **Melosira granulata** which formed over 99 % of the total diatoms there. In the highly eutrophic Lake Mariut which is contaminated with sewage and industerial wastes, the diatoms were more sensitive to pollution and constituted only 15.9 % of the total phytoplankton counts, with an average annual of 8,893 thousand cells/l (Ghobrial, 1987). The diatoms there were only represented by 12 species but were dominated by a single diatom, **Cyclotella meneghiniana**, which constituted about 96.0 % of their total numbers. On the other hand, the diatoms in the mesotrophic Lake Edku were more diversified and included 54 species. They contributed numercially about 87 % of the total phytoplankton there although their total numbers decreased to 13,700 cells/l (Soliman, 1983). Several species remained more or less frequent in Lake Edku with different degree of abundance. These included; **Cyclotella meneghiniana** (21.0 % of the total diatoms) **Navicula** spp. (15.0 %), **Nitzschia** spp. (15.5 %), **Rhoicosphenia curvata** (12.0 %), **Cocconeis placentula** (10.7 %), **Synedra** spp. (9.1 %) and **Bacillaria paradoxa** (8.5 %). For Lake Burollus the diatoms contributed about 26.8 % of the total phytoplankton counts during the present investigation (842 thousand cells/l). Like Lake Edku, they were also diversified comprised 59 species. However, the dominant species remained few and included **Nitzschia palea** (27.4 % of the total diatoms), **N. microcephala** (23.5 %), **N. reversa** (9.6 %) and **Cyclotella meneghiniana** (13.4 %).

These results indicate that in most productive lakes few species of phytoplankton are usually responsible for the increased numbers of the population although the community may harbour several species.

Concerning the phytoplankton community in Lake Burollus, Bacillariophyceae as a whole ranked as the second important component after Chlorophyceae which constituted about 53 % of the total phytoplankton counts (Samaan et al., 1989). Cyanophyceae was less frequent and contributed only about 18.7 % of their total numbers. The main plankters in the Lake were **Nitzschia** spp., **Cyclotella meneghiniana**, **Dictyosphaerium pulchellum** and **Scenedesmus**.

Referring to the phytoplankton types given by different investigators for certain lakes (Hutchinson, 1967), Lake Burollus is considered as an eutrophic lake with a mixed chlorococcal-diatom plankton type.

REFERENCES

Aleem, A.A. and A.A. Samaan, 1969. Productivity of Lake Mariut, part II- Primary production. **Int. Revue Ges. Hydrobiol.**, 54 (4): 491-527.

Cupp, E.E., 1943. Marine plankton diatoms of the west coast of North America. **Bull. Scripps Inst. Ocean, Univ. California**, V (1): 1-238.

Dowidar, N.M., 1974. The phytoplankton of the Mediterranean waters of Egypt. I-A cheklist of the species recorded. **Bull. Inst. Oceanogr. & Fish.**, 4: 319-344.

El-Nayal, A.A., 1936. Contribution to our knowledge of the fresh-water algae of Egypt. Bull. Fac. of Sc., Cairo, Part I (9): 105 pp.

El-Sherif, Z.M., 1983. Limnological investigations on the aquatic plant life in Lake Burollus in relation to the dominant environmental conditions. Ph.D. Thesis, Faculty of Science, Cairo University, 385 pp.

Foged, N., 1948. Diatoms in water-courses in Tunen. Dansk Botanisk Arkiv., Bind 12 (5,6,9 and 12).

Foged, N., 1949. Diatoms in the salt bog labgemose in east Funen., Dansk. Botanisk Arkiv., 13 (6).

Ghobrial, M.G., 1987. Effect of water pollution on the distribution of phytoplankton in Lake Mariut. M. Sc. Thesis, Fac. Sc. Alexandria University, 265 pp.

Gergis, W.L., 1983. Distribution of the phytoplankton Along the Egyptian Mediterranean Coast west of Alexandria. M.Sc. Thesis submitted to the Faculty of Science Alexandria University, 103 pp.

Hashim, M.A., 1954. Distribution and ecology of Diatoms in Lake Edku. M.Sc. Thesis, Alexandria University, 113 p.

Hustedt, Fr., 1939. Die Diatomeen - Flora des kustgebietes, der Nordsee Vom Dollard bis zur Elbem-undung I. Abh. Nat. ver. Bremen, 31: 572-677.

Hutchinson, G.E., 1967. A treatise on limnology, vol. II Introduction to lake biology and the limnoplankton. John Wiley & Sons, INC., New York., 1-1115.

Kolbe, R.W., 1927. Zur okologie, Morphologie und Systematik der Brackwasser Diatomeen die Kieselagen des Spereberger Salzgebiets. Pflansenforschung Heft, 7 : 1-146.

Kopczynska, Elzbieta., E., 1980. Chloride effect on the growth of Cyclotella meneghiniana and Melosira granulata. Biol Abstr., 71 (5)/ 29994 (1981).

Krasske, G., 1939. Zur kieselagen-Flora Sudchiles. Arch. Hydrob., 35.

Peterson, J.B., 1943. Some halobion Spectra. Det. Kgl. Dansk. Vied. Slesk., Biol. Medd., 17, (9).

Salah, M.M., 1960. The phytoplankton of Lake Mariut and Lake Edku with a general contribution to the Halbion System. Alexandria Inst. of Hydrobiol., Notes and Memoires, No. 57, 15 pp.

Salah, M.M., 1961. Biological productivity of Lake Mariut and Lake Edku. Alexandria Inst. of Hydrobiol., Notes and Memoires, No. 63, 35 pp.

Samaan, A.A., 1974. Primary production in Lake Edku. Bull. Inst. Oceanogr. & Fish., ARE, 4: 261-317.

Samaan, A.A.; Z.M. El-Sherif and E.Y. El-Ayouty, 1989. Distribution of Chlorophyceae in Lake Burollus (Egypt). Bull. Inst. Oceanogr. & Fish. ARE, 15.

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

Venkateswarlu, V., 1970. An Ecological Study of the Algae of the River Moosi, Hyderabad (India) with Special Reference to water pollution. IV. periodicity of some common species of algae. J. Hydrobiologia. 35: 45-64.

Zaghloul, F.A., 1976. Plankton production and composition in the Nile waters between Edfina and Rashid in relation to environmental conditions. M.Sc. Thesis, Faculty of Science, Alexandria University, 273 pp.

Zaghloul, F.A., 1985. Seasonal variations of plankton in Lake Nasser. Ph.D. Thesis, Faculty of Science, Suez Canal University, 364 pp.