PHYCOLOGICAL ASSESSMENT OF WATER QUALITY OF RIVER NILE DELTA - EGYPT.

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Abstract

The number, biomass and diversity of phytoplankton as well as physico-chemical characteristics of surface water at the three sites (El- Rahawi, El - Serw and El - Ziaat) representing Delta region of the river Nile were studied in response to discharged liquid wastes from April, 1998 to April, 1999. A total of 214 algal taxa belonging to 99 different genera were identified. Chlorophyta (81 genera), Bacillariophyta (71 genera), Cyanophyta (28 genera) and Euglenophyta (24 genera) were the dominant group. The minimum phytoplankton growth was in drainage canal of El-Ziaat factory. Moreover, the lower values of diversity and saprobity indicated at drain water concomitant with the higher values of saprobic quotient (SQ) might reflect the pollution status of water. The physico-chemical assessment of water could point to indicate that the upstream and down-stream water is mesotrophic while, water of the mixed station is eutrophic and at drain station was varied between eutrophic to hypereutrophic conditions. Moreover, the low pH values at discharged waste of Soda factory at El-Ziaat and the undetectable dissolved oxygen at El -Rahawi drain were considerably retracted at the mixed and more at down-stream water.

Introduction

In spite of the Egyptian Environmental Affairs Agency (EEAA) and the ministry of the environmental protection legislation's, some institutions and drains still discharge their pollutants into the river Nile. These pollutants adversely change the environment in the river by changing the growth rate of species and interfere with food chain or with public health (Seiki *et al.*, 1991).

River pollution is the ultimate manifestation of nontoxic pollution that might deplete of the dissolved oxygen from water (Kwandrans *et al.*, 1998). However toxic pollution are metabolic poisons, it can seriously injure or destroy the photosynthetic organisms (Doudoroff and Katz, 1953). Due to algal photosynthetic activity, 70% of the world's atmospheric oxygen is generated and it plays the main role in the carbon dioxide absorption in aquatic ecosystem (Mullineaux, 1999). Since algal species are generally sensitive to fluctuations in the surrounding environment, they can often be utilized as biological indicators of water pollution (Villegas and Giner, 1973).

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Eutrophication (as a result of sewage, industrial and agriculture runoff) may lead to low diversity of phytoplankton species (Shaaban - Dessouki *et al*., 1993, Tilman *et al*., 1996), increases in productivity of aquatic habitats (Fairchild *et al.*, 1989) and increases the biomass of the phytoplankton (Hickman, 1980). Thus, the major purpose of this research was to follow up the pollution status of the River Nile Delta through studying of some representative sites (namely; El Ziaat; El Serw and El-Rahawi), which still receive diverse types of pollutants. The research was conducted by bimonthly evaluating water quality by testing the physico-chemical and phycological assessment of water at the selected sites.

Study area: (Figure 1).

1- El-Rahawi site, which receives mainly domestic and some agriculture wastes effluent. 2- Kafr El-Ziaat, which receives industrial effluent discharged from soda and sulfur factories. 3- El-Serw site, which receives mainly agriculture effluent with some domestic sewage.

For each site, four positions were chosen as study stations representing the up-stream water, the drain water itself, the mixed water and the down-stream water. At Kafr El-Ziaat, two additional stations were, moreover, chosen because of the presence of two kinds of industrial discharged water from Soda and Sulfur factories.

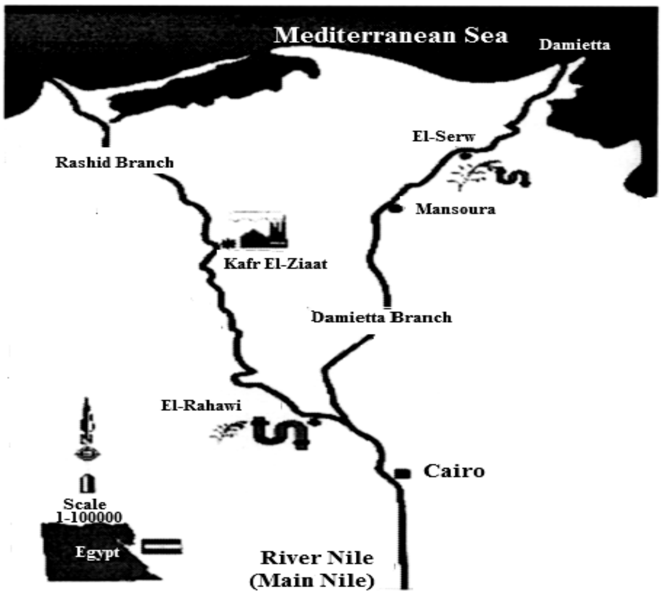


Figure (1): A map showing the sampling sites.

Material and Methods

Water samples were regularly collected bi-monthly from April, 1998 to April, 1999. Temperature and pH values were recorded at each sampling station. The methods of APHA (1989) were performed for the determination of Cl^-, salinity, ph.ph alkalinity, total alkalinity, total hardness, turbidity, dissolved oxygen, ammonia, NO_2^-, NO_3^-, PO_4^{---}, total P, SO_4^{--}, silica, Na, K, Fe, Cu, Pb, Co and Zn.

Pearson product moment correlation was performed using software program SPSS to explain the relationship between all physico-chemical parameters as well as between physico-chemical and biological parameters (Nie *et al*., 1975). Cluster analysis was carried out by using Bray - Curtis dissimilarity index (Clifford and Stephenson, 1975). The matrix of biological parameters and environmental variables of 91 samples were subjected to Canonical corresponding analysis using CANOCO (canonical community ordination) program (Ter Braak, 1987).

Result and Discussion

The changes in physico-chemical characteristics lead to qualitative and quantitative changes in the planktonic organisms (El-Naggar *et al.*, 1997). As shown in Table (1). The relative variations in water temperature (16-36 ^oC) between different stations were due to different season and temperature of discharged wastes. The temperature of discharged water at Kafr El-Ziaat was relatively higher than that of the other stations; this may be due to the industrial effluents dumped into water bodies.

The minimum pH value (3.0) and undetectable total alkalinity were recorded at El-Ziaat site mainly due to the washing of soda factory by H_2SO_4 solution. In other sites total alkalinity (1.8 -3.7) might indicate eutrophic condition of the water. Total alkalinity values were greater than 1.4 m equ L^{-1} indicates eutrophication conditions (Moss, 1973). The results declare also that oxygen content was very low within the discharged water, especially within El-Rahawi drain. This could be attributed to the presence of organic compounds within the domestic sewage. In this accordance, there is an evidence that, organic wastes input leads to the deoxygenation (Juttner *et al.*, 1996). Regarding the B.O.D. values, the up-stream water had relatively lower levels than the discharged water at El-Rahawi and El-Serw. This may be due to the relative higher biotic content in the discharged polluted water. On the contrary, industrial runoff at El-Zaait was characterized by undetectable value of B.O.D.; this may be attributed to the absence of aquatic biota. In this connection, Tebbutt (1977) reported that, growthly polluted water is characterized by having B.O.D. of 12 mg .L^{-1} or more in average.

The mean values of ammonia, organic nitrogen and organic phosphorus at El-Rahawi drain were higher than at El-Serw drain (Table.1). This may be due to

Table(1): Changes in physico - chemical parameters at the different stations of El-Rahawi, El -Zaait and El-Serw sites 1,2,3 and 4 refer to upstream, discharged, mixed and down stream water respectively. Values are the mean during the peroid from April 1998 to April 1999. Two additional stations 2* and 3* at El-Zaait sites refer to discharge of sulfur factory and its Mixed.

Parameters		Temperature °C	PH	Total alkalinity (m equ.L^{-1})	D.O (mg.L^{-1})	B.O.D (mg.L^{-1})	Ammonia-N (mg.L^{-1})	Nitrite-N (mg.L^{-1})	Nitrate-N (mg.L^{-1})	Total inorganic-N	Organic nitrogen (mg.L-1)	Total nitrogen-N (mg.L^{-1})	Reactive Silica (mg.L^{-1})	Orthophosphate (mg.L^{-1})	Organic phosphorus (mg.L^{-1})	Total phosphorus (mg.L^{-1})	Conductivity(m moh)	Salinity (‰)	Cl^- (mg.L^{-1})	SO_4^{--} (mg.L^{-1})	Hardness (m equ.L^{-1})	Na (ppm)	K (ppm)
El-Rahawi	1	26.4	7.7	1.8	7.6	9.3	0.0	0.0	0.0	0.1	1.3	1.5	0.3	0.1	0.6	0.6	0.4	0.2	9.7	0.5	104.5	38.5	4.4
	2	25.2	7.3	3.7	0.9	22.2	5.9	0.1	0.2	6.3	6.1	12.2	0.4	0.4	5.4	5.8	2.2	1.0	54.5	1.4	183.9	112.9	10.7
	3	26.1	7.4	3.0	3.2	16.8	3.3	0.1	0.1	3.4	3.4	6.8	0.4	0.2	2.9	3.0	1.0	0.6	31.8	0.9	140.7	82.8	8.1
	4	26.6	7.5	2.7	5.7	11.3	0.7	0.0	0.0	0.7	1.8	2.5	0.3	0.1	1.4	1.5	0.6	0.6	15.6	0.6	130.8	61.9	6.5
	Max.	32.0	8.2	4.5	10.5	30.6	9.8	0.1	0.8	10.0	8.7	18.6	0.8	0.7	10.4	7.1	2.5	1.1	58.7	1.9	206.0	118.0	11.4
	Min.	18.0	7.0	1.4	0.0	6.1	0.0	0.0	0.0	0.0	0.6	0.7	0.0	0.0	0.2	0.3	0.3	0.1	7.3	0.3	46.9	32.7	4.2
El-Zaait	1	25.8	7.7	2.3	6.8	10.2	0.1	0.0	0.0	0.1	1.5	1.6	0.2	0.1	0.5	0.5	0.4	0.2	12.9	0.7	104.0	47.3	4.6
	2	31.7	6.4	1.9	3.6	4.8	0.0	0.1	0.1	0.1	0.1	0.2	3.1	0.2	0.0	0.3	3.8	1.8	238.5	2.7	247.7	161.6	5.2
	2*	28.1	7.5	2.9	7.1	0.0	0.0	0.0	0.1	0.2	0.7	0.9	4.7	0.4	0.0	0.4	5.0	2.8	155.6	1.8	551.2	125.8	6.7
	3	26.1	7.3	2.2	4.8	4.8	0.0	0.0	0.0	0.1	0.4	0.4	0.6	0.0	0.2	0.2	0.6	0.3	17.0	1.1	126.6	51.1	5.0
	3*	26.4	7.6	2.4	6.8	7.0	0.0	0.0	0.1	0.1	1.0	1.1	1.8	0.1	0.2	0.4	0.8	0.4	23.8	1.0	168.0	55.3	5.2
	4	25.9	7.6	2.3	6.2	8.5	0.0	0.0	0.0	0.1	1.2	1.3	0.8	0.1	0.4	0.4	0.5	0.3	14.6	1.0	123.8	52.1	5.0
	Max.	36.0	8.7	3.1	9.0	13.9	0.1	0.1	0.2	0.4	1.9	2.1	10.2	0.7	0.7	0.8	13.5	6.5	242.3	3.4	652.8	207.2	7.6
	Min.	19.0	3.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.2	11.3	0.4	45.6	40.8	4.2
El-Serw	1	24.9	7.8	2.2	6.4	10.3	0.1	0.0	0.1	0.1	2.0	2.2	0.3	0.1	0.5	0.6	0.5	0.2	13.5	0.7	127.5	47.3	4.3
	2	24.9	7.5	3.5	3.1	18.9	1.9	0.2	0.5	2.5	5.7	8.3	0.8	1.9	2.8	4.8	3.0	1.3	73.4	1.2	218.7	136.1	5.9
	3	24.6	7.5	3.3	4.1	16.5	0.9	0.1	0.2	1.2	3.8	5.0	0.6	0.7	1.6	2.4	2.4	1.1	59.4	0.9	206.1	106.2	5.5
	4	25.8	7.6	2.5	5.5	12.2	0.5	0.1	0.1	0.6	2.7	3.3	0.4	0.1	0.9	1.0	1.2	0.4	21.0	0.8	162.0	50.8	4.6
	Max.	32.0	8.3	4.1	8.9	25.9	3.3	0.3	1.4	3.7	7.7	9.6	1.3	7.2	4.9	12.1	4.7	1.8	103.7	2.2	244.8	177.7	7.4
	Min.	16.0	7.2	1.6	1.8	7.3	0.0	0.0	0.0	0.1	1.1	1.2	0.0	0.0	0.2	0.3	3.3	0.2	10.6	0.4	79.2	36.8	3.6

that El-Rahawi receives a highly polluted organic waste (domestic sewage) than that of El-Serw site. However, Soria *et al.* (1987) reported that urbane sewage water usually carry high amount of ammonia, organic nitrogen and organic phosphorus. Moreover, Leester (1975) reported that water body within ammonia-N in excess of 4 mg $.L^{-1}$ is in greatly polluted conditions. In addition, as shown from the table, the discharged water at El-Serw and El-Rahawi sites sustained, in general, higher values of nitrogen and phosphorus, either organic or inorganic, than that of the up-stream water and discharges water at El Zaait site. Such high levels could be attributed to the agricultural run off (Juttner *et al.*, 1996) and fecal pollution in rivers (Adam. 1993).

Water with total soluble inorganic nitrogen greater than 0.3 mg $.L^{-1}$ was considered to be eutrophic (Vollenweider, 1971). Therefore total soluble inorganic nitrogen of water in the present work within the up-streams of the three sites did not reach the eutrophic level. Nevertheless, the discharged water could be considered as a hyper-eutrophic water. In the same pattern, the discharged effluents at El-Rahawi and El-Serw tended to sustain relatively higher values of silicate than the up-stream water, where diatoms attained its maximum standing crop. While the discharged hot water of Sulfur factory was characterized by very high values of silicate may be attributed to the decay of diatoms, fishes and the decomposition of organic matter (Elewa *et al.*, 1995). However, the industrial effluent at El-Ziaat sustained the highest values of sulfate (Table.1). This expected high level of sulfate could be attributed to the type of the discharged effluent of Sulfur factory and Soda factory during their washing process. There was also high sulfate content of the discharged water at El-Rahawi and El-Serw sites but, on the contrary, could come from the agriculture wastes which contain different types of sulfate fertilizers beside the domestic wastes (Gil *et al.*, 1989).

Conductivity, salinity, chlorisity, sulfate, total phosphorus sodium and potassium were found to be higher within the discharged water than that of the up-stream water (Table.1). These indicate that, the discharged water contains high amount of pollutants. There is an evidence that, the industrial discharges (Aziz *et al.* (1996), domestic wastes discharged (Saad and Abbas, 1985) and agriculture runoff (Golterman, 1999) mostly increase salinity and chloride content in the water.

The discharged water at El-Rahawi and El-Serw sites were more or less stable in their physico-chemical characteristic than that of the Sulfur factory drain, which tended to have different physico-chemical characters (Fig.2). However it was sometime included in more subgroups with some other stations but with a relatively high dissimilarity coefficient indicating more or less conspicuous differences along its physico-chemical characters. The same was held true for the Soda drain except during summer, 1998 and winter, 1999.

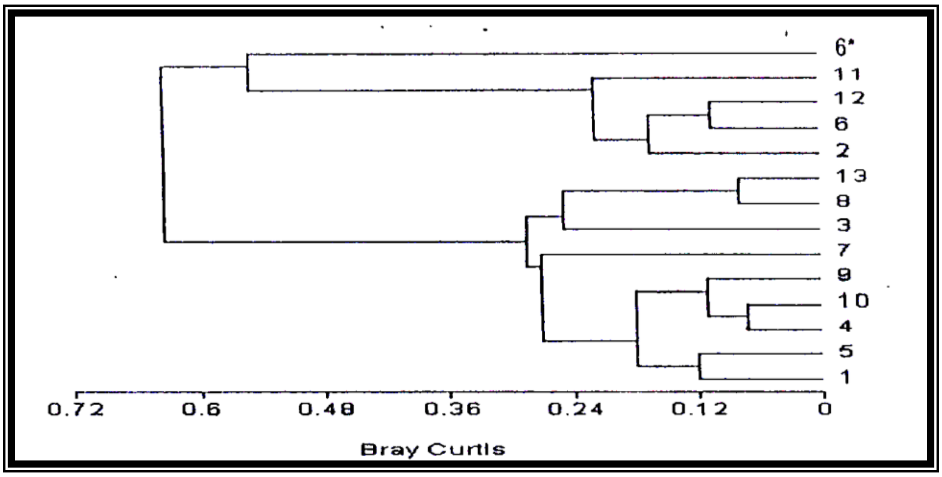


Figure (2): Similarity between stations according to the physico-chemical parameters using Bray-Curtis measure of dissimilarity (clusters analysis). 1,2,3,4: Upstream, Drain, Mixed and Downstream of El-Rahawi; 5,6,6*,7,8 and 9: Upstream, Drain soda, Drain sulfur, Mixed and Downstream of K. El-Zaait; 10,11,12,13: Upstream, Drain, Mixed and Downstream of El-Serw.

There was marked regional variation in the heavy metals within the studied area. These variations were attributed to the effects of the different pollution point sources. For instance, the highest concentration of Co, Cu, Pb, Fe and Zn were recorded within the discharged water at K. El-Ziaat especially that of the first pollution point source (table.2). Where, the River Nile received a considerable amount of untreated industrial effluent. Abdel-Hamid *et al.*(1992).

Table (2) Mean variations in Heavy metals (ppm) at different stations within three sites.

	El-Rahawi				El-Zaait					El-Serw			
	1	2	3	4	1	2	3	3`	4	1	2	3	4
Co	Un.d	0.09	0.04	Un.d	Un.d	0.24	0.06	0.02	Un.d	Un.d	0.13	0.01	0.01
Cu	Un.d	0.05	0.06	Un.d	Un.d	1.2	0.05	0.44	0.32	Un.d	0.16	0.55	0.004
Pb	0.01	0.33	0.079	0.009	0.01	1.7	0.58	0.36	0.192	0.001	0.40	0.19	0.01
Fe	Un.d	0.32	0.11	0.02	0.00 1	1.36	0.51	0.26	0.15	Un.d	0.31	0.13	0.001
Zn	Un.d	0.03	0.007	0.001	Un.d	0.12	0.05	0.03	Un.d	Un.d	0.02	0.005	0.001

Biological characteristics

From the different stations of the three sites, 214 total algal taxa belonging to 99 different genera were identified. Chlorophyta (81 genera), Bacillariophyta (71 genera), Cyanophyta (28 genera) and Euglenophyta (24 genera) were the dominant group. The minimum phytoplankton growth was in drainage canal of El-Ziaat factory.

Cyanophyta was the most elaborated group at the three sites. It formed about 98% to 31% of the total phytoplankton standing crop (cell number) at El-Rahawi site, and about 90% to 35% at El-Ziaat site, while it varied from 98% to 38% at El-Serw site. The dominance of this group may attributed to the presence of high concentrations of organic wastes and high level of both N and P come with the agricultural and domestic sewage discharged in the aquatic habitat (Knuuttila *et al*., 1994). In contradiction, no algal flora was recorded within the industrial effluent of Soda factory in spite of the detection of some unhealthy diatom cells. This may be attributed to the acidic water that possesses very low pH. *Microcystis* and *Oscillatoria* were the most frequent and abundance taxa (Table 3).

Chlorophyta almost formed the second elaborated group (as cell number Table 4). Mohammed *et al*. (1986) recorded that, Chlorophyta occupied the second position of dominance in the Nile. In the present results, standing crop of Chlorophyta appeared higher in the up-stream water than in the discharged water or in the water receives it. This may revealed that, the discharged water exhorted retarding effects on the growth of Chlorophyta. In support, Adam *et al.* (1993) reported that, the reduction of Chlorophyta and Bacillariophyta counts may be attributed to the toxic substance such as herbicides and industrial substances. *Ankistrodesmus, Coelastrum, Kirchneriella, Oocystis* and *Scenedesmus* were the most common and frequent genera (Table 3).

Bacillariophyta tends to be the third position dominant group after Cyanophyta and Chlorophyta at both El-Serw and K. El-Ziaat sites, and appeared the second in most months at El-Rahawi site. The maximum abundance of Bacillariophyta seemed to be as in the following sequence: El-Ziaat > El-Serw > El-Rahawi. *Achnanthes, Cocconeis, Melosira, Navicula* was representing the most abundant and frequent genera (Tab.3) Euglenophyta occupied the fourth position of dominance, and connected with the organically polluted stations. The discharged water (industrial wastes) at El-Ziaat seemed to suppress the development of Euglenophyta. This appeared to be in accordance with Danilov and Ekelund (1999) who reported that, industrial effluent might cause harmful effects on the growth rate developments of Euglenophytes. *Euglena* and *Facus* were the most abundant and frequent taxa (Table 3).

In terms of biomass, (Table 4B) represents also that the phytoplankton standing crop was mainly consists of Bacillariophyta. In few cases Bacillariophyta was substituted by Euglenophyta, especially within the organically rich effluent. Euglenophyta formed the second component of the phytoplankton standing crop followed by Chlorophyta and/or Cyanophyta. Moreover, because of the differences in cell size of taxa dominating in winter versus summer, the peak algal biomass in this work was in winter (December), while the highest cell density (cell number) occurred in summer (August 98) and changes in algal composition were more evident in relative cell number than in

Table (3): Variations in frequency of abundance taxa at different stations within the three sites.

Sites and Stations / Taxa	El-Rahawi 1 2 3 4	K. El-Ziaat 1 2 3 3* 4	El-Serw 1 2 3 4	General frequency
Cyanophyta				
Microcystis aeruginosa f.flos-aquae Elenk.	3 7 7 7	4 1 4 2 4	7 7 7 7	67
Oscillatoria subtilissima kÜtz.	5 7 7 7	4 5 7 5 7	7 7 7 7	82
O.tenuis Ag.	- 6 6 6	1 4 5 5 6	6 7 7 7	66
Chlorophyta				
Ankistrodesmus angustus Chodata et Oettli.	- - - -	7 4 6 6 7	7 3 7 7	77
*A.gracilis (*Reinsch) Korsch.	6 3 6 6	4 3 4 3 4	3 2 3 3	50
Chlorella vulgaris Beij.	5 6 6 6	6 2 3 2 6	5 5 5 5	62
Coelastrum microporum Naegeli.	5 1 4 4	7 3 7 7 7	6 6 6 6	69
Crucigenia tetrapedia (Kirch.)W.et G.S.West.	- 4 4 4	7 1 7 5 7	4 2 4 4	53
C. irregularis Wille	- - - -	3 2 2 1 3	3 – 3 3	20
Franceia armata (Lemm.)Korsh.	5 – 5 5	7 – 3 3 7	5 1 5 5	51
*Kirchneriella contorta (*Schmidle)Bohliae	6 2 6 6	7 3 5 6 7	6 3 6 6	69
K.intermedia Korsch.	6 4 6 6	7 3 6 7 7	7 4 7 7	77
Oocystis marssonii Lemm.	6 2 5 5	7 1 7 7 7	7 3 6 7	70
O.solitaries Wittrock	5 3 5 5	3 1 7 4 7	5 3 5 5	58
Pediastrum .simplex Meyen.	6 – 4 4	7 2 5 5 7	- 5 5 5	55
Scenedesmus opoliensis var. opoliensis P.Richter	4 2 4 4	7 2 6 7 7	5 2 4 4	58
S. perforatus Lemm.	6 1 6 6	7 1 5 6 7	6 3 6 6	66
S. qudricauda var. quadrispina G.M.Smith	5 4 5 5	7 4 5 4 7	4 4 4 4	62
Stichococcus atomus Skuga.	5 – 5 5	5 1 5 5 5	5 5 5 5	56
Bacillariophyta				
Achnanthes linearis (W.Smith)Grun.	7 2 7 7	6 1 5 3 6	6 5 6 6	67
*Cocconeis placentula var. rouxii(*Brun et herb.) Cl.	6 5 6 6	6 2 5 6 7	7 5 7 7	75
*Cyclotella atomus (*Ehr.) Kutz.	6 5 6 6	6 3 6 7 7	5 5 5 5	72
C.bodinica Eulenst	6 6 6 6	7 4 7 7 7	6 6 6 6	80
C.comta (Ehr.)Kutz.	5 5 5 5	7 4 4 6 7	7 3 7 7	72
C.glomerata Bachmann	6 4 5 5	4 3 4 4 4	4 2 3 3	51
C.menghiniana Kutz.	7 7 7 7	7 5 5 7 7	5 6 6 6	82
Fragilaria crotonensis Kitt.	7 4 7 7	7 2 6 6 6	5 – 1 1	59
Melosira crenulata Kutz.(Synon. M. italica)	7 7 7 7	7 5 7 7 7	5 6 6 6	84
M. granulata (Ehr.)Ralfs.	7 7 7 7	7 6 7 7 7	7 7 7 7	90
Navicula elongata Poretzky	5 2 5 5	7 1 4 6 7	6 7 7 7	69
N. lanceolata (Ag.) Kutz.	6 7 7 7	7 2 6 5 7	7 7 7 7	82

Table (3) continue

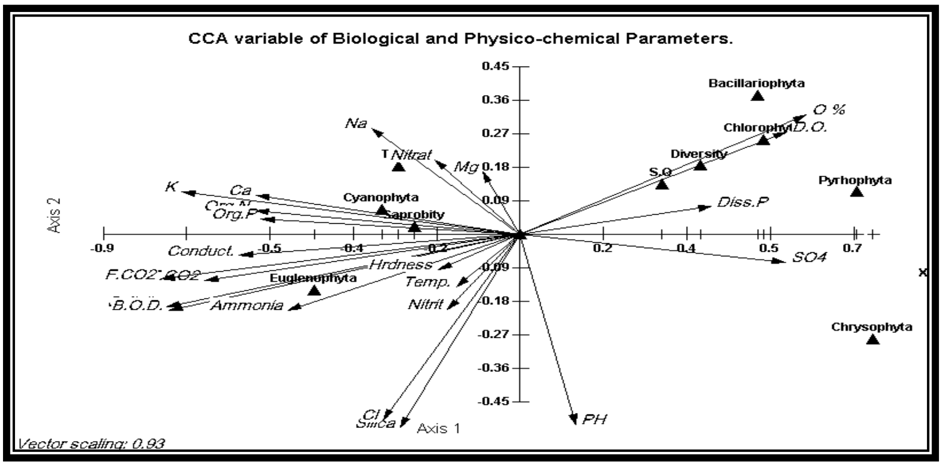
N. pygmaea Kutz.	3 6 6 6	6 2 5 5 6	5 4 5 5	64
N.scalaris (Ehr.)W.Smith.	6 4 5 5	7 3 7 6 7	4 2 4 4	64
N.vericularis (Ehr.) Grun.	7 6 6 6	6 4 5 7 7	7 6 6 6	79
*Synedra ulna (*Nitzsch.) Ehr.	7 3 5 5	7 5 5 7 7	7 6 7 7	78
S.ulna var.oxyrhynchus (Kutz.)V.H.	4 2 4 4	4 1 4 5 5	6 3 6 6	54
Euglenophyta				
Euglena spathirhyncha Skuja.	2 4 4 4	6 – 4 6 6	- 5 5 4	50
Phacus fominii Rolf.	1 7 7 6	3 – 3 3 3	1 6 6 5	51

relative biomass. In agreement with these findings, Grover *et al*. (1999) found that, seasonal succession of Phytoplankton consisted of a shift form relatively large-celled diatoms, Chlorophytes and flagellates at cold temperature to small-celled colonial and filamentous Cyanophytes at worm temperature.

Table (4): Bimonthly variations in total number (A) and total biomass (B) of phytoplankton standing crop at different stations within the three sites.

A- Total number $x10^6$													
	El-Rahawi				El-Zaait					El-Serw			
	1	2	3	4	1	2	3	3`	4	1	2	3	4
April -98	1.7	7.3	4.9	2.5	2.2	0.2	0.8	1.3	1.4	1.6	1.6	1.7	1.8
June-98	1.4	7.9	5.4	3.4	1.6	1.3	1.8	1.4	1.6	1.8	4.7	3.6	2.8
August-98	1.3	16.4	5.3	3.8	1.8	3.3	3.0	5	2.2	2.1	6.5	5.9	3.9
October-98	1.5	10.5	4.2	2.7	2.6	0.3	0.6	1.0	1.5	3.3	1.4	1.7	2.7
December	1.5	4.4	3.4	3.1	1.6	0.5	0.6	0.5	0.8	1.8	0.7	0.6	1.5
Feruary-99	2	7.5	4.9	3.2	1.5	1.1	1.3	0.6	1.3	0.8	0.2	0.4	0.5
B- total biomass mg/l													
	El-Rahawi				El-Zaait					El-Serw			
	1	2	3	4	1	2	3	3`	4	1	2	3	4
April -98	1.8	0.5	0.7	10	2.6	0.3	0.6	1.0	1.5	3.3	1.4	1.7	2.4
June-98	2.2	0.8	1.1	1.1	1.6	0.5	0.6	0.5	0.8	1.8	0.7	0.6	1.5
August-98	0.6	1.0	0.5	0.5	1.5	1.1	1.3	0.6	1.3	0.8	0.2	0.4	0.5
October-98	2.1.	0.8	1.1	1.6	1.9	0.5	0.5	0.7	1.1	2.7	0.8	0.9	1.7
December	1.9	0.5	0.9	1.4	2.3	2.0	0.8	0.8	1.4	3.7	1.0	1.7	2.5
Feruary-99	2.0	0.9	1.2	1.5	2.4	0.8	1.3	1.1	1.5	4.5	1.3	1.9	2.3

Inspection of figure (3) reveals that, Cyanophyta was highly correlated with conductivity, salinity, chloride, free CO_2, total CO_2, K^+, ammonia-N, organic phosphorus, BOD, organic nitrogen, while it was less correlated with saprobity quotient, species diversity, dissolved oxygen and ortho-phosphate. Romo and Miracle (1994 a) found that, the stability of phytoplankton could be related to K^+ selective strategy of the dominant filamentous Cyanophytes.



Figure(3): Canoco analysis plot of physico-chemical and biological parameters.

In the same pattern, Chlorophyta was highly correlated with species diversity, dissolved oxygen, sulfate and pH, while it was low correlated with saprobity quotient, BOD, ammonia-N, organic-N, free CO_2, total CO_2 and salinity, diversity and saprobic quotient. Also, Bacillariophyta showed a low correlation with saprobity quotient, temperature, total CO_2, BOD and salinity. It was highly correlated with species diversity, Si and phosphates. Both diatoms and green algae meet their requirements within the up-stream water at which they attained their maximum growth in the present work. Enrichment of natural water with phosphorus, reactive silicate and some times with iron or manganese stimulated the growth of diatoms (Kulka and Richards, 1996). In addition, Euglenophyta highly correlated with saprobity quotient, BOD, nitrite-N, conductivity, salinity, ammonia-N and organic nitrogen, also there are correlation between Euglenophyta cell number and its calculated biomass. Moreover, Euglenophyta showed a negative correlation with dissolved oxygen, saprobity quotient and species diversity. Tilman *et al*. (1986) suggested that, the dominance of major algal groups in relation to Si : P and N : P supply ratios were temperature dependent.

Similarity index between stations (except that of the discharged water) within the same site were relatively high, especially the similarity between the mixed and down-stream water (Fig. 4). Meanwhile, the similarity index between different stations with the different sites was widely fluctuated. However, a relatively high similarity coefficient (77.3%) was recorded between the up-stream of El-Ziaat and down-stream of El-Rahawi. This may attribute to the fact that, down-stream at El-Rahawi could be considered as up-stream of K. El-Ziaat on Rossetta Branch of the River Nile.

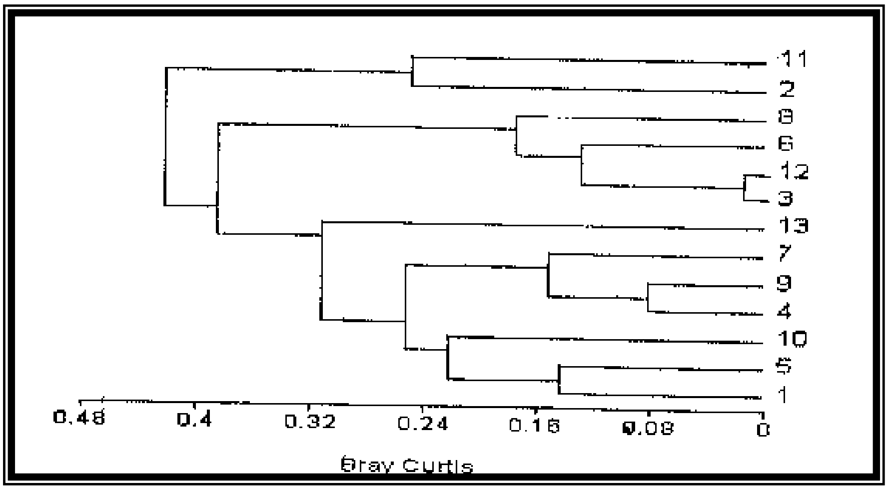


Figure (4): Similarity between stations according to the abundance of phytoplanktonic group using Bray - Curtis measure of dissimilarity. 1,2,3,4:Upstream, Drain, Mixed and Downstream of El-Rahawi; 5,6,7,8 and 9: Upstream, Drain soda, Drain sulfur, Mixed and Downstream of K. El-Ziaat; 10,11,12,13: Upstream, Drain, Mixed and Downstream of El-Serw.

The algal group at the three sites recorded a relatively high similarity between the discharged water and the water receiving it. However, at El-Ziaat, such similarities were low; it did not exceed 16.6% in case of Euglenophyta. It was concluded by Mukai (1987) that the differences in phytoplankton composition could be attributed to the differences in microhabitats caused by in situ environmental heterogeneity within the different stations and corresponding habitats preference of individual phytoplankton species. This relationship may be interpreted as primary response of the phytoplankton community to changes in environmental conditions (Huszar and Caraco, 1998). Since the algal species are generally sensitive to fluctuation in the surrounding environment and thus, it can often be utilized as biological indicator of water pollution (Villegas and Giner, 1973).

It is clear from Table (5, A) that, the diversity value within the studied area ranged between 0.63 at wastewater of Soda factory and 3.85 within the up-stream water at El-Rahawi site. The values of diversity index clearly revealed that up-stream at the three sites were slightly polluted. On the other hand the pollutionary status of the discharged water at the three sites fluctuated between heavy to moderate pollution. However the pollutionary status of the mixed water at the three sites was affected by the discharged water, therefore the down-stream water was slightly affected. The same table also shows that maximum saprobic index was for the discharged water, especially at El Ziaat (3.95) which signified a saprobity level polysaprobity. On the contrary the minimum values of this index within up-stream signified a saprobity level univocal oligosaprobity. It is obvious that, the saprobic indices of the mixed, as well as down-stream water within the three sites were affected by the discharged water in most cases during the entire period of investigation. Nevertheless, there were negative relationships between saprobity and dissolved oxygen as well as alkalinity (Fig.3). In contradiction, saprobity was positively correlated with other parameters as K^+ levels of total inorganic nitrogen, BOD, ammonia-N, organic phosphorus and nitrogen, nitrite-N, nitrate-N and salinity. Similarly, saprobic quotient appeared minimum at the discharged water of Soda factory (-1.00) and maximum at the up-stream water of El-Rahawi (1.16). These values might indicate that water quality lies between α-meso - poly saprobic (considerable pollution) and β meso -oligosaprobic (slight pollution).The saprobic quotient of the mixed as well as the down-stream water (which appeared to be affected by the discharged water) pointed to a water quality of β-α-mesosaprobic (moderate pollution) to β-mesosaprobic (slight pollution).

Ortho-phosphate and dissolved oxygen were positively correlated with S.Q. Meanwhile, ammonia-N, organic phosphorus, BOD, total CO_2, organic nitrogen, salinity, conductivity and K^+ were negatively correlated with S.Q.

These data of water quality indices could confirm that, there are at least three distanced types of water masses based on differences in the phytoplankton community as reflective of the effect of the discharged water on the biodiversity and water quality of water as explained by Polishchuk (1999). Actually many field studies have demonstrated that, decreasing of species diversity associated with the presence of high level of organic sewage as well as toxic material (Steed and Morin, 2000).

In general, the results obtained from the physico-chemical characteristics of water at the studied sites and the community structure and biodiversity of phytoplankton as well might reflect the undesirable effect(s) of the discharged water on the water quality of the River Nile in the vicinity of the studied sites. Effluent must pass through a tertiary treatment to remove phosphate, nitrate and organic pollutants to avoid eutrophication or its discharge into the River Nile must be prevented, if this is at all possible to avoid non toxic and toxic pollutants. It is also recommended to continue such type of investigations to follow up the water quality of the River Nile to diagnosis the early deterioration of the water quality and take all the requirements and precautions to prevent these deteriorations.

Table (5): Phycological assessment of water quality characterization at El -Rahawi, El-Zaait and El - Serw during the period of April 1998 to April 1999. The stations 1,2,3,3 and 4 refer to up-stream, discharge, mixed, sulfur discharge and down stream respectively.

Sites / Months		El-Rahawi				Kafr El-Ziaat					El-Serw			
		1	2	3	4	1	2	3	3*	4	1	2	3	4
Apr. 98	A) Diversity	3.70	1.80	1.60	2.50	3.08	1.00	1.80	2.50	2.30	3.20	2.10	2.80	3.09
Jun. -98		2.90	1.10	2.45	2.70	3.10	0.98	2.05	2.34	2.88	2.69	1.30	2.08	2.11
Aug. -8		2.70	0.87	1.80	2.20	2.52	0.85	1.10	0.96	2.80	2.50	1.10	1.96	2.20
Oct. -98		3.10	1.40	1.98	2.50	2.70	1.10	2.07	2.10	2.50	3.03	1.73	2.12	2.84
Dec. -98		3.40	1.60	2.10	2.20	3.37	0.63	2.06	2.97	3.10	3.62	2.01	2.67	3.26
Feb. -99		3.85	2.20	2.70	3.32	3.35	1.80	2.97	3.25	3.30	3.70	2.32	2.68	3.24
Apr. -99		3.78	1.00	1.67	2.70	3.02	0.67	2.00	2.53	2.80	3.30	1.60	1.96	2.95
Apr. -98	B) Saprobic	1.95	3.55	2.84	2.31	2.00	1.50	2.65	2.20	2.40	2.00	2.90	2.50	2.18
Jun. -98		2.55	3.36	3.15	2.65	1.00	1.95	2.17	2.00	2.00	1.95	2.30	2.20	2.00
Aug. 98		2.10	3.73	3.20	2.70	2.30	1.98	2.00	2.00	2.10	1.90	3.30	2.20	2.15
Oct. -98		2.00	3.57	2.00	2.00	2.00	1.70	2.30	2.26	2.00	1.95	3.55	2.36	2.10
Dec. -98		1.80	3.60	3.20	2.16	1.00	1.35	3.55	3.00	3.55	1.63	3.55	3.15	1.98
Feb. -99		0.90	3.60	2.60	1.10	1.55	1.95	3.55	3.56	3.95	1.35	3.60	3.20	2.90
Apr. -99		1.00	2.88	1.90	1.30	0.50	1.95	2.30	1.95	1.95	1.90	2.08	2.00	1.95
Apr.-98	C) Saprobic quotient	0.92	0.46	0.66	0.64	0.74	0.50	0.48	0.63	0.70	0.86	0.45	0.62	0.64
Jun. -98		0.88	0.42	0.72	0.78	0.67	0.11	0.52	0.60	0.62	0.76	0.36	0.48	0.63
Aug. 98		0.72	0.30	0.54	0.56	0.74	0.99	0.99	0.69	0.71	0.79	0.24	0.56	0.77
Oct. -98		0.75	0.36	0.58	0.57	0.91	0.96	0.94	0.87	0.90	0.92	0.39	0.63	0.71
Dec. -98		1.16	0.55	0.76	0.84	0.89	1.00	0.58	0.67	0.66	1.02	0.53	0.83	0.88
Feb. -99		0.87	0.64	0.79	0.83	0.96	1.00	0.90	0.88	0.92	1.00	0.60	0.84	0.84
Apr. -99		0.83	0.52	0.78	0.83	0.82	1.00	0.67	0.67	0.76	0.89	0.54	0.73	0.76

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استخدام الخصائص الفيزيائية والكيميائية والطحلبية لتقدير جودة مياه نهر النيل في منطقة الدلتا

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يهدف هذا البحث إلي دراسة جودة مياه النيل عن طريق دراسة الهائمات الطحلبية واستخدامها كدليل بيولوجي لقياس جودة المياة أو مستوي التلوث علاوة علي دراسة الخصائص الفيزيائية والكيميائية للمياه. ولذا تم اختيار ثلاثة مواقع (تبعاً لنوع الملوث) بدلتا نهر النيل وهي منطقة الرهاوي في بداية فرع رشيد والتي بها ملوثات عضوية وزراعية ومنطقة كفر الزيات (فرع رشيد) والتي بها مصدرين للتلوث الصناعي (مصنع الصودا ومصنع الكبريت) ومنطقة السرو الأعلى (فرع دمياط) وبها ملوثات زراعية مع بعض الملوثات العضوية. وتم تجميع العينات كل شهرين من إبريل 1998 وإبريل 1999م من أربع محطات في كل موقع : مياه النيل قبل الخلط بمياه الصرف - مياه الصرف ذاتها - منطقة الخلط - مياه النيل بعد منطقة الخلط بالإضافة إلي محطتين إضافيتين في منطقة كفر الزيات .

أوضحت الدراسات النوعية والكمية للهائمات الطحلبية آن هناك 214 طحلب معظمها ينتمي إلي الطحالب الخضراء (11جنس) و الدياتومات (71 جنس) والطحالب الخضراء المزرقة (28 جنس) واليوجلينيا (24 جنس). وكانت الطحالب الخضراء المزرقة في المقام الأول بالنسبة لعدد الخلايا أما الدياتومات تليها اليوجلينيا فإنها تمثل الأساس للكتلة الحية للهائمات الطحلبية. وباستخدام مقياس التنوع في الهائمات الطحلبية تميزت مناطق الصرف بقيم منخفضة من مقياس التنوع دليلاً علي أنها عالية التلوث عن باقي المحطات وباستخدام مقياس التعفن للهائمات الطحلبية أعطي قيماً عالية عن باقي المحطات دليل طحلبي أخر علي مستوي التلوث العالي لمياه الصرف وأنه يقل تدريجياً داخل مياه النيل بزيادة البعد عن المصدر. وأكدت النتائج أن هناك تماثلا كبيراً بين اختبار جودة المياه باستخدام الخواص الطبيعية والكيميائية وبين تعيينها باستخدام المقاييس الحيوية. حيث أثبتت الخصائص الطبيعية والكيميائية للمناطق الدراسة (التي تأثرت من جراء إلقاء الأنواع المختلفة من المخلفات) أن مياه النيل عالية التلوث في منطقة الصرف وملوثة في منطقة الخلط كما تأثرت منطقة بعد الخلط بهذه الملوثات . وتوصي الدراسة بوقف الصرف في النيل لتوفير كوب ماء نظيف من الملوثات السامة و غير السامة مع استمرار الدراسة بشكل دوري باستخدام الهائمات الطحلبية كدليل لتقيم والتنبأ بجودة مياه النيل .