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SOME PHYSICAL FEATURES OF THE POLLUTED BASIN AND FISH FARM IN LAKE MARIUT, EGYPT.

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ABSTRACT

The physical conditions in the polluted basin (Lake proper) and fish farm in Lake Mariut were estimated monthly from August 1975 to July 1977. The polluted basin receives most of its water from the Qalaa Drain which is contaminated with sewage and industrial wastes. Other effluents of sewage and industrial wastes were also discarded directly into the basin through separate pipes.

Results indicate that these pollutants affect the physical charateristics of the lake water. Thus, the water temperature in the area surrounding the industrial waste disposal pipe was relatively higher than the rest of the lake by values ranging from 0.5 to 1.0°C. Also, the temperature of the bottom water in regions subjected to the direct outfall of sewage sustained higher temperature early in the morning by about 0.5°C than the surface water, due to putrefaction of organic detritus accumulated on the bottom. The average Secchi depth has been reduced to 20 cm in localities subjected to direct pollution. The highest concentration of suspended matter was recorded around the sewage disposal pipe, reaching about 84 mg dry wt/L.

The fish farm was nearly free of pollution as it receives most of its water from Mariut El-Gedida Pumping Station. The turbidity of water there was mainly due to the suspended silt particles. The average Secchi depth reached 68 cm and suspended matter amounted to about 62 mg dry wt/L.

The suspended matter in Qalaa Drain dropped to 24 mg dry wt/L and the Secchi disc reading amounted to 44 cm.

DESCRIPTIVE ACCOUNT OF THE LAKE

a- Morphometry:

Lake Mariut is a small shallow lake that lies beside Alexandria at latitude 31° 10' N and longitude 29° 55' E. Its area amounts to 5,500 hectare and has an average water depth of about 120 cm. The lake is divided by the Desert Road and the Umum Drain into four basins, namely the lake proper, the fish farm, the south east and south west basins (Fig. 1).

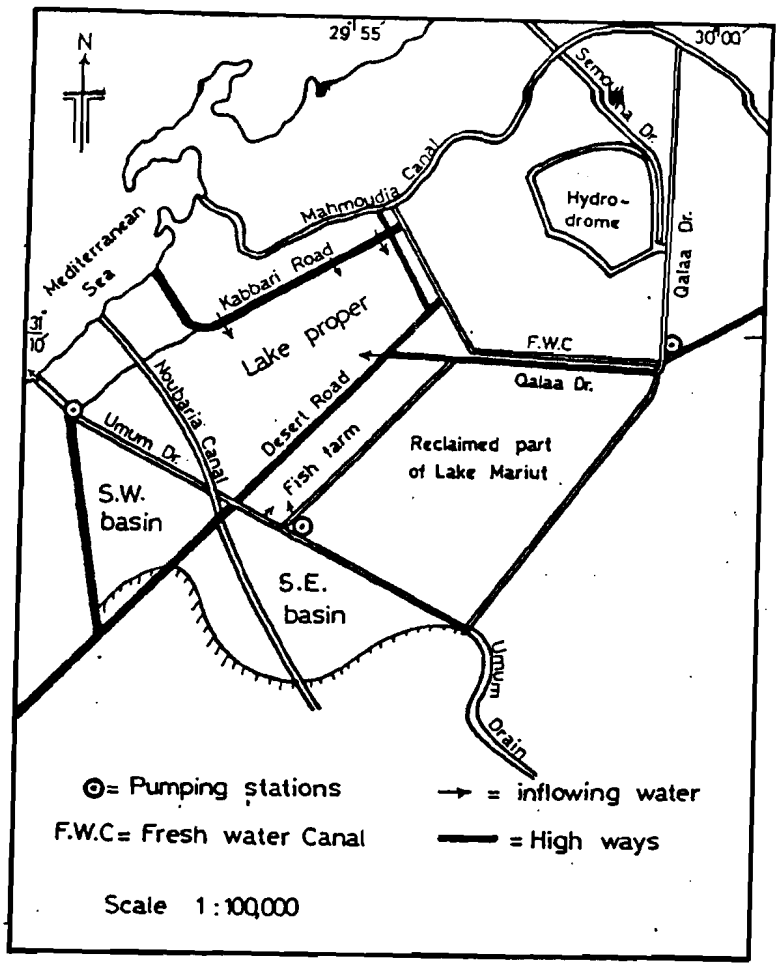

Fig. (1)
Morphometry of Lake Mariut.

The lake proper represent the main basin in Lake Mariut. Its area is about 2,500 hectare and it is bordered by highways from three sides and by the Noubaria Navigation Canal and the Umum Drain at the west. It receives most of its water from the polluted Qalaa Drain through Moharrem Bey Bridge. Other sources of pollution include industrial wastes discarded at the north eastern corner and two sewage disposal pipes receiving sewage effluents from Karmous and El-Kabbari Districts and pour them at the north margin. The bottom of the basin lies at - 3.8 m. (B.S.L.). The average depth of water there is about 120 cm.

The fish farm extends for 6 Km beside the Desert Road, and has a total area of about 420 hectare. It receives most of its water from Mariut El-

Gedida Hydraulic Pumps and the Umum Drain at the southern margin. The fish farm is also connected with the Qalaa Drain at its northern extremity through a movable gate which is usually closed. The average depth of the water there is about 130 cm.

The S.W. and S.E. basins are totally separated from the lake by the dyke bordering the Umum Drain. They are extremely shallow and free of pollution with the exception of the partial contamination of the S.W. basin with some mineral oils discharged from the cooling pipes of El-Nasr Petroleum Company. The total area of the S.W. & S.E. basins amounts to 2,500 hectare.

b- Water economy:

The Umum Drain served previously as the main source of water supply to Lake Mariut. The drain was constantly pouring its water into the lake through wide opening situated along its dyke to keep the lake water at its same level. Partial contamination of the lake proper was produced by sewage effluents discarded from Karmous District.

During the year 1965 a plan was designed to decrease the water level of the Umum Drain by about 40 cm to improve the drainage system of the Beheira Province. Thus, the drain was totally separated from the lake. Few underground pipes were constructed between the lake and the drain at a level of - 2.5 m. B.S.L. in order to discharge the surplus lake water exceeding such a level.

The original supply of the Umum Drain water to the lake proper was substituted by an excess water discharge from the Qalaa Drain. The construction of the Noubaria Navigating Canal that extended parallel to the Umum Drain has bordered most of the western margin of the lake proper. The later became nearly separated from the Umum Drain with the exception of a small portion lying at the south corner (Fig. 1).

During the last few years the Qalaa Drain water became highly contaminated with industrial wastes and sewage effluents after being connected with Semouha Drain. The later drain carries most of sewage and industrial wastes of the eastern section of Alexandria City. Nevertheless, the Sanitary Engineering Department of Alexandria started a project for partial treament of the Semouha Drain water before being discharged into the lake. The proper lake was further sujected to other sources of pollution. These include sewage and industrial wastes discarded beside El-Kabbari Highway and at the north eastern corner respectively.

The average amounts of water discharged monthly into the lake proper through the different sources during a year (from August, 1975 to July, 1976) are shown in Fig. 2. These can be summarized in the following points:

1- The quantity of water discharged from El-Qalaa Drain fluctuated between 8.40 and 17.98 million cubic meter per month. The lowest amounts were recorded in January and February. These increased gradually during

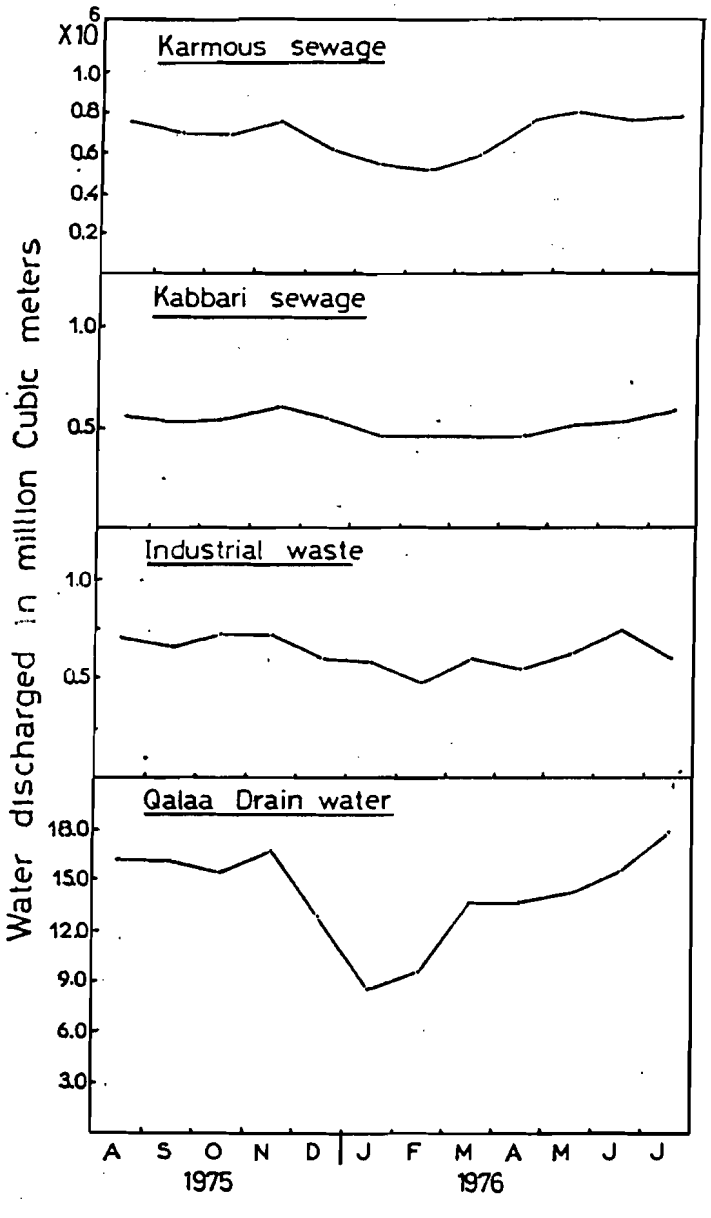

Fig. (2)
Amount of water discharged monthly into the lake proper between August 1975 to July 1976.

the spring and the summer but dropped again in December. The annual water discharge reached 170.88 million cubic meter, comprising about 88.75% of the total water poured into the lake proper.

2- The amount of sewage effluents discharged into the lake proper through Karmous sewage pipe ranged between 0.53 and 0.81 million cubic meter per month. It remained more or less constant throughout the year, but tending to decrease slightly during the period January-March. The annual sewage discharge reached 8.24 million cubic meter, constituting about 4.27% of the total water received by the lake proper.

3- The amount of sewage effluents discharged from El-Kabbari sewage pipe ranged between 0.45 and 0.6 million cubic meter per month. It tended also to decrease during the winter. The annual discharge amounted to 6.24 million cubic meter, representing about 3.24% of the total water introduced into lake proper.

4- The amount of water discharged from industrial waste disposal pipe flutuated from 0.48 to 0.73 million cubic meter per month. It tended to decrease during the winter. The annual discharge reached 7.56 million cubic meter, comprising about 3.92% of the total water discharged in the lake proper.

5- The total amount of water discharged into the lake proper from the different sources reached 192.92 million cubic meter per year. The average daily discharge amounted to 0.53 million cubic meter.

6- Most of the water introduced into the fish farm comes from Mariut El-Gedida Pumping Station as well as from the Umum Drain through its southern margin. Small quantities of the Qalaa Drain water may also enter the fish farm on rare occasions through the movable gate.

As shown on Table (1), the average monthly water evaporation in the proper ranged between 2.61 and 4.59 million cubic meters. It decreased during the autumn and winter but increased again throughout the spring and summer, parallel to the increase of water temperature. The annual water evaporation is calculated as 41.10 million cubic meter. Such a quantity exceeds the water budget of the lake proper which equals to 30.24 million cubic meter.

Comparing the annual amount of water discharged into the lake proper which reached 192.92 million cubic meter with the annual evaporation in the same basin, it appears that excess water is constantly poured into the lake and subseqently discarded through the Umum Drain which represents the only available outlet to get rid of the excess lake water.

TABLE (1)

Average monthly water discharged into the lake preper and water evaporation in cubic meters recorded during the period from August, 1975 to July, 1976.

Month	Water discharge	Water evaporation
August, 1975	18,319,600	3,553,000
September	18,288,000	3,679,000
October	17,537,500	3,679,000
November	19,013,200	2,606,000
December	14,839,000	2,772,000
January, 1976	10,004,000	2,621,000
February	11,055,000	2,990,000
March	15,039,000	3,276,000
April	15,094,000	3,881,000
May	16,151,800	4,586,000
June	17,663,100	3,604,000
July	19,917,300	3,856,000
Total (m^3/year)	192,921,500	41,103,000

MATERIAL AND METHODS

a- Physical Methods:

The limit of visibility of the lake water was estimated by using a white enamelled Secchi disc 30 cm in diameter. The water temperature was measured with a simple bucket thermometer graduated to 0.2 °C. Evaporation data was obtained from the Meteorological Station of Alexandria.

The suspended matter present in water was determined by filtering fixed quantities of water samples using membrane filters with 0.45 µm pore size and 35 mm diameter (Gottengen, Germany). The filters were firstly dried at 105 °C, then cooled in a dissicator and weighed. After filtration of the water samples, membrane filters containing the retained suspended matter were dried again at 105 °C for an hour, cooled and weighed. The suspended matter is calculated in mg dry wt/L.

b- Choice of Stations and Period of Sampling:

The present investigation was restricted to the lake proper and fish farm to estimate some physical parameters affected by pollution. Fourteen stations in the lake proper as well as three stations in the fish farm were selected as sampling stations. Water samples were also taken directly from

the Qalaa Drain and Noubaria Canal. The position of these stations are shown in Fig. 3. The habitats represented by the different stations are given as follows:

1- Area affected by industrial wastes (Station 1):
This area lies at the north eastern corner of the lake proper in front of the industrial waste disposal pipe. It is affected by the outfall of industrial remains collected from several factories.

2- Area subjected to sewage effluents (Stations 4, 7 and 10):
The area is situated on the north side parallel to El-Kabbari Highway. It recives sewage effluents from Karmous and El-Kabbari sewage pipes. Station 4 is heavily contaminated with Karmous sewage outfalls. Pollution decreased gradually at stations 7 and 10.

3- Area receiving the direct flow of Qalaa Drain (Station 3):
This area surrounds Moharrem Bey Bridge through which the Qalaa Drain water pours into the lake proper. Subsequently, the wastes introduced into this area are controlled by the water quality of the Qalaa Drain.

4 - The middle lake (Stations 2, 5 and 8):
It lies about the middle of the basin and it is less affected by the outfalls of both sewage and industrial wastes, as well as by the Qalaa Drain water. This area is usually more productive than the other regions of the lake proper.

5- The south west parts of the lake proper (Stations 6,9,11,12,13 and 14):
It represents the area lying at the west and is bordered by the Noubaria Canal and the Desert Road. This sector is located away from direct pollution.

6- The fish Farm (Stations 15,16 and 17):
Three stations were chosen to represent the north, middle and south parts of the fish farm and were represented respectively by stations 15,16 and 17.

Sampling was carried out monthly at the different stations during the period from August 1975 to July, 1977, covering two years cycles.

RESULTS

a- Air and Water Temperature:
The general climate of Mariut area is that of the warm temperate zones. The average monthly air temperature recorded during the present investigation dropped to a lowest value of 15°C (around midday) in Janauary. It increased gradually throughout the spring and the summer, reaching a peak of 29.5°C in July. The air temperature decreased again gradually from September to the end of the year (Table 2).

According to the shallowness of the lake, the water temperature was

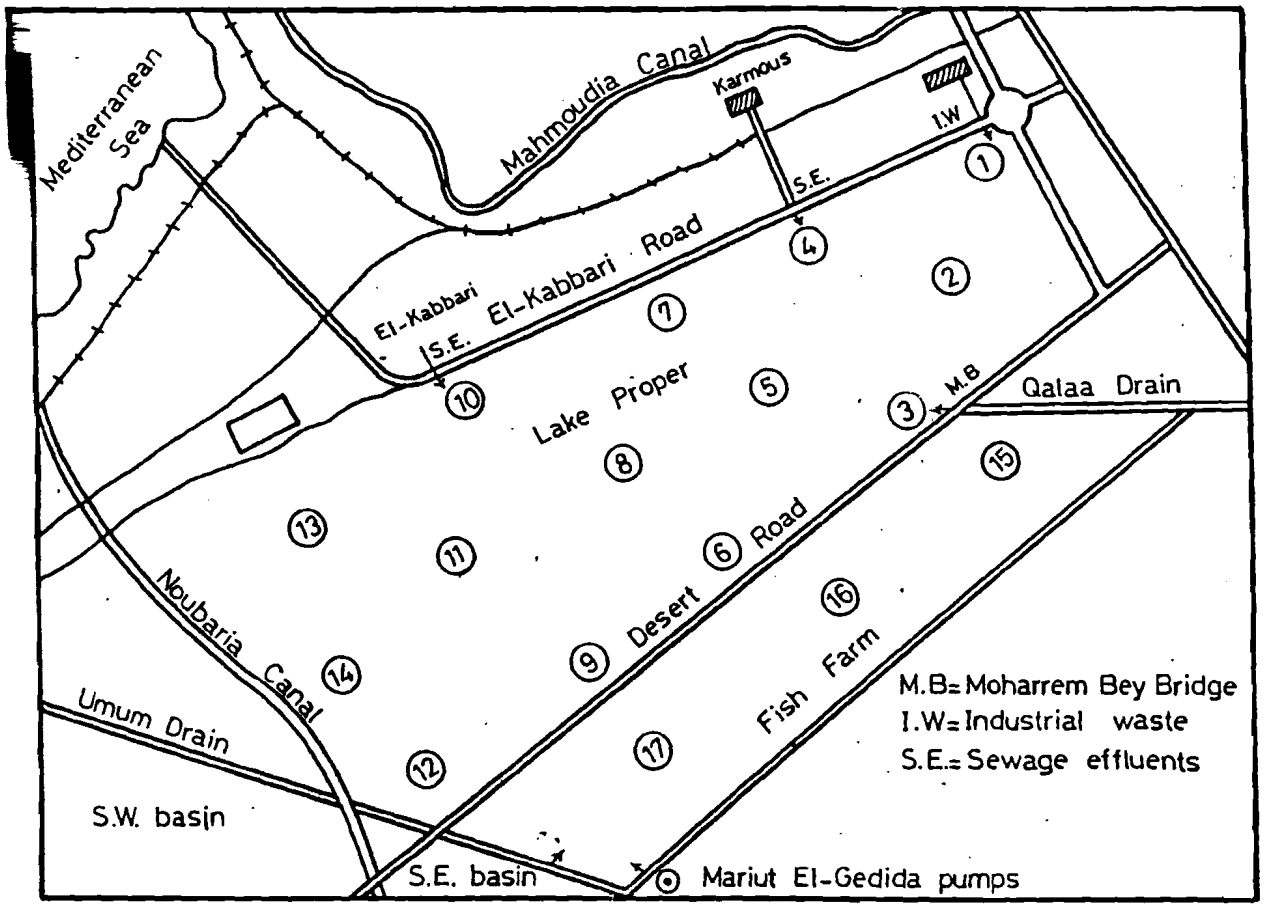

Fig. (3)
Position of stations.

TABLE (2)

Average monthly air and water temperature recorded in situ during the period July, 75 to June, 1977.

Month	Average temperature in °C		Month	Average temperature in °C	
	air	water		air	water
July, 1975	29.0	29.0	July, 1976	29.5	29.0
August	29.0	28.5	August	29.0	28.5
September	28.0	27.5	September	27.7	26.5
October	27.0	25.0	October	24.0	24.5
November	20.5	18.5	November	20.0	20.5
December	17.5	15.5	December	17.0	16.0
January, 1976	15.0	13.5	January, 1977	15.5	14.5
February	17.0	15.5	February	18.0	16.0
March	20.0	19.0	March	21.0	21.0
April	20.0	23.0	April	22.0	22.0
May	24.0	25.5	May	25.5	26.5
June	28.0	27.0	June	28.0	28.5

subjected to both diurnal and seasonal variations. However, the difference between the maximum and minimum daily water temperature did not exceed 4°C (cf. Sutton, 1946).

The average monthly water temperature fluctuated between 13.5 and 29.0°C. The lowest value was recorded in January while the highest appeared in July and August.

The temperature of water discarded from industrial waste disposal pipe was relatively high and it fluctuated between 23 and 36°C. Subsequently, it raised the water temperature at the neighbouring station 1 by a value ranging between 0.5 and 1.0°C higher than the rest of the lake water. The temperature of the bottom water recorded early in the morning, in areas receiving sewage effluents attained also values of about 0.5°C higher than that of the surface water as a result of putrefaction of organic detritus accumulated at the lake bottom.

b- Water Transparency:

The transparency of the lake water remained low throughout the present investigation as a result of the high content of suspended organic detritus in addition to the increased density of phytoplankton during certain periods. The Secchi disc readings in the lake proper ranged between 12 and 120 cm. The lowest transparency was recorded in areas subjected to direct pollution (stations 1,4,7 and 10) and it increased gradually towards the south west (Fig. 4).

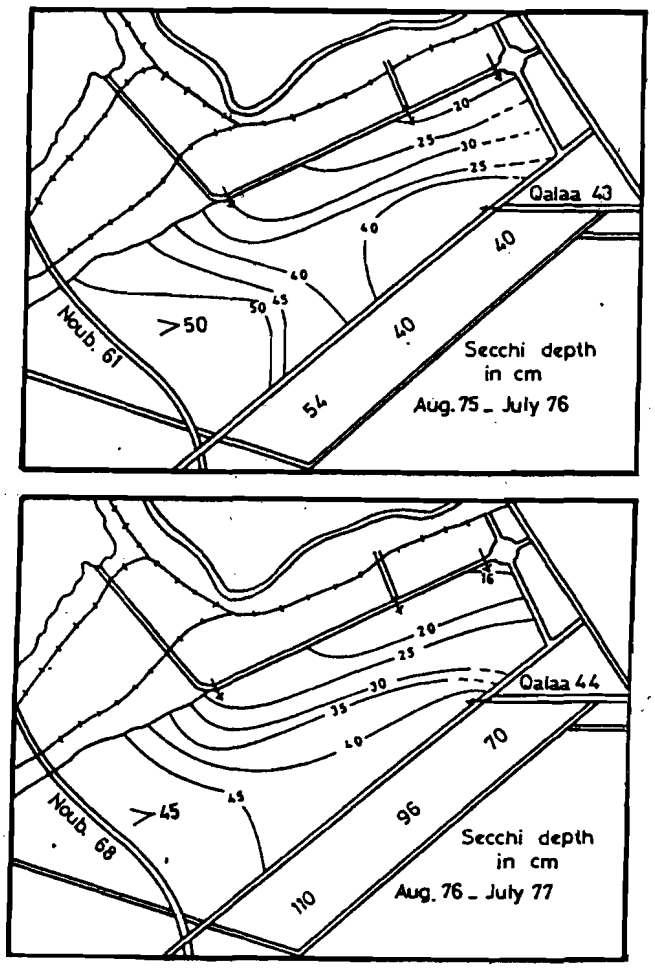

Fig. (4)
Distribution of Secchi depth in cm. during the two successive years, from Aug. 1975 to July 1977.

The water in the fish farm was more transparent, particularly during the second year of investigation. The Secchi depth there ranged between 20 and 140 cm. The lowest transparency was observed in area adjacent to the Qalaa Drain.

The transperency of the Qalaa Drain water was mostly higher than the lake water and this was attributed to its lower content of suspended matter. The Secchi depth there ranged between 20 and 70 cm. The secchi disc readings in the Noubaria Canal fluctuated between 27 and 100 cm.

As shown in Fig. 5 the Secchi depth in the lake proper remained low during most of the year with the exception of a pronounced increase observed in early spring. The transparency of water in the fish farm showed wide fluctuation from one month to the other. It appeared relatively low during the period September 1975 - April 1976, but increased rapidly and remained high throughout the rest of the investigation period. The transparency of the Qalaa Drain water was subjected also to irrelgular fluctuations, depending on the quality of water discharged into it.

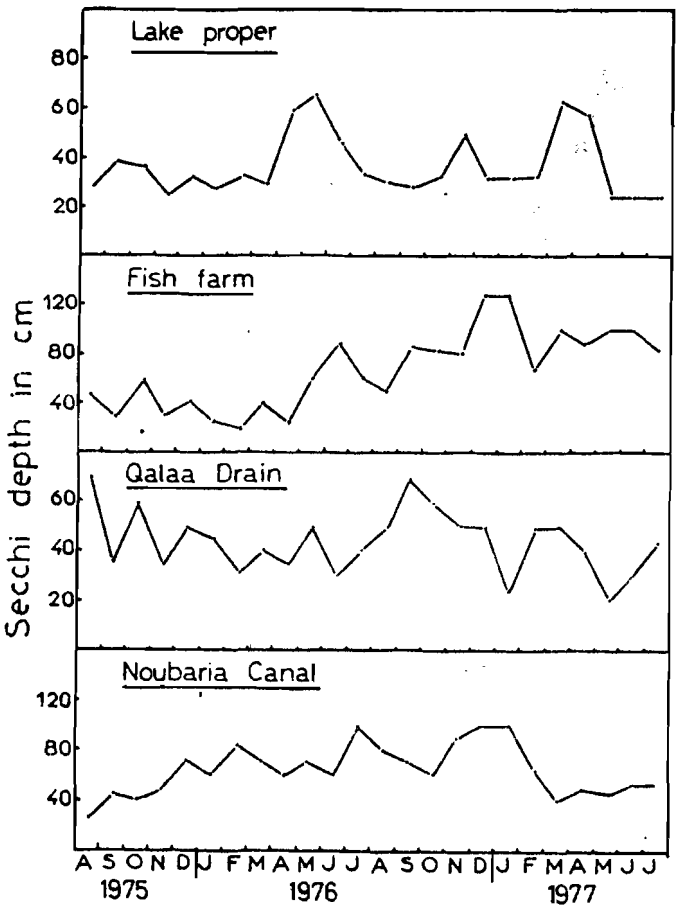

Fig. (5)
Seasonal variations of Secchi depth in cm.

c- Suspended Matter:

The particulate organic and inorganic seston in Lake Mariut was estimated monthly during the period from September, 1975 to March, 1976 and the results are shown in Fig. 6. The suspended matter in the lake proper ranged between 15 and 125 mg dry wt/L. It consisted mainly of the particulate organic load introduced with sewage effluents and industrial wastes as well as plankton growing in the lake water. Thus, the highest concentration of suspended matter was recorded in localities subjected to the direct outfalls of sewage and industrial wastes particularly at station 4, beside Karmous sewage pipe. It decreased towards the south west, away from pollution.

On the other hand station 3 sustained lower concentration of suspended matter as affected by the more clear water of the Qalaa Drain (average 30 mg dry wt/L). The suspended matter in the fish farm fluctuated from 30 to 130 mg dry wt/L, with an average of 63 mg dry wt/L. Unlike the proper lake, a big fraction of the seston there consisted of silt particles.

The Qalaa Drain sustained the lowest concentration of suspended matter which ranged between 6 and 35 mg dry wt/L. The suspended matter in the Naubaria Canal remained also lower than that of the proper lake and it fluctuated between 10 and 55 mg dry wt/L.

As shown in Fig. 7 the seasonal variations of the suspended matter was similar in the lake proper, fish farm and Qalaa Drain. It dropped in October, 1975 but increased again gradually till January 1976, attaining 83, 88 and 32 mg dry wt/L in the three localities respectively. Another gradual decrease was observed in February and March particularly in the lake proper. The higher concentration of suspended matter recorded in January was accompanied by decreased amounts of Qalaa Drain water discharged into the lake. The Naubaria Canal sustained also highest concentration of suspended matter in September, 1975 and January, 1976 (55 mg dry wt/L). Otherwise it decreased gradually between October and December. Another increase was observed during January, 1976 coinciding with its increase in the lake proper, but this was followed by a sharp drop in February.

DISCUSSION

The hydrology of Lake Mariut is of prime importance in assessing the physical features of the different regions. The lake is a small shallow basin which is divided into four sections. The lake proper represents the main basin in Lake Mariut (2,500 hectare). It receives most of its water from the Qalaa Drain which is heavily polluted. Sewage effluents as well as industrial wastes are also discharged into the lake proper along its north margins beside El-Kabbari Highway. The total amount of water discharged annually from the different sources into the Lake proper amounted to 192.9 million cubic meter. The Qalaa Drain supplied the lake proper by about 88.6 % of the total water discharged into it. Sewage effluents and industrial wastes comprised respectively about 7.5 and 3.9 % of the total water discharged.

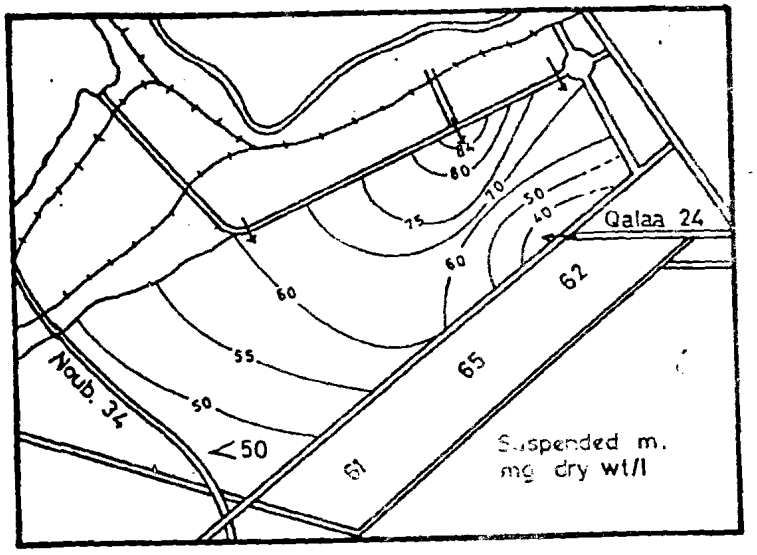

Fig. (6)
Distribution of suspended matter in mg. dry wt. / l recorded during the period September, 75 - March, 1976.

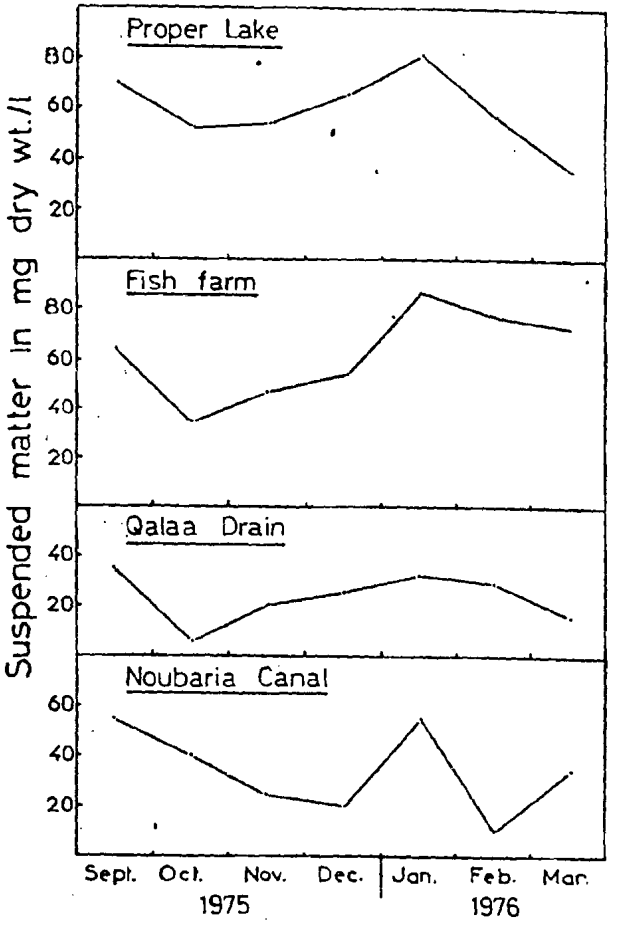

Fig. (7)
Seasonal variations of suspended matter in mg. dry wt. / l.

The effect of sewage and industrial wastes were more pronounced along the north margin of the lake proper, lying beside El-Kabbari Highway (stations 1,4,7 and 10) and this decreased gradually towards the south west. The effect of the Qalaa Drain water was confined to the area surrounding Moharrem Bey Bridge (station 3).

The middle lake (stations 2,5 and 8) sustained mixed water coming from the Qalaa Drain and from sewage and industrial wastes pipes. The water there was partially self-purified mainly by the growth of phytoplankton. The south west parts of the lake proper were less affected by pollution.

The fish farm receives most of its water from Maruit El-Gedida Pumping Station which is free of pollution. A small quantity of the Qalaa Drain water may also enter the fish farm through a movable gate connecting the drain with the fish farm.

As regards to the water temperature, it was subjected to both diurnal and seasonal variations, following that of the air temperature. The average monthly water temperature fluctuated between 13.5°C (in January) and 29.0°C (in July and August). The industrial waste disposal pipe discharged water of a relatively high temperature that fluctuated between 23°C and 36°C. This raised the water temperature in the neighbouring station I by a value ranging between 0.5°C and 1.0°C. The bottom water in areas receiving seawge effluents sustained also temperature of about 0.5°C higher than the surface water, early in the morning, due to the putrefaction of organic detritus accumulated on the bottom of the lake.

Results obtained from Secchi disc readings indicate that the lake water is mostly turbid due to the high content of suspended organic detritus in addition to the increased density of phytoplankton during certain periods. The Secchi depth in lake proper ranged between 12 and 120 cm. The lowest transperency was recorded in areas receiving industrial waste and sewage effluents, and it increased gradually towards the south west away from pollution.

Turbidity of water in the fish farm was mainly due to suspended silt particles introduced with the drain water. The Secchi depth there ranged between 20 and 140 cm. The Qalaa Drain water was more transperent than that of the lake due to its lower content of organic seston. It sustained an average Secchi depth of 44 cm.

The transperency in the lake proper has decreased slightly during the second year of investigation indicating a gradual accumulation of pollutants there, while it showed a pronounced increase in the fish farm.

The depth of 1% light transmission in Lake Mariut has been evaluated as equivalent to 2.5 the Secchi depth (Aleem and Samaan, 1969). Such a depth represents the photic zone. Thus it is suspect that the photosynthetic activities of phytoplankton in the lake proper are mostly confined to the

upper 50 cm in the highly polluted area. This depth increases gradually away from pollution till it reaches the lake bottom in the south west regions.

The transperency of the lake proper as estimated during the present investigation did not change much from the records of 1960 where the Secchi depth fluctuated between 11 and 66 cm (Aleem and Samaan, 1969). However, the low transperency observed in 1960 was mostly attributed to the blooming of phytoplankton.

The suspended organic matter in the lake proper consisted mainly of the particulate organic load carried out by sewage effluents and industrial wastes and less so to the plankton surviving in the water. It fluctuated between 15 and 125 mg dry wt/L. The highest concentration appeared beside Karmous sewage pipe (average 84 mg dry wt/L) and this decreased gradually southwards. The Qalaa Drain water sustained the lowest concentration of suspended matter (average 24 mg dry wt/L) and subsequently it reduced the suspended matter at the adjacent station 3 to 30 mg dry wt/L.

The suspended matter in the fish farm attained an average value of 62 mg dry wt/L and this consisted mainly of silt.

In conclusion, the physical parameters affected by water pollution in Lake Mariut are manifested by the increased turbidity of the lake water and high fraction of suspended seston. A slight increase of water temperature was also observed in regions receiving industrial wastes, showing partial thermal pollution.

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