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SOME LIMNOLOGICAL STUDIES ON THE NILE WATER AT CAIRO, EGYPT.

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ABSTRACT

Regional variations of some physical and chemical conditions in the Nile water at Cairo were studied. The water temperature reached a maximum value of 31 °C in the surface layer in summer and a minimum of 16 °C in Winter. Transparency values were higher in the cold season (85 cm) and lower in the hot period (50 cm). At the same time, it increased northward from Helwan reaching its highest values at Roud El-Farag. However suspended solids varied in the opposit direction. Dissolved oxygen showed maximum concentration in January and lowest values in July. The higher oxygen concentration at Roud El-Farag in the surface water (11.5 mg/l) was accompanied by higher transparency and lower suspended matter. The minimum oxygen content (6.3 mg/l) measured at Helwan may be due to oxygen consumption in the decomposition of organic matter. The chemical oxygen demand had the maximum values at Roud El-Farag (averages 26.1 and 27 mg/l) in the surface and at 5 m depth respectively, and lowest values at Helwan (averages 23.4 and 24.4 mg/l) in the surface and 5 m depth respectively. COD gave a maximum in January (averaves 28.7 and 30.1 mg/l) for the surface and 5 m depth respectively. The levels of BOD in the study area showed a trend similar to that of COD.

Bicarbonate content varied seasonally and regionally with maximum values in October at Helwan and the minimum in January at Roud El-Farag. Chlorosity varied seasonally with highest values in July (averages of 26 and 23.7 mg/l for surface and 5 m depth and lowest of 10.6 mg/l in January and also regionally to reach a higher value of 20.8 mg/l at Helwan and 18.6 mg/l in the surface water at Roud El-Farag. The slight irregular variation in pH values can be attributed mainly to mixing of the Nile water. Calcium and Magnesium distributions have the same trend as shown in concentration of HCO_3 The maximum value of electrical conductivity 380 µmhos measured at Helwan in July and the minimum of 310 µmhos at El-Rodah in October.

INTRODUCTION

The River Nile extending for about 6,825 km represents the main source of water and life in Egypt.

Several limnological studies were carried out on the Nile ecosystem. The earliest investigation was performed on the White and Blue Niles by Beam (1906 and 1908), Tottenham (1926) Talling (1957) and Bishai (1962). A review on the physical and chemical parameters of the Nile system was given by Visser (1962); Talling and Talling (1965), Viner (1969), Beadle (1974). Also, the water chemistry has been discussed by Golterman (1975), and Talling (1976 and 1976a).

Concerning the Egyptain part of the River Nile, early information were given by several authors (Lucas, 1908; Aladjam, 1926 and 1928; Abdin 1948a; and Hurst, 1957). Ramadan (1972) characterized the Egyptian Nile water perior to the High Dam. Recently, also several studies on the Nile chemistry have been carried out (Shehata, 1976; El-Gohary, 1978 and Saad, 1980).

The present investigation represents a survey on the seasonal and regional variations of some physical and chemical limnological parameters of the Nile water at Cairo along an area of about 60 km. from Helwan in the south to Road El-Farag in front of Cairo (Fig. 1) to evaluate the effect of pollution on the Nile water quality.

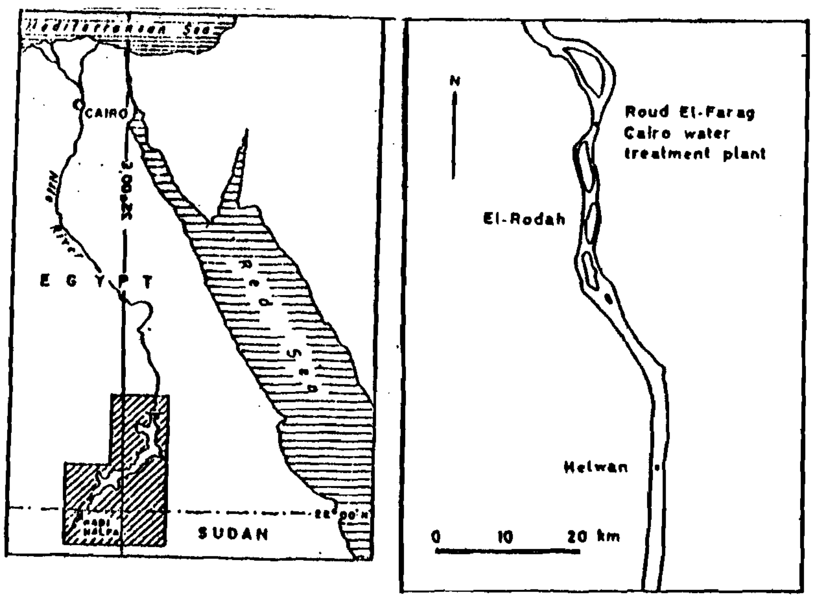

Fig. (1)
Map of the study area showing the sampling sites in the River Nile at Cairo.

MATERIALS AND METHODS

Sampling was carried out during the period from July 1985 to April 1986 at three ststions along the River Nile at Cairo, viz Roud ElFarag in front of the water treatment plant, up stream El-Rodah and at Helwan in front of Iron and Steel Factiry. Water samples were collected from surface, and at 5 m depth by Van Dorn plastic bottles. The samples were kept in well stoppered polyethylene bottles.

Transparency was measured using a white enamelled Secchi disc of 25 cm diameter. Water temperature was registered using thermometer. pH values were measured by pH meter. Electrical conductivity was measured by conductivity meter (YSI Model 33, S-C-T). Determination of suspended solids, dissolved oxygen, chemical and biochemical oxygen demand, bicarbonte, chlorosity, Calcium and magnesium were carried out according to the methods described by American Health Association, (Anon., 1975).

RESULTS AND DISCUSSION

Temperature

As given in table (1), the highest water temperature in the Nile water was 31°C measured at El-Rodah and Helwan in the upper 5 m Layer during Summer, compared with the lowest values of 16 - 18°C measured in Winter. Generally speaking the Nile water is homothermal with no stratification all the year round, due to, its small depth and also from inflow of the running water from the south.

TABLE 1
Water temperature (°C)

Month	July		October		January		April	
	Depth (m.)							
Site	0	5	0	5	0	5	0	5
Roud El-Farag	30	29	22	24	16	16	21	21
El-Rodah	31	31	25	26	17	16	21	21
Helwan	31	31	25	26	18	17	23	23
Average	30.7	30.3	24	25.3	17	16.3	21.7	21.7

Transparency

On the whole, phytoplankton blooming and suspended matter lowers the transparency. The transparency values were generally higher in cold season (average 79 cm) and were lowest in hot period (average 52 and 63 cm) (Table 2). Transparency was relatively higher in the norhern station at Roud El-Farag (lower suspended matter) and lower at the southern area at Helwan (averages 71 and 59 cm, respectively).

TABLE 2
Transparency (cm.)

Site / Month	July	October	January	April	regional average
Roud El-Farag	70	55	85	75	71.0
El-Rodah	65	53	80	66	66.0
Helwan	55	50	73	58	59.0
Averages	63.3	52.7	79	66.3	

Suspended Matter

According to Hurst (1957), about 100 million tons of suspended sediments, consisting of 30% fine sand, 40 % silt and 30 % clay, were carried annually with the Nile water on entering Egypt. These sediments greatly increases at the begining of the Nile flood. Elster and Vollenweider (1961) pointed out that the average value of the suspended matter found at the Egyptian borders during the flood period (August / October) amount to 1.6 Kg /m^3.

Before the erection of the High Dam, the flood water was uncontrolled, and was left to drain into the Mediterranean Sea; the turbid flood water was extending along the whole of Egypt. In the Postdam period however, the water released north of Aswan is free from silt Aboul-Atta (1978) pointed out that the highest values of suspended matter found at El-Gaafra lying at Aswan was 2.7 gm/l in Augustt 1958 - 1963 as compared with only about 0.04 - 0.05 gml for the period 1968 - 1976.

According to Ramdan (1978), an important change in the Nile water quality after construction of the High Dam is the increase of its dissolved salt content, due to the high rate of evaporation of the stored Nile water in High Dam Lake. However, before the construction of the Hig Dam a typical Nile flood used to have high concentrations of suapended matter and low values of dissolved salts. In conteast, the post - dam river conditions exhibit consistant low leves of suspended matter and relatively high levels of dissolved salts (Elewa, 1985).

During the present syudy (Table 3), the highest concentrations of suspended matter were measured at Helwan and the recorded values decreased northwards seasonally, The values of suspended matter are minimum in winter, followed by summer, spring and autumn. They increased with depth, giving the highest values at 5 m depth.

TABLE 3
Total suspended Solids ($mg l^{-1}$).

Months	July		October		January		April		regional averages	
	Depth (m.)									
Site	0	5	0	5	0	5	0	5	0	5
Roud El-Farag	27.1	29.5	41.1	44	20.3	24.5	30.4	32.9	29.7	32.7
El-Rodah	29.9	32.7	42.6	46.4	22.9	25.7	32.0	35.1	31.9	34.9
Helwan	34.3	38.9	48.2	51.9	26.1	30.0	36.3	40.1	36.2	40.2
Averages	30.4	33.7	44	47.4	23.1	26.7	32.9	36.0		

Electrial Conductivity

The highest of (E.C.) was 380 µmhos measured in the surface water at Helwan in July (Table 4) and the minimum value of 310 µmhos measured at El-Rodah in October at 5 m depth . Again the seasonal average value of E.C. shows the peak at Helwan and the minimum value at El-Rodah. On the other hand, the peak for all area of study shows in July with the minimum value in October. ElGohary (1978), shows the E.C. in the Nile at Cairo segment fluctuated in the range of 299 - 499 µmhos in February 1976 and September 1977 respectively. Again the value of E.C. in the High Dam Lake shows lower values compared with the present study ones and ranged between 185 260 µmhos (Elewa, 1980).This is mainly due to the sedimentation of suspnded solids with the ionic salts leaving the water free from chemical elements. The higher values of E.C. in the Nile at Cairo is mainly attributed to the leaching of ionic salt from the Nile bank and to the influence of the drainage water.

Dissolved Oxygen

The (D.O.) distribution in the Nile water (Table 5) shows a slight difference between surface and 5. depth due to overturn and the current. In the other hand the highest oxygen contents are found in winter time (11.5 mg/l) followed by spring, autumn and least in summer (6.3 mg/l). Again, the D.O. values increased downstream from south of Cairo at Helwan to the north at Roud El-Farag. This decrease in oxygen concentration at Helwan may

TABLE 4
Electrical Conductivity (µmhos cm^{-1})

Site \ Months	July 0	July 5	October 0	October 5	January 0	January 5	regional averages 0	regional averages 5
Roud El-Farag	360	365	370	370	370	370	366.6	368.3
El-Rodah	375	375	320	310	370	370	355.0	351.8
Helwan	380	375	375	375	360	365	371.7	371.7
Averages	371.7	371.7	355.0	351.7	366.6	368.3		

Depth (m.)

TABLE 5
Dissolved Oxygen (mgl^{-1}).

Site \ Months	July 0	July 5	October 0	October 5	January 0	January 5	April 0	April 5
Roud El-farag	8.1	7.8	9.9	9.6	11.5	10.9	11.1	10.9
El-Rodah	7.9	7.8	8.8	8.8	11.0	11.3	10.8	10.1
Helwan	6.3	5.9	9.0	8.7	9.0	8.8	9.0	8.6
Averages	7.4	7.2	9.2	9.0	10.5	10.3	10.3	9.9

Depth (m.)

be due to the oxygen consumption in the decompostion of organic matter and in oxidiation of chemicals from polluted effluent of different factories around this area.

Chemical Oxygen Demand (COD)

The higher concentration of COD 30.9 mg/l was observed at 5 m depth at Roud El-Farag during January as compared with the lowest value of 20 mg/l at Helwan in the surface water during July (Table 6). In the other hand there is a coincidence between the distribution of COD and dissolved oxygen. The low values of COD found in the Nile at Helwan can be attributed

TABLE 6
Chemical Oxygen Demand (mgl^{-1}).

Months	July		October		January		April		regional averages	
	Depth (m.)									
Site	0	5	0	5	0	5	0	5	0	5
Roud El-Farag	22.9	23.4	25.5	25.7	29.1	30.9	27	28.1	26.1	27.0
El-Rodah	22	22.8	23.3	24.3	29.0	30.1	25.8	26.4	25	25.9
Helwan	20	20.7	21.6	22.2	28	29.2	24	25.3	23.4	24.4
Averages	21.6	22.3	23.5	24.1	28.7	30.1	25.6	26.6		

mainly to phytoplankton abundance and surface runoff, as well as the effect of sewage and industrial pollution (Saad, 1980). The higher values at Roud El-Farag on the other hand, coincided with the decrease in the autochthonous and allochthonous supply of organic matter as well as the increase in the rate of its decomposition.

Biochemical Oxygen demand (BOD).

As given in Table 7, the highest value of BOD 5.5 mg/l measured in the surface water at Roud El-Farag during January and the lowest value of 0.5 - 0.6 mg/l measured at Helwan in July. Again there is a higher concentration of BOD in the surface water than underlying water. The low concentration of BOD measured at Helwan is mainly attributed to the presence of pollution or industrial wastes,(Anon., 1975).

TABLE 7
Bichemical Oxygen Demand (mgl^{-1}).

Months	July		October		January		April		regional averages	
	Depth (m.)									
Site	0	5	0	5	0	5	0	5	0	5
Roud El-Farag	2.6	2.1	3.2	2.8	5.5	4.3	3.5	3.3	3.7	3.1
El-Rodah	2.4	2.5	2.6	2.6	4.7	4.5	2.6	2.5	3.0	3.0
Helwan	0.6	0.5	2.0	1.4	4.2	2.8	2.2	1.6	2.3	1.6
Averages	1.87	1.7	2.6	2.2	4.8	.87	2.77	2.47		

Bicarbonate:

In the Nile water, the bicarbonate contents are higher in the surface water than at 5 m depth. At the same time it is higher at Helwan (average 128.3 mg/l) compared with 109.7 mg/l at Roud El-Farag (Table 8). Seasonally, the bicarbonate content showed higher values in Autumn as compared with the lowest values in spring. This decrease in bicarbonate during spring may be due to increase in photosynthesis. Again there is a parallel correlation between the distribution of bicarbonate concentration and the electrical conductivity.

TABLE 8
Bicarbonate alkalinity (mgl^{-1}).

Month	July		October		January		April		regional averages	
	Depth (m.)									
Site	0	5	0	5	0	5	0	5	0	5
Roud El-Farag	100.4	97.9	168.6	161.2	84.3	81.8	85.6	84.3	109.7	106.3
El-Rodah	109.1	94.2	171.1	111.6	88.0	96.7	96.7	88.0	116.2	97.6
Helwan	119.0	116.6	171.1	167.4	111.6	99.2	111.6	100.4	128.3	120.9
Averages	109.5	102.9	170.3	146.7	94.6	92.6	97.9	90.9		

pH values:

The pH values in the Nile water are always on the alkaline side with slight variation between the surface and bottom. Increasing the pH value to 8 in January at El-Rodah and Helwan is related to increase in primary production by increased photosynthesis involving the uptake free carbon dioxid from carbonate - bicarbonate buffer system and precipitation of calcium carbonate (Ruttner, 1953 and El-Wakeel and Wahby, 1970). The lower values of pH (7.2) at Helwan in April are associated with decomposition of organic matter (Table 9).

Chlorosity:

The principal factors affecting the chlorosity content in the Nile water are the influx of drainage water and sewage wastes contamination. Thus, the high chlorosity content was measured in July and decreased in January (Gonzalves and Joshi, 1946; zafar, 1946; Morgan and Falk, 1970 and Elewa, 1980). In turn the maximum value recorded at Helwan (average 20 mg/l in the surface water and lowest value measured at Roud El-Farag (average 18.6 mg/l) (Table 10). Again chlorosity content in the Nile was higher during

TABLE 9
pH values

Month Site	July 0	 5	October 0	 5	January 0	Depth (m.) 5	April 0	 5	regional averages 0	 5
Roud El-Farag	7.3	7.3	7.5	7.5	7.5	7.5	7.6	7.4	7.5	7.4
El-Rodah	7.4	7.3	7.5	7.5	7.6	8.0	7.4	7.3	7.5	7.5
Helwan	7.7	7.6	7.8	7.8	7.5	8.0	7.2	7.4	7.6	7.7

TABLE 10
Chlorosity content (mgl^{-1}).

Months Site	July 0	 5	October 0	 5	January 0	Depth (m.) 5	April 0	 5	regional averages 0	 5
Roud El-Farag	24	23.4	20	20.6	10	10	20.2	19.8	18.6	18.5
El-Rodah	24	23.8	21.8	22	10.2	9.8	20	19.6	19	18.8
Helwan	30	24	23.8	25.4	11.6	11.0	17.8	17.8	20.8	19.6
Averages	26	23.7	21.9	22.7	10.6	10.3	19.3	19.5		

summer, averaging 26 and 23.7 mg/l and in winter, averaging 10.6 and 10.3 mg/l in the surface and 5 m depth, respectively. As given by El-Gohary, 1978 during 1976 77 the chlorosity content in the Nile water was varied in the range of 12 - 28 mg/l. This mean that chlorosity content in the Nile water shows no wide variation within the last 10 years.

Calcium

In the Nile water, calcium concentration (Table 11) reaches the highest at Helwan (average 77.3 and 78.0 mg/l) and the lowest values at Roud El-Farag (average 65.4 and 66 mg/l) in the surface and 5 m depth respectively. Again calcium is more concentrated during October (average 80.5 mg/l) compared with the lowest value of 62.5 mg/l in january.

Magnesium

In the Nile water at Cairo, the higher magnesium contents measured at Helwan, with the average 35.9 and 54.6mg/l in the surface and 5 m depth

TABLE 11

Calcium concentration (mgl^{-1}).

Site	July 0	July 5	October 0	October 5	January 0	January 5	April 0	April 5	regional averages 0	regional averages 5
Roud El-Farag	66	70.5	76.5	75	57	57	61.5	61.5	65.4	66
El-Rodah	73.5	73.5	76.5	78	66	61.5	64.5	70.5	70.1	70.9
Helwan	79.5	82.5	88.5	88.5	67.5	69	73.5	72	77.3	78.0
Averages	73	75.5	80.5	80.5	63.5	62.5	66.5	68		

Months: July, October, January, April, regional averages; Depth (m.): 0, 5.

were copmared with the lowest value of 35.7 and 38.9 mg/l at Roud El-Farag in the above two depths respectively (Table 12). Again as given in the calcium distribution, Mg has higher concentration in October (average 71.4 and 70.5 mg/l) in the surface and 5 m depth; as compared with lowest values measured in April with the average of 31.7 and 33.1 mg/l for the above depths, respectively.

TABLE 12

Magnesium (mgl^{-1}).

Site	July 0	July 5	October 0	October 5	January 0	January 5	April 0	April 5	regional averages 0	regional averages 5
Roud El-Farag	30.8	35	57.4	58.8	28.0	32.2	26.6	29.4	35.7	38.9
El-Rodah	33.6	39.2	68.6	68.6	33.6	40.6	30.8	30.8	41.7	44.8
Helwan	50.4	54.6	88.2	84	39.2	40.6	37.8	39.2	53.9	54.6
Averages	38.3	42.9	71.4	70.5	33.6	37.8	31.7	33.1		

Months: July, October, January, April, regional averages; Depth (m.): 0, 5.

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