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EUTROPHICATION IN LAKE MARIUT.

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ABSTRACT

Lake Mariut shows a quite drastic eutrophication phenomena. It is a shallow brackish semi-closed environment which receives a constant high input of industrial wastes and sewage effluents. The Lake water is characterized by high nutrient load particularly PO_4 and NH_3, (average 1.34 mg PO_4 -P/l and 0.39 mg NH_3 -N/l), as well as a wide amplitude of dissolved oxygen concentration (0.0 - 15.33 ml O_2 /l). The amounts of dissolved organic matter and suspended detritus are also high (average 43 mg O_2 consumed /l). As a result of excessive nutrient impact, the lake sustained high density of phytoplankton all the year round with average annual of 55,940 x 10^3 units /l. The phytoplankton community is charactarized by low species diversity and regular pattern of blooms, dominated by pollution tolerant algal species such as **Merismopedia tenuissima, Spirulina platensis, Cyclotella meneghiniana, Planktosphaeria gelatinosa, Crucigenia tetrapedia, Oocystis borgei, Kirchneriella spp.** and **Eugelena granulata**. The simple correlation coefficients were used to measure the relationship between variations in phytoplankton standing crop versus some physical and chemical parameters of lake water. Data showed that PO_4 and NH_3 exist at levels beyond their limiting growth concentrations.

INTRODUTION

Eutrophication can be regarded as an over enrichment of a water body with nutrients and is considered as a form of nutrient pollution (Lincoln et al. 1985). Lake Mariut is a small semi-closed shallow brackish water basin situated to the south of Alexandria at latitude 31° 10′ N and lengitude 29° 55′ E (Fig. 1). Its maximum length is 12 Km and maximum width 8 Km with an average area of 63 Km^2. The depth of water fluctuates between 60 and 130 cm, with an average of 100 cm. The area of the present Lake has been reduced due to land reclamation. It is divided by artificial embankments into four basins. The eastern basin or Lake proper (the field of the present investigation) has an area of 27.3 Km^2. The fish farm, amounts to about 4.2 Km^2. The south-eastern and south-western basins have total area of 31.5 Km^2. The water supply of the Lake proper is drived

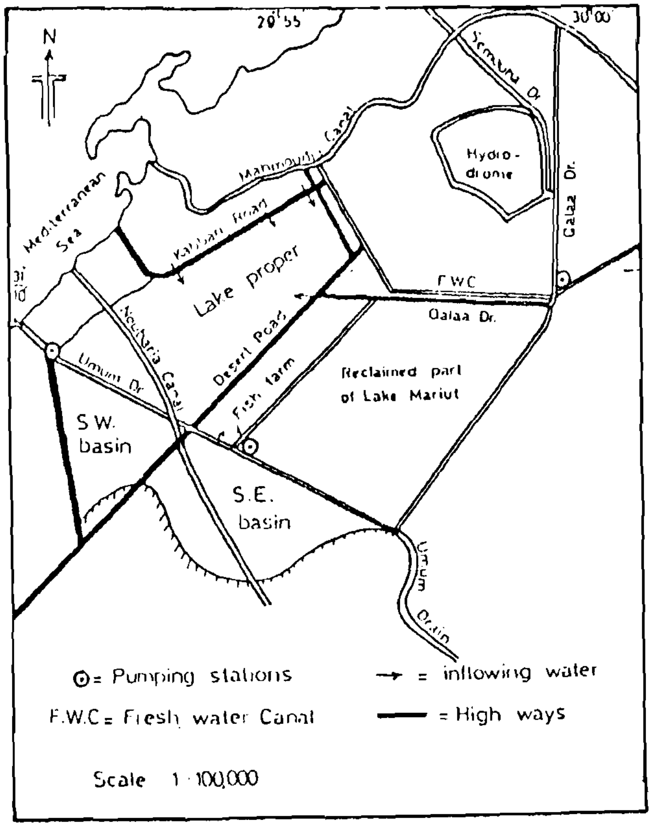

Fig. 1

Morphometry of Lake Mariut.

mainly from El-Qalaa Drain which flows at a rate of 482-893 x 10^3 m^3/day (Samaan and Abdelmoneim, 1986). Its water is a mixture of agricultural runoff and sewage effluents contaminated with industrial wastes discarded from Alexandria drainage system. The Lake proper receives also at its northern margin considerable amounts of sewage, flowing through Karmous and El-Kabbari sewers at a daily average of 25 x 10^3 and 19 x 10^3 m^3/day respectively. An industrial waste disposal pipe is located at the eastern corner of the Lake proper and it pours untreated wastes of several industrial plants at a rate of 18-23 x 10^3 m^3/day. The aim of the present work is to evaluate the Lake eutrophication in relation to phytoplankton and some physical and chemical parameters.

MATERIAL AND METHODS

Fourten stations were selected to represent the different habitats in the Lake proper as shown in Fig. 2. Sampling was carried out monthly for the year, 1982. Air and surface water temperatures were measured using a simple thermometer graduated to 0.1°C. Transparancy was measured by Secchi disc 30 cm in diameter. Hydrogen ion concentration was determined using a glass electrode pH meter. Dissolved oxygen was measured by the winkler standard method (Strickland and Parson, 1965). The concentration of dissolved organic matter was estimated by using potassium permanganate as an oxidizing agent (Ellis et al. 1946). Reactive phosphate was determined spectrophotometrically according to Murphy and Riley (1962). Dissolved ammonia was measured according to Koroleff (1969). The standing crop of phytoplankton was estimated numerically using the sedimentation technique where one litre of water sample was reduced to 100 ccs and subsamples of 0.2 ml were transfered to a counting cell and the different phytoplankton species were identified and counted under a research microscope. Statistical treatment of the data was performed according to standard methods given by Moore and Shirley (1972).

RESULTS AND DISCUSSION

Temperature:

The average monthly water temperature ranged between 15°C and 27.7°C. The lowest temperature was recorded in February, increasing gradually throughout spring and summer to reach its maximum in August (Fig.3). The diurnal variations of water temperature was small and it did not exceed 3°C between highest and lowest daily water temperature.

Water transparency:

The Secchi disc readings fluctuated between 10 and 90 cm with an average annual of 34 cm. The water transparency was subjected to both regional and seasonal variations as shown in Table 1 and Fig. 3. The colour of lake water was usually dark yellowish-green, which is mainly attributed to the dense living stook of phytoplankton and suspended organic detritus associated with the sewage effluents and industrial wastes. The lowest transparency was generally recorded at the northren and middle sectors, coinciding with the dense growth of phytoplankton. El-Qalaa Drain water remained more clear due to its poorness in phytoplankton. subsequantly the highest water transparency appeared at station 9 which was subjected to the direct influx of the drain water.

Hydrogen ion cocentration:

The pH values in Lake Mariut lie on the alkaline side, showing spatial and seasonal variations between 7.1 and 11.0. The average annual values recorded at the different

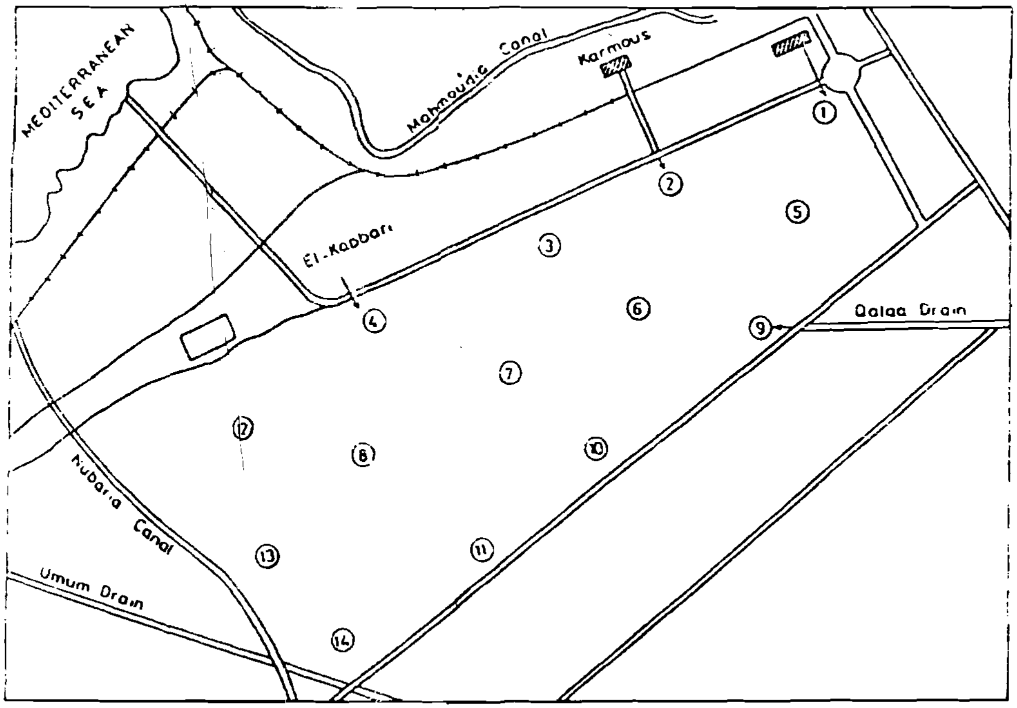

Fig. 2

Position of stations sampled in the Lake proper region of Lake Mariut.

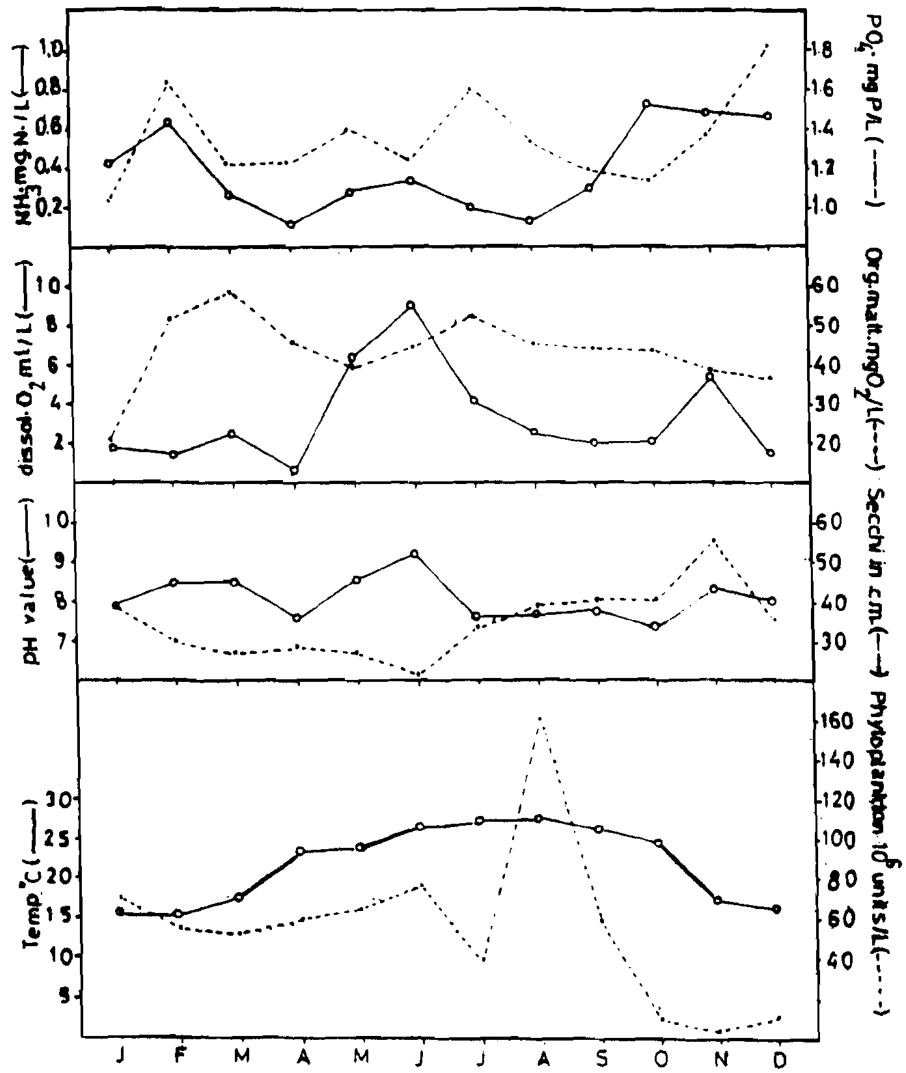

Fig. 3

Seasonal variations of some physico-chemical parameters and phytoplankton standing crop in Lake Mariut.

stations and their seasonal variations are given in Table 1 and Fig. 3 respectively. The lowest pH values were observed around the opening of El-Kabbari sewer and industrial waste disposal pipe, as well as on the western side. The pH tended to increase gradually towards the middle of the Lake proper to reach a maximum annual average of 8.4 at station 6. The seasonal variations of the pH readings appeared to be related to the density of phytoplankton standing crop as well as the quality of water introduced from the different sources into the Lake. Generally, there was a pronounced increase in pH during June and less so in February, March and November at most stations. The lowest pH was between July and October, and this was accompanied by a parallel decrease in dissolved oxygen.

Table 1.

Annual means of some physico-chemical parameters and phtoplankton standing crop at different stations in Lake Mariut.

Station	Secchi disc in cm	pH	dissolved oxygen ml O_2/l	dissolved organic matter mg O_2/l	PO_4 mg P/l	NH_3 mg N/l	Standing crop x 10_3 cell/l
1	23	7.90	3.00	50.4	2.20	0.67	69,597
2	28	8.20	3.30	50.5	1.51	0.38	57,547
3	30	8.15	4.42	52.5	1.27	0.34	81,545
4	19	7.84	1.33	44.3	1.79	0.58	50,550
5	24	8.30	4.38	50.9	1.35	0.32	63,574
6	24	8.40	4.46	49.8	1.31	0.36	56,800
7	27	8.18	5.09	47.4	1.34	0.38	77,846
8	45	8.20	6.50	34.3	0.91	0.25	55,896
9	55	7.90	0.00	29.8	1.43	0.50	12,240
10	34	8.20	3.07	40.8	1.16	0.34	52,107
11	38	8.10	5.67	35.8	1.01	0.32	66,391
12	31	7.90	4.70	39.5	1.47	0.44	37,495
13	52	7.95	4.60	34.7	1.17	0.26	33,599
14	47	8.20	6.10	41.4	0.91	0.31	76,994

Dissolved oxygen:

Values of dissolved oxygen in Lake Mariut showed considerable wide variations, fluctuating between 15.33 ml O_2/l and complete depletion. The average annual values for the different stations and seasonal variations are given in Table 1 and Fig. 3. This range is comparable to the previous records of dissolved oxygen estimated during the last two decades (Aleem and Samaan, 1969a; Abdelmoneim, 1977; Hafez, 1982; and Saad, 1985), although the present peaks were generally higher than the former ones which fluctuated between 8.2 and 9.9 ml O_2/l. In general, the higher values of dissolved oxygen appeared in the middle Lake and western sector where pollution is less pronounced. It is to be noted that oxygen depletion was one of the main characteristic features of station 9 which is subjected to the direct influx of El-Qalaa Drain water deficient in dissolved oxygen. A pronounced decrease of dissolved oxygen occurred in summer at most stations, although the total phytoplankton was at its maximum yield in August. This may be attributed to the low solubility of oxygen and increased rate of its utilization through biochemical reactions at high temperatures.

Dissolved organic matter:

The dissolved organic matter fluctuated between 1.5 and 118.7 mg O_2 consumed/l. With an annual average of 43 mg O_2 consumed/l. The previous work of Saad (1974) and Abdelmoneim (1977), gave an annual average of 19.8 and 22.5 mg O_2/l respectively. This reflects a pronounced increase of dissolved organic matter throughout the last two decades, due to the increased contamination of the Lake water. The spatial and seasonal distributions of dissolved organic matter are given in Table 1 and Fig. 3. The highest amounts of dissolved organic matter were usually observed along the northern Lake, where sewage effluents are discarded.

Reactive phosphate:

The concentration of reactive phosphate showed considerable wide variations from 0.11 to 3.1 mg PO_4-P/l, with an annual average of 1.34 mg PO_4-P/l. Its seasonal and regional variations are given in Table 1 and Fig. 3. The peaks of dissolved phosphate were reached in February, July and December while the lowest concentration appeared in January. The dissolved phosphate attained its highest levels at the northern Lake, particularly in front of industrial waste disposal pipe (station 1) as well as at station 9 which receives El-Qalaa Drain water, while it tended to decrease gradually towards the southwest.

Dissolved ammonia:

The previous work done by Samaan et al. (1988) proved that the dissolved ammonia formed over 95 % of the total inorganic nitrogen in the Lake. Thus, the estimation of inorganic nitrogen compounds during the present

The simple correlations between the major abiotic variables and phytoplankton (Table 2), showed that the latter exhibted significant correlation with Secchi disc readings, pH, dissolved oxygen and dissolved organic matter. It is to be expected that phytoplankton is related to pH values and dissolved oxygen as a result of photosynthetic activities. Also the increase of phytoplankton density reduces water transperancy. Thus in most cases, high pH, high dissolved oxygen and low Secchi disc readings are actually a result rather than a cause of high phytoplankton standing crop. On the other hand, the positive correlation of phytoplankton versus dissolved organic matter is attributed to the stimulatory effect of some biodegradable organic matter associated with sewage and industrial wastes, which have controlling effect on the growth of the population in particular those species which are responsible for most massive and long-lasting blooms in heavily

Table 2.

Simple correlation coefficients between phtoplankton and abiotic variables at Lake Mariut. (based on data of Táble 1.).

	Secchi disc	pH	dissolved oxygen	dissolved organic matter	PO_4	NH_3	stand. crop
Secchi disc		-0.117	0.159	-0.832**	-0.61**	-0.459*	-0.50*
PH			0.518**	0.403	-0.523**	-0.637**	0.448*
disol. O_2				0.056	-0.62**	-0.689**	0.542*
disol. organ.					0.428	0.203	0.703**
PO_4						0.917**	-0.032
NH_3							-0.125
stand. crop							

* significant at 0.1 level
** significant at 0.05 level

polluted coastal environments (Stirn, 1988). The insignificant correlations of phytoplankton standing crop versus dissolved phosphate and ammonia are attributed to their existence at higher concentrations, exceeding phytoplankton requirements. Such high values of dissolved phosphate or ammonia may even cause excess stress load on the Lake ecosystem.

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