EGYPTIAN JOURNAL OF AQUATIC RESEARCH 1687-4285
VOL. 31 NO. 2, 2005: 72-88.

SOME FACTORS AFFECTING THE PRIMARY PRODUCTION OF PHYTOPLANKTON IN LAKE BURULLUS

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Keywords: Lake Burullus - Primary production – Phytoplankton – Physico-chemical conditions.

ABSTRACT

This study which was carried out at the different stations and sectors of Lake Burullus during the period from January till December 2000 showed that the identified species of phytoplankton community in Lake Burullus during the period of study included the classes of Bacillariophyceae, Cyanophyceae, Chlorophyceae, Euglenophyceae and Dinophyceae. The total number of species recorded during this period was 65 species. The standing crop and primary production of phytoplankton showed pronounced variations at different stations and months correlated with physicochemical conditions of water especially phosphate , nitrate and silicate contents. Stations 6,10 and 15 were the most productive in the eastern sector ,the middle sector, and the western sector respectively. The productivity was lower at stations nearby the drains mouth. Positive correlation was observed between the transparency and the net production. Levels of temperature and dissolved oxygen are among the factors affecting the productivity.

In general, the dominance of Bacillariophyceae in the lake plays an important role in productivity, where it represented more than 65 % to the total count of phytoplankton during the period of study.

The results obtained indicated that, Lake Burullus harboured lower phytoplankton standing crop and primary production as compared with that previously recorded .

INTRODUCTION

It is very important to study the northern Delta lakes which represent a considerable source of fish production in Egypt. The role of phytoplankton as the main source of food supply for fish is well known, thus it is necessary to study the primary production and the standing crop of phytoplankton in Lake Burullus which is considered one of the most important northern lakes.

The phytoplankton population in Lake Burullus was investigated by many authors. Anon (1980) studied the seasonal variation of different species; El-Sherif (1983) Studied the limnological conditions affecting the aquatic plants in Lake Burullus in relation to the environmental conditions, El- Sherif and Aboul Ezz (1988) carried out preliminary study on phytoplankton-zooplankton relationship, Kobbia (1982) studied the standing crop and primary production of phytoplankton and El-Sherif (1993) studied the phytoplankton standing crop, diversity and statistical multispecies analysis.

The site diagnosis

Lake Burullus is situated at the northern part of the Nile Delta between the two Nile branches. Its area during the period of investigation was about 410 km^2. This lake is separated from the Mediterranean Sea at the north by sand dunes and sand bars and is connected to the sea with Boughaz El-Burullus. The eastern and southern borders are characterized by agricultural lands and fish farms (Fig. 1).

Large amounts of agricultural water enter the lake via several drains which are considered as the main source responsible for increasing productivity of phytoplankton and the community structure.

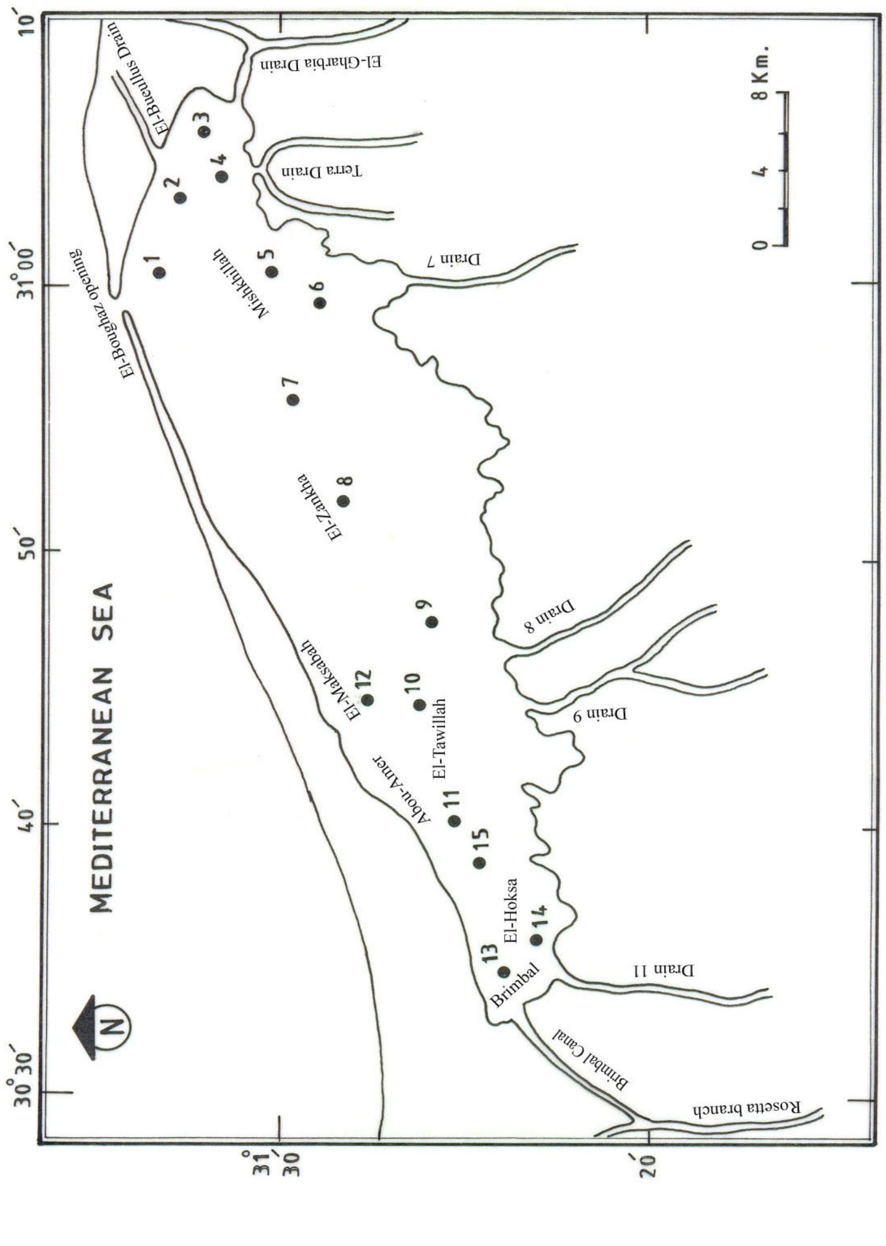

Fig . 1 : Map of Lake Burullus showing sampling locations

MATERIALS AND METHODS

Water samples were collected monthly during the period January-December 2000, at fifteen stations covering three sectors of the lake for estimating the standing crop through cell counts and measuring of chlorophyll-a content of the phytoplankton spectrophometrically according to Moss (1967).

Water temperature was measured by a thermometer accurate to 0.1^{o}C, transparency by Secchi disc (diameter of 30 cm), dissolved oxygen, total alkalinity, nutrient salts (Phosphate, Silicate & Nitrate) were determined according to standard method described in APHA (1989).

The concentrated phytoplankton samples by sedimentation technique were measured after siphonation and subsample one ml each, was transferred into counting cell for counting the phytoplankton cells or coenobia or filaments per liter

The identification of phytoplankton was carried out by using a binocular research microscope. For the identifications of phytoplankton species, the following references were consulted: El-Nayal (1935 and 1936), Prescott (1962 , 1978), Bold and Wynne (1978) and Vinyard (1979).

Measurements of oxygen changes in dark and transparent bottles were used to determine the primary production at the different stations of the lake according to Strikland and Parson (1972).

The following equations were used for determination of gross and net primary production as well as the rate of respiration.

Gross primary production (mg C/m^3/hr)=

$$\frac{CB - DB}{t} x \frac{12}{32} x1000$$

Net primary production (mg C/m^3/hr)=

$$\frac{CB - IB}{t} x \frac{12}{32} x1000$$

Rate of respiration (mg O_2/m^3/hr)=

$$\frac{IB - DB}{t} x1000$$

Where:

IB = Oxygen concentration as ml per liter for the initial bottle.

CB= Oxygen concentration as ml per liter for the transparent bottle.

DB= Oxygen concentration as ml per liter for dark bottle.

t = The period of incubation in hours.

Description of stations

Lake Burullus is affected mainly by agricultural drainage water mixed with different types of wastes from fish farms (Terra drain, drain 7, drain 8 and drain 11), industrial effluents (Terra drain , drain 7 and El - Gharbia drain) as well as domestic drainage water discharged mainly from El - Gharbia drain and drain 11.

As Shown in figure (1), the different stations can be identified as follows:

1- Station 1, located in front of Boughaz EL-Burullus.

2-Station 2, located in front of EL-Burullus drain.

3- Station 3, located in front of EL-Hawiss gate.

4- Station 4, located in front of Nasser drain.

5- Station 5, located near to Mish Khilla island.

6- Station 6, located in front of drain No. 7.

7- Station 7, located in the middle of the eastern sector.

8- Station 8, located in the middle sector of the lake (EL- Zanka zone).

9- Station 9, located in front of drain No. 8.

10- Station 10, located in the middle sector at EL – Tawila zone.

11- Station 11, located in the western side of the middle sector (Abou – Amer)

12- Station 12, located in the northern side of the lake (EL- Maksabah zone).

13- Station 13, located in the western sector of the lake, in front of Brimbal canal.

14- Station 14, located in front of drain No. 11 (western sector).

15- Station 15, located in the middle of the western sector.

Statistical analysis

Correlation coefficient at confidence limit 95% (n = 180) was estimated for all lake area.

RESULTS AND DISSCUSSION

I – physico – chemical Conditions

1-Temperature

The water temperature of the lake varied from season to season. The maximum average values of temp. (29.1 C°) were recorded in June and July, while the minimum one (16 C°) was recorded in February (Fig.2). The temperature plays an important role in the distribution and productivity of phytoplankton with populations variations in the levels of nutrient salts.

It was found that the temperature changes during the period of investigation have a pronounced effect on the total count of phytoplankton and chlorophyll ***a*** in summer months (July, August and September) together with the increase in the levels of nutrient salts in front of the mouths of drains. This coincides with Kobbia (1982) who reported that the temperature variations had great influence on standing crop and productivity. The highest value of net production recorded in November was due to predominance of diatoms during this month.

Statistical analysis of the results in different months showed a significant positive correlation between the total count of phytoplankton, chlorophyll a and water temperature (Table 2), while the relation was insignificant in the different stations (Table 3) due to the difference between the algal communities and their succession from season to season. This observation is in agreement with Brehrendt (1990) who mentioned that the effect of temperature variations on phytoplankton is mostly manifested on periodicity and communities succession of algae.

2- Water Transparency

The values of secchi disc readings showed that the thickness of the euphotic zone ranged between 10– 55cm at the investigated stations throughout the period of study. The average minimum value (21.7 cm) was recorded during January (Fig. 3) while the average maximum one (40 cm) was noticed during October. Station 4 recorded the lowest value (21.8 cm as an average), while the highest one (43 cm) was recorded at station 15 (Table 1).

Transparency values showed a pronounced significant positive correlation with total count of phytoplankton , chlorophyll ***a*** and net production in the different months and stations (Tables 2 & 3), where the photosynthetic activities increased with the increase of transparency. This observation is in agreement with Alleem and Samaan (1969) who illustrated a linear relation between phytoplankton production and Secchi disc reading in Lake Mariut.

3- Hydrogen Ion Concentration (pH)

PH value plays an important role in many life processes. It may also reflect the redox potential productivity and pollution level of the aquatic environments. The pH values in the present study were found to lie on alkaline side.

Table 1 : Annual average of some physico-chemical parameters and primary production at the different stations in Lake Burullus during the period of investigation

St.	Eastern sector							Middle sector					Western sector		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Transp.(cm)	32.5	27.9	23.8	21.8	24	22	29	28	23.5	27.8	38.8	30.8	38.8	30	43
Phosphate (μg-at/l)	1.2	1.2	1.6	3.3	0.9	3.4	0.8	1.2	1.3	2.2	1.4	0.9	0.8	1.7	0.8
Silicate(μg-at/l)	10.5	14.6	13.4	16.3	12.9	17.2	11.7	20.8	20	20.9	27.8	21	26.6	20.3	30.6
Nitrate (μg-at/l)	0.6	2.4	3.8	3.8	1.8	3.4	1.6	1.8	2.3	1.3	0.9	0.8	2.2	3.3	2.2
T. alkalinity mg Ca CO3 /l	248.2	276.8	287.3	278.2	279.9	255.7	245.2	246.5	307.5	287.2	279.7	253.9	221.5	207.5	187.6
Oxygen (ml/l)	8.9	7	7.5	6.6	7.7	8.0	9.2	8.2	8.9	8.5	8.9	8.3	9.8	6.7	9.2
Temp. C$^{\circ}$	22.5	22.8	22.2	21.9	22.4	22.9	22.8	22.3	22.8	22.2	21.8	22	22.6	23.2	23
pH	7.80	7.90	7.80	8.10	7.70	8.15	8.00	8.30	7.60	8.30	8.50	8.60	8.40	8.20	8.50
Total count of phyt .x 10^3	404	357	245	410	254	2585	194	536	152	913	939	1615	649	501	796
Chlorophyll a	9.0	6.9	5.1	8.3	5.4	13.7	3.7	9.2	3.8	13.0	12.8	13.4	9.7	7.5	9.4
Net prod (mg C/m^3/hr)	215	168	157	228	188	333	149	244	151	294	237	276	216	184	262
Respiration rate(mg O_2/ m$_3$/hr)	719	486	488	382	458	456	671	413	522	513	411	593	487	678	372

Temp. Temperature

Table (2). Correlation coefficient between the total count of phytoplankton , chlorophyll a, net production, respiration rate and some phsico –chemical parameters of Lake Burullus at the different months.

Variables	Tr .	PO_4	NO_3	SiO_2	T.Alk.	DO	Temp.
Total phyt. count	+.600*	-. 420	+. 211	+. 356	+.620 *	- . 088	+. 793*
Chlorophyll a	+. 637*	-. 501	+. 159	+. 468	+. 649 *	+. 159	+. 660*
Net prod .	+. 198	+. 031	+. 375	-. 047	+ . 144	+. 539	+. 248
Respiration rate .	-. 393	+. 535	-. 691 *	-. 573	- . 563	-. 563	+. 541

Table (3). Correlation coefficient between the total count of phytoplankton, chlorophyll a, net production, respiration rate and some phsico –chemical parameters of Lake Burullus at the different stations .

Variables	Tr .	PO_4	NO_3	SiO_2	T.Alk.	DO	Temp.
Total phyt. count	+. 007	-. 459	-. 002	+. 265	-. 145	+ . 065	+. 065
Chlorophyll a	+. 305	+. 338	-. 293	+. 482	-. 159	+. 140	+. 140
Net prod .	+. 144	+. 457	-. 250	+. 407	-. 198	+. 125	+. 125
Respiration rate	-. 034	-. 262	- 471	-. 477	-. 150	+. 077	+. 077

Tr. Transparency

In Lake Burullus, the maximum average value of pH (8.6) was recorded at station 12. The high surface pH – value at this station is mainly related to the increase in the total count of phytoplankton . On the other hand, the low value of pH (7.60) at station 9 due to the effect of discharges from drain 8 (Table 1).

4- Total Alkalinity

The total alkalinity values in Lake Burullus during the study period revealed that the highest values were recorded during autumn months, while the lowest value was recorded in March (Fig. 4). The average maximum value of Ca CO3 (307.5 mg /l) was determined at station 9, while the minimum (187.6 mg Ca CO3 /l) was recorded at station 15 (Table 1).

The total alkalinity in Lake Burullus differed from one station to the other. The high average values were observed at stations near to the mouth of drains especially in the eastern sector, due to the discharge of strongly alkaline wastes. The low values of total alkalinity were recorded after flourishing of phytoplankton in some stations and months. These results agreed with Halim *et al* (1976) who mentioned that a low total alkalinity values were recorded after the flourish of phytoplankton in the Egyptian Delta lakes .

In this context, the total alkalinity cleared a significant positive correlation with the total count of phytoplankton and chlorophyll a in the different months (Table2), where the high average values of alkalinity were associated with high density of phytoplankton coinciding with Radwan (1994). On the other hand, the relation was negative at the different stations (Table 3), where it correlated with the discharges at each station

5- Dissolved Oxygen

Oxygen is often considered one of the most fundamental water quality parameters of lakes because it is essential to the metabolism of all aquatic organisms.

In Lake Burullus, the dissolved oxygen in the surface water ranged between 6.6 and 9.8 mg O_2/l. The seasonal variations of dissolved oxygen in Lake Burullus indicated that, increase was observed in late autumn and winter due to the water movement by wind action and to the decrease in water temperature and increasing oxygen solubility. On the other hand, a pronounced decrease of dissolved oxygen occurred in summer (August) due to low solubility of oxygen and increased rate of its utilization through biochemical reactions at high temperature (Fig. 5).

The dissolved oxygen varied clearly from the stations nearby the mouth of drains to the other stations far from the drains. The maximum average value of dissolved oxygen (9.8 mg O_2/l) during the period of investigation was recorded at station 13 (in the western sector infront of Brimbal Canal). On the other hand, the minimum average value (6.6 mg O_2 /l) was determined at station 4 (in front of Nasser drain in the eastern sector) as shown in Table (1).

The relation between dissolved oxygen (DO) and total count of phytoplankton, chlorophyll a and net production showed a positive correlation (Tables 3 & 2) and coinciding with Abdalla *et al.* (1991) who found that high DO is a result high phytoplankton density at the examined stations of Lake Mariut.

6- Nutrient Salts

The relation between DO and total count of phytoplankton chlorophyll a and net production showed a positive correlation and coinciding with Abdalla *et al.* 1991. found that high DO is a result of the obtained results indicate that the primary production and standing crop in Lake Burullus are controlled by the nutrients discharged from the drains in addition to the other physicochemical factors.

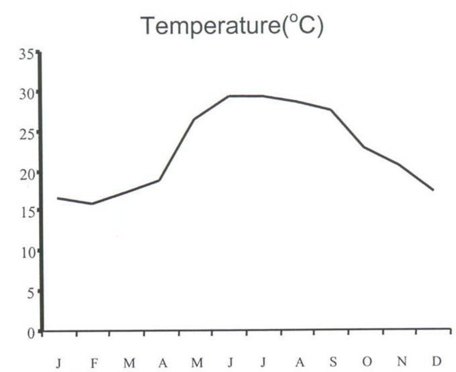

Fig. (2): Average monthly variations of water temperature

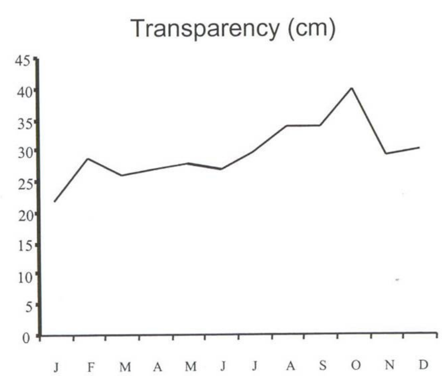

Fig. (3): Average monthly variations of transparency

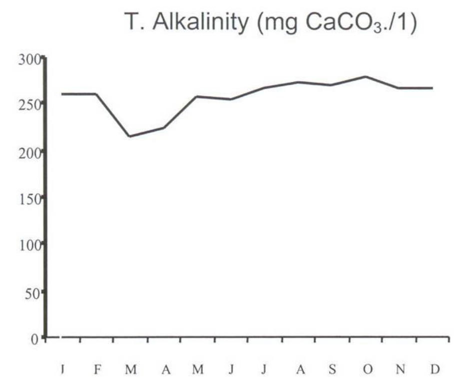

Fig. (4): Average monthly variations of T. Alkalinity

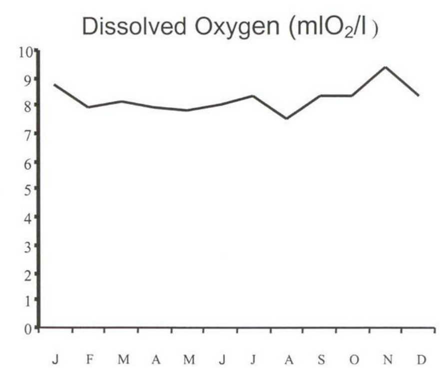

Fig. (5): Average monthly variations of dissolved oxygen

The environmental importance of phosphate arises out of its role as a major nutrient for both plants and microorganisms in addition to it is very important and limiting factor for the production of phytoplankton.

i – Nitrate

Nitrate is the most stable form of inorganic nitrogen in oxygenated water. It is the end product of nitrification process in natural water. The main source of nitrate in Lake Burullus is the agricultural drainage water and fish farms neighbouring to the lake.

The maximum amount of nitrates (3.8 µg – at/l as an average) was measured at stations 3 and 4, while the minimum (0.6 µg – at/l as an average) was measured at station 1 (Table 1). At the same time their highest concentrations were observed during winter and autumn (Fig. 6), while the lowest ones were observed in spring.

The importance of nitrates as nitrogen source for phytoplankton and primary production in fresh and brackish water habitats has been studied by Fayed & Shehata (1980) and kobbia (1982). They revealed that in absence or deficiency of nitrate, the production decreases.

Nitrates content in the studied stations showed a negative correlation with the total count of phytoplankton (Table 3), while the relation was positive in the different months (Table 2) depending on the amount of discharges from the drains and the location of each station from the point of discharge.

ii - Phosphate

Phosphate is known to be the main limiting nutrient for the growth of phytoplankton and chlorophyll a. The presence of high and moderate phosphorus at some stations was accompanied in most cases by increase in phytoplankton count and chlorophyll a.

The maximum concentration of phosphates (3.4 µg – at /l) was determined at station 6. The minimum value (0.8 µg – at /l) was recorded at station 7,13 and 15 (Table). On the other hand , the maximum average was determined in May. While the minimum one was observed during September (Fig. 6).

The maximum amounts of phosphate were demonstrated at stations 6, 10, 11 and 12, giving remarkable growth of phytoplankton counts and chlorophyll a. This agrees with Radwan (1994) who mentioned that highly significant positive correlation exists between phosphate concentration and phytoplankton numbers and Pieterse and Toerien (1978) who found, statistically presence of significant correlation between chlorophyll a and phosphorus.

The statistical analysis revealed insignificant correlation between the total count of phytoplankton, chlorophyll a, net production and phosphate at the stations. (Table 3) correlated with the amount of agricultural drainage which increases the phosphate content according to the site of stations from the drains. On the other hand, a negative correlation was observed between the total count of phytoplankton and Chl.a and phosphate through months (Table 2) .This coincided with Abdalla *et al* (1991) who reported that the depletion in phosphate content was due to high density of phytoplankton in Lake Mariut (negative correlation).

iii – Silicon

Silicon is the second most abundant element in the earth's crust . There are innumerable mineral sources of silica for natural waters, but most are quite resistant to chemical processes (Faust and Aly 1981).

The maximum amount of silicates (30.6 µg – at / l as an average) was recorded at station 15, while the minimum value (10.5 µg – at / l as an average) was observed at station 1 (Table 1). The highest concentrations of silicates were determined during autumn months, while the lowest ones were estimated during spring season (Fig .6).

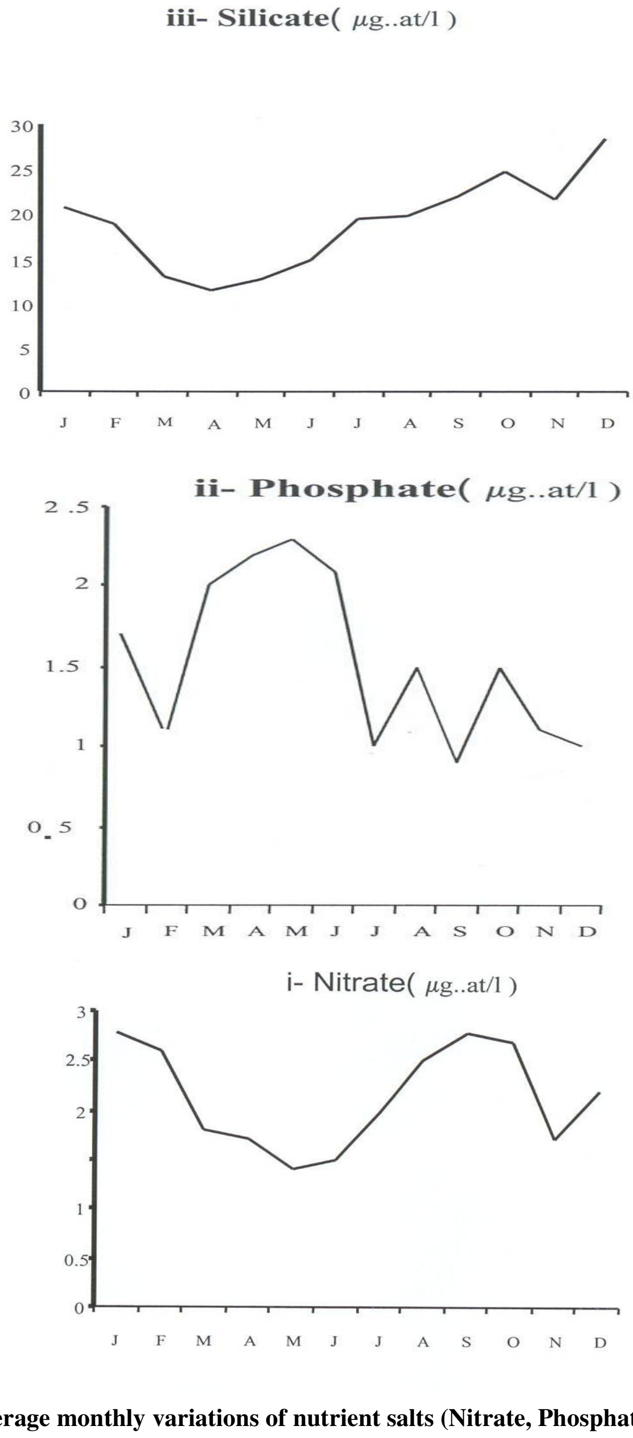

Fig. (6): Average monthly variations of nutrient salts (Nitrate, Phosphate and Silicate)

The importance of silicates seemed to be of specific effect particularly for diatoms. In the present study, Bacillariophyceae was the most productive class. Thus a positive correlation exists between silica and diatom organisms and the standing crop of phytoplankton, as well as chlorophyll a (Tables 2&3). This coincides with Kobbia, (1982) who reported that during the period of increasing water level when nutrients are sufficient and phytoplankton population is undergoing rapid growth, chlorophyll a tends to accumulate in the euphotic zone.

II- Phytoplankton Standing Crop

i- Community composition

The total number of identified and recorded phytoplankton species at all the investigated stations during the period of study 65 species (Appendix A) belonging to 5 classes namely; Bacillariophyceae (28), Cyanophyceae (15), Chlorophyceae (15), Euglenophyceae (5) and Dinophyceae (2). The maximum count of phytoplankton was recorded at station 6 in the eastern sector (2585 x 10^3 unit/l as an average), followed by station 12 in the middle sector (1615 x 10^3 unit/ l as an average), while the least number occurred at station 9 in the middle sector (152 x 10^3 unit / l as an average) (Table 1).

It was generally observed that the maximum number of counted species was belonging to class Bacillariophyceae which represent the most productive group at all stations during the period of study. In addition, the distribution and frequency of algal species along all sites showed that Bacillariophyceae together with some species of Chlorophyceae were always dominant especially at stations 6 (eastern sector), 12 (middle sector) and 15 (western sector).

ii- Distribution and monthly variations

Study of phytoplankton population at the different sectors and stations in Lake Burullus revealed that, the community was affected by the physico-chemical conditions of water, seasonal fluctuations, in addition to the different sources of pollution especially at station 6 (infront of drain 7) in the eastern sector. The total phytoplankton at this station ware recorded in high counts due to the flourish of diatoms especially species *Cyclotella meneghiniana* Kutz which represent the most dominant among diatoms population at this station due to the heavy load of organic pollution and nutrient salts discharged from drain 7. This observation was coincided with Abdalla *et al*. (1991) who reported that this species developed in Lake Mariut with the increase of the organic load.

In the middle and western sectors, the highest counts of phytoplankton were recorded at station 12 in the middle sector and 15 in the western sector due to the flourish of diatoms with the increase of silicate concentration (Table 1).

The dominance of diatoms especially at stations 6, 12 and 15 may be attributed to the increased concentrations of silicon with the effect of fresh water discharged from drain 7 (St. 6) as well as the levels of salinity at stations 12 &15.

Regarding the distribution and monthly variations, the total counts of phytoplankton in Lake Burullus showed maximum existence in summer season.

(July , August and September) accompanied with the highest values of phosphate and nitrate leads to the development of phytoplankton and the minimum count was recorded in winter (February and March) due to the low levels of nutrient salts (Fig.7).

From the data obtained its obvious that, the community composition reduced to 65 species recorded in Lake Burullus during the study period, including 28 diatoms, 15 blue-green algae, 15 green algae and 7 species of other forms , while the previous data recorded 124 species (El-Sherif, 1983) and 198 species (El-Sherif, 1988)

Generally, a pronounced decrease in the community composition and standing crop of phytoplankton in Lake Burullus as compared with the previous data. In the present study the standing crop of phytoplankton was 2,745,364 unit/l during 1978, 3,429,582 unit/l during 1979 and 1,039,641 unit /l (El-Sherif, 1988) during 1987.

III- Chlorophyll a

From the results obtained for Chlorophyll a contents of the phytoplankton at the different surveyed stations of the three sectors was more or less similar to the pattern of phytoplankton counts (Table 1). The maximum average contents of chlorophyll a were determined during summer season (July) at station 6 (21.7 µg /1) while the average minimum values of chlorophyll a were measured during winter (February) at station 9 (1.3 µg /l) in the middle sector. In general, stations nearby the drains recorded the lowest content of chlorophyll a. Otherwise, no significant differences were recorded in the average values of chlorophyll a during summer or autumn (Fig. 8).

IV- Net Production and Respiration Rate

The primary production of phytoplankton at the studied stations was indicated by net production from January to December 2000 in figure (9) and table (1).The maximum value of production (333 mg C/ m^3 /hr) was recorded at station 6 during November, while the minimum value 151 mg C/ m^3/hr was reported at station 9 during February. The mean primary production for winter season was186 mg C/ m^3/hr, while for summer it was 218 mg C/ m^3/ hr.

It is worthy to mention that the primary production in Lake Burullus varied from one season to another and with the load of nutrient salts, in addition to phytoplankton species and their numbers. Hence the presence of a high percentage and number of Bacillariophyceae which represented the first productive group as mentioned before. Furthermore, the shallow lake water leads to a rapid change in the productivity with the change in physico-chemical conditions of water.

The average level of respiration rate in Lake Burullus water was 510 mg O_2 / m^3 / hr. The maximum rate of respiration was recorded in June and July (659 and 639 mg O_2 /m^3 / hr respectively), while the minimum value was noticed in February (379 mg O_2 / m^3 / hr) as shown in Figure (10).

The results obtained at the different stations revealed that the maximum rate of respiration (719 mg O_2/m^3 /hr) was reported at station 1(in the eastern sector in front of El- Boughaz), while the minimum value (372 mg O_2/ m^3/ hr) was determined at station 15 (in the middle of the western sector) (Table 1).

The rate of respiration in the lake during the period of investigation attained the highest value at station 1 in front of El-Boughaz, due to the effect of drainage water discharged from the different drains around this station. These effluents enhance the biological activities of bacteria, especially in summer months due to the decomposition of organic matter. This observation agree with El-Sherif & Aboul Ezz (1988) who reported that the lowest standing crop at the stations which lie nearby the Boughaz area due to the high density of zooplankton in addition to the low counts of phytoplankton at stations 1,2,3 and 4 in the vicinity of El-Boughaz opening resulting from the grazing effect of zooplankton on phytoplankton .

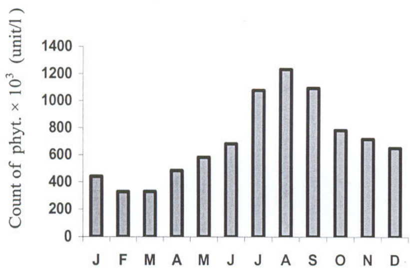

Fig (7) : Average monthly variations of total phytoplankton counts x 10^3 in the whole area of investigation .

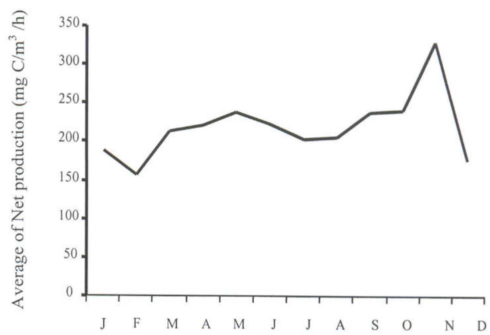

Fig (9) : Average monthly variations of Net Production in the whole area of investigation .

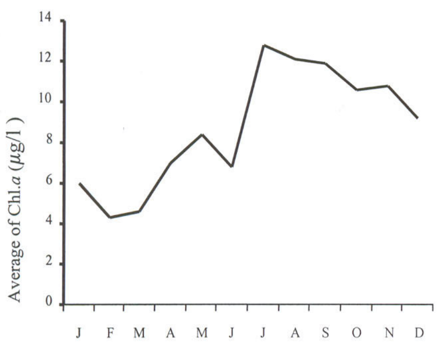

Fig (8) : Average monthly variations of chlorophyll "a" in the whole area of investigation

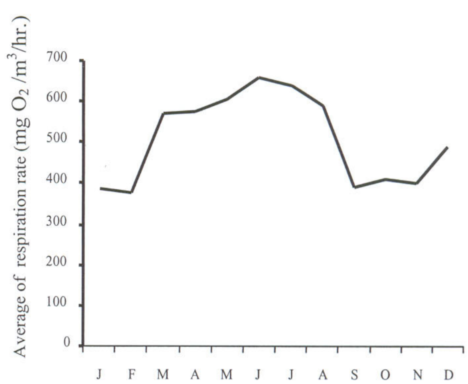

Fig (10) : Average monthly variations of respiration rate in the whole area of investigation .

SUMMARY AND CONCLUSION

The Egyptian Northern Delta lakes has been subjected in the last few years to a drastic rate of pollution due to the high loads of discharges leading to a pronounced changes in physico-chemical conditions and phytoplankton community .

The study of some physico-chemical parameters and their impacts on the standing crop of phytoplankton and primary production indicated that:

1- The maximum number of phytoplankton species counted was belonging to class Bacillariophyceae which represents the first productive one.

2- Chlorophyll a content is more or less similar to the pattern of phytoplankton counts . The stations nearby the drains recorded the lowest content of chlorophyll a.

3- The primary production (net production) in Lake Burullus varied from season to another and with the load of nutrient salts in addition to phytoplankton species and their numbers .

4- The maximum rate of respiration was estimated in the eastern sector, while the minimum one in the western sector due to the level of pollution .

5- Physicochemical conditions affected the primary production with different patterns according to the results of statistical analysis as the following :

- Significant positive correlation between the total count of phytoplankton, chlorophyll a and water temperature through months,while the relation was insignificant at the stations .
- Transparency exhibited significant positive correlation with the total count of phytoplankton, chlorophyll a and net production at all months.
- Phosphate and dissolved oxygen showed a significant positive correlation with the primary production while nitrate exhibited negative correlation with the total count of phytoplankton at different stations, and a positive correlation was observed in the different months .
- The correlation of total alkalinity with the total count of phytoplankton and chlorophyll a, was positive.
- The relation of silicate in the different months and stations was correlated with the density of Bacillariophycea .

From the data obtained, Lake Burullus is considered as an slightly eutrophic due to nutrient levels which not reach to over fertility and a few species of phytoplankton are usually responsible for increased numbers of the community especially infront of drains.

It very important to mentioned that, the source of pollution in Lake Burullus originated mainly from the drains and fish farms neighbouring to the lake.

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Appendix A: Check List of phytoplankton species recorded in Lake Burullus during the period of investigation :

1- Bacillariophyceae :

Cyclotella meneghiniana **Kütz**.
Cyclotella kutzingiana Thwait.
Cyclotella opaerculata (**Ag.)**
Nitzschia palea (**Kütz**.)W.Sm.
Nitzschia longissima (**Breb** *)* **Ralfs**.
Nitzschia closterium **(Ehr**.) W.Sm.
Navicula humerosa **Breb.**
Navicula cryptocephala **Kütz**.
Navicula schizonemoids **H.Van.**
Navicula yarrensis **Grun.**
Navicula cuspidata **Kütz.**
Navicula viridula **Kütz.**
Navicula gracilis **Ehr**.
Synedra tabulata **Kütz.**
Synedra ulna **Nitzsch.**
Synedra longissima **W.Sm**.
Diatoma hiemale
Diploneis bombus **A.S.**
Pleurosigma delicatulum **Sm**.
Synedra acus **(Kütz.)**
Surirella stratula (**Turp.**)
Melosira granulata (**Ehr.) Ralfs**.
Cymbella affinis **Kütz.**
Cocconeis placentule **Ehr.**
Diploneis didyma **Ehr.**
Amphora ovalis **kütz.**
Bacillaria paradoxa **Gmel.**
Melosira varians **Ag.**

2- Cyanophyceae :

Chroococcus dispersus **(Keissl.) Lemmer.**
Chroococcus turgidus **Kütz.**
Chroococcus limneticus **Lemm.**
Gloeocapsa rupestris **kuetzing . Kütz** .
Microcystis incerta **Lemm.**
Microcystis aerioginosa .**kutz. ; emend . Elenkin** .
Merismopedia punctata **Meyen .**

Mrismopedia tenuissima **Lemm .**
Merismopedia minima **Beck.**
Anabaenopsis circularis **(F.S. West.) Wol & Miller .**
Oscillatoria limnetica **Lemm**.
Nostoc **sp**.
Spirulina **sp.**
Oscillatoria princeps **Voucher**
Anabaena **sp.**

3- Chlorophyceae :

Scenedesmus quadricauda **(Turp) Bréb**
Scenedesmus bijugatus **(Turp Kütz)**
Scenedesmus acuminatus **(Largerh) Chodat**
Actinastrum hantzschii Lagerh.
Chlorella vulgaris Beij.
Pediastrum duplex Meyen.
Pediastrum simplex (**Meyen**) Lemm.
Pediastrum boryanum (**Turp**.) Menegh
Botryococcus braunii Kütz **.**
Chlorococcum humicola **(Nag.)**
Closterium kuetzingii Bréb
Staurastrum tetracerum Ralfs
Volvox **sp.**
Ankistrodesmus falcatus **Var. spiriformis G .S West .**
Spirogyra **sp.**

4- Euglenophyceae :

Euglena acus **Ehr.**
Euglena gracilis **Kelbs** .
Euglena **sp.**
Phacus longicauda **(Ehr.) Dujadin**.
Phacus pleuronectes **(Muell) Dujardin** .

5- Peridiniaceae :

Gymnodinium **sp.**
Peridinium **sp.**