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ALGAL COMMUNITIES AND ITS RELATIONSHIP WITH THE WATER QUALITY OF RIVER NILE AT EDFU, EGYPT

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ABSTRACT

Monitoring of the water quality of the river Nile at Edfu district was carried out. Phytoplanktons composed of five groups, namely, Chlorophyta (green algae), Euglenophyta (flagellated algae), Bacillariophyta (diatoms) and Chrysophyta (motile brown algae). Diatoms were the most dominant and diversified group present in all the seasons.

The water quality was represented by the phytoplanktonic diversity of river Nile during the period investigated. In addition to the phytoplanktonic diversity, ammonia, nitrite, nitrate and phosphorus concentrations indicated that Nile water at Edfu is oligotrophic.

INTRODUCTION

Algae are important components of lotic ecosystems. Among other functions, they are a major source of primary production (McConnell and Sigler, 1959; Minshall, 1978), they are essential factor in stream recovery from pollution (Hynes, 1974; Jenntt *et al.*, 1980) and are useful indicators of environmental conditions (Lowe, 1974; Johansson, 1982). Algae in water supply have an important influence on its quality and usage. Different kinds of algae are known to cause taste and odor problems and also cause interference with sand filter capacities (Palmer, 1962).

Nile water is the major source of potable water supply in Egypt. Algal pulses in the river Nile change tremendously everyday and from one place to another depending on the original algal feed gaining access from the lake waters to the river. Conditions prevailing in the river along its run-off, would certainly induce changes in the number

and types prevalent in the stream. Records of Nile water quality provide information on the suitability of the water for different uses (Shehata & Badr, 1985 and Badr, 1990).

Therefore, Information concerning the distribution pattern of algal flora and their relation to physicochemical characters at areas or sectors not covered in the previous studies are important for the understanding of the water quality of Nile, Edfu.

The main objectives of this study are :

1. To monitor the water quality of the river at Edfu district in relationship to the phytoplankton composition.

2. To evaluate the water quality at different distances and depth from the bank.

3. To select the water intake of Edfu water works for production of potable drinking water.

MATERIALS AND METHODS

1. Location and sampling Sites

The study area (Fig. 1) is located a long a distance of about 119 km from the high Dam.

Nile water was collected monthly for a year. Samples were collected from distances of (DI) 10 m and 20 m from the bank. Three samples were collected from each 0.5 m, 1.0 m, and 2.0 m depths (DE) at each distance (Fig. 1). For deep, water samples, the standard sampling bottle with kipp thermometer was employed.

2. Phytoplanktonic Parameters

Enumeration of phytoplankton and quantification of chlorophyll

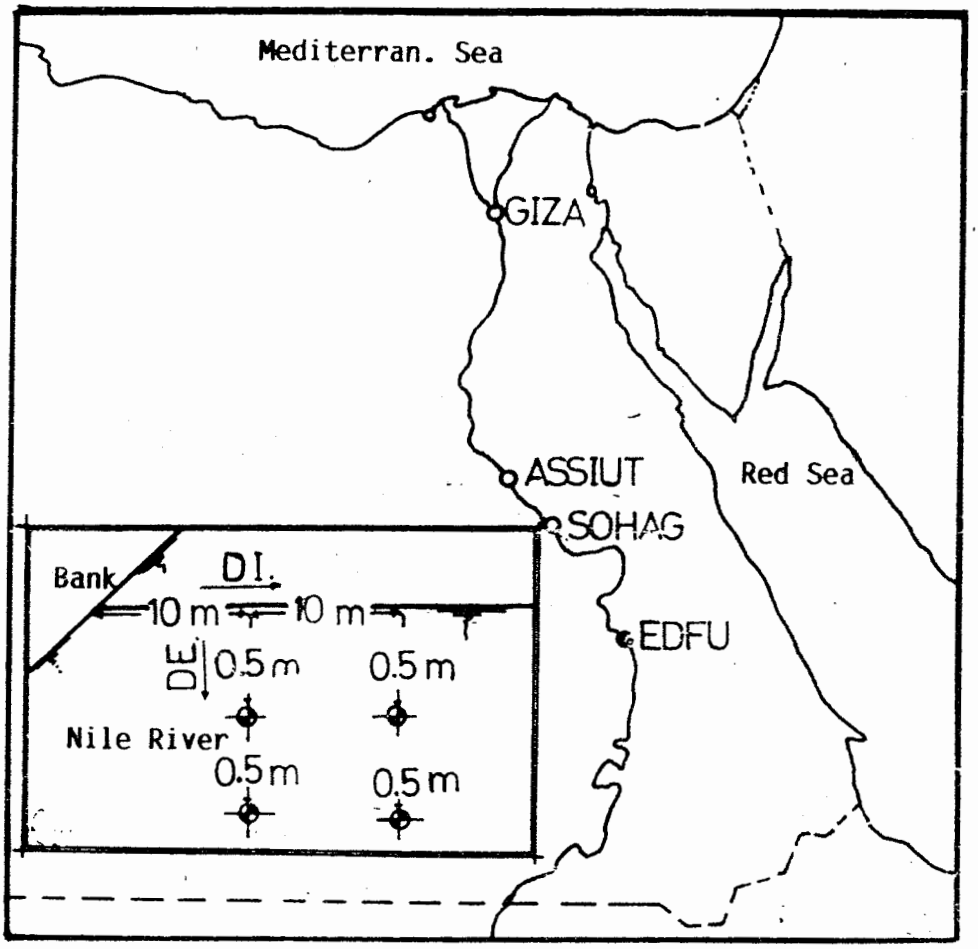

Fig. 1. : Study area showing the location of the site and the sample station.

"a" concentration was done according to the Standard Methods (APHA, 1989).

a) Enumeratin of Phytoplankton

Algae collected from Nile water were concentrated via Sedgwick-Rafter Method (Standard Methods, 1965). Algae were identified up to the species level according to the key for freshwater algae (Streble and Kranter, 1978). The number of phytoplanktonic organisms present in the sample was calculated according to the standard method (APHA, 1989).

b) Chlorophyll "a"

For estimation of chlorophyll "a" (extracted via organic solvents) spectrophotomertic measurment of absorbency and optical density at three different wave lengths was done. The procedure involves the addition of 0.5 ml oF magnesium carbonate suspension to the known volume of the sample in order to prevent chlorophyll degradation. The sample was shaken and filtered through 0.45 μm membrane filter.

3. Physico-chemical parameters

Determinations of the physico-chemical characters involves the pH of water, turbidity, electric conductivity, total dissolved solids, suspended solids, total alkalinity, total hardness, calcium hardness, magnesium hardness , chloride, iron, silica, and dissolved oxygen content. The standard Methods, recommended by the American public Health (1989) was followed.

RESULTS AND DISCUSSION

Differential Phytoplanktonic Structure at Various Stations :

The deviation in phytoplankton counts in the samples collected over two months at biweekly intervals are demonstrated in Fig. (2). No clear differences in phytoplankton could be detected in waters collected either from 10 m or 20 m distance from the bank of the river. Also, to be noted is the close relation between phytoplankton counts at 0.5 m depth and 2.0 m. However, deviation in phytoplankton count in September at DI 10 m and DE 1.5 m was observed.

In general, phytoplankton distribution in Nile water at Edfu district revealed slight variation between various stations. This may be due to the low nutritional requirements, high temperature, low turbidity, and radiant sun throughout the different depths.

According to the previous results, samples were collected from 20 m DI at 1.5 m DE over one year at monthly intervals to describe the phytoplanktonic composition in river water infront of Edfu water works as influenced by changes resulting from the seasonal variations.

Changes in phytoplanktonic Community Structure :

The examination of Nile water throughout different seasons showed various phytoplanktonic structures belonging to five groups, namley, Chlorophyta (green algae), Euglenophyta (flagellated algae), Cyanophyta (blue-green algae), Bacillariophyta (diatoms) and chrysophyta (motile brown algae).

Five algal groups were recorded including 171 species, out of which 47 species belong to green algae, 8 species to motile green algae, 32 species to blue-green algae, 81 species to diatoms, and 3

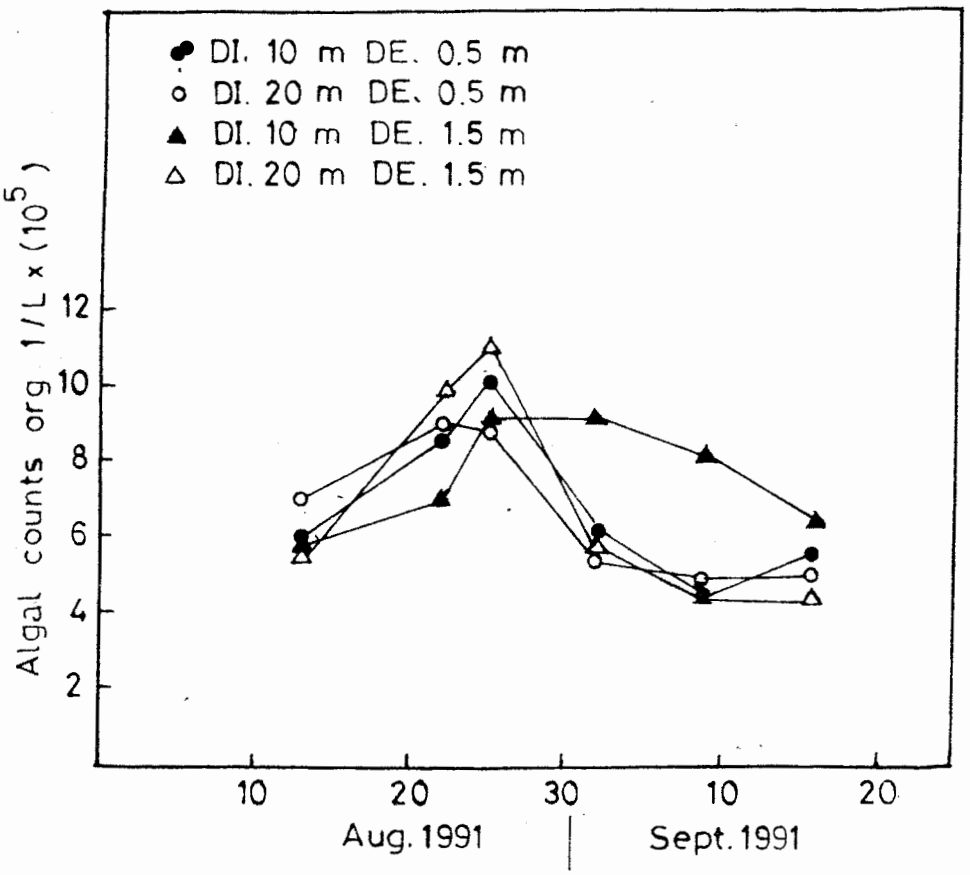

Fig. 2. : Changes in algal counts at different distances and Depths.

species to motile brown algae. Draganov & Stoyneva (1989) recorded that phytoplankton composition in River Danube contains 208 species, varieties and forms of the blue-green, golden, and yellow green algae.

The general distribution of phytoplankton according to the four seasons and different group is demonstrated in Fig. 3. Diatoms represent the most abundant group in all the sample investigated through out the year especially during the winter season. The most abundat genus was *Cyclotella*, some species of *Melosira* were also encountered in all the samples (Fig. 3d).

Also, to be noted is the prevalence of blue-green algae in Nile waters at Edfu district during winter season. The two principal forms were *Oscillatoria* and *Cylindrospermum*. *Oscillatoria* may be considered as being the most common and dominant species of all blue-green algae during the four seasons (Fig. 3e).

Chlorophyta were present in small numbers in most of the samples. However the total numbers of green algae increased during May due to the abundance of *Oocystis* (Fig. 3a).

Euglenophyta were present through the entire period of investigation. They were found in almost every sample, but their relative abundance varied each month and its occurrence peaked in May (Fig. 3b). The number of Chrysophyta was low during the year, and increase in *Peridinium* sp. occurred during the summer season (Fig. 3c).

Changes in phytoplankton counts in Nile water usually deviate within the same logarithm denoting the absence of excessive overgrowth relevant to seasonal changes (Fig. 3f).

In general, undesirable algae causing taste and odour problems or influencing the different processes of water treatment have not been detected in Nile waters at Edfu district.

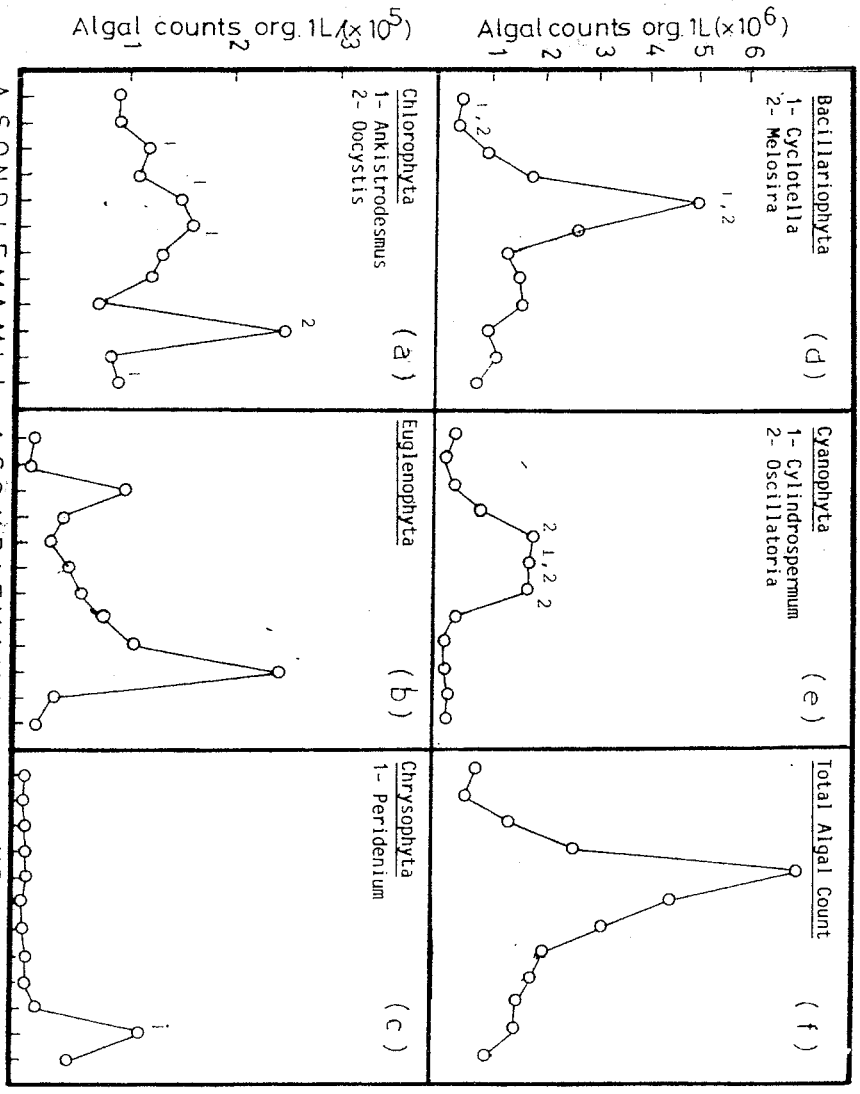

Fig. 3. : Distributions pattern of algal groups and Dominant Genera.

The percentage distribution of the above mentioned groups is illustrated in Fig. 4. Diatoms were most abundant throughout the different seasons, followed by blue-green algae. Green algae tend to appear in small percentage except in summer which it is found in small percentage. These results confirm the results obtained from Nile water at Cairo district, by Shehata & Badr (1985), and Badr (1990).

Community Properties

Diversity indices have been developed for the data on community structure (Van Dam, 1982; Washington, 1984 and Hodgkiss & Law 1985).

The community composition parameters namely, diversity ($H^{1`}$) and redundancy (R) of the river Nile were estimated according to Shannon's equations (1948). Diversity was estimated as follows :

$$H^{1`} = \sum_{i=1}^{s} (ni/N) \log_e (ni/N)$$

Where :

s = number of taxa samples.

ni = number of individuals of i - th taxon.

N = Sample size.

In addition, redundancy (or dominance) index (R) was estimated for each group using the following equation:

$$R = \frac{H`(max/S) - H^{1`}}{H`(max/S) - H`(min/S)}$$

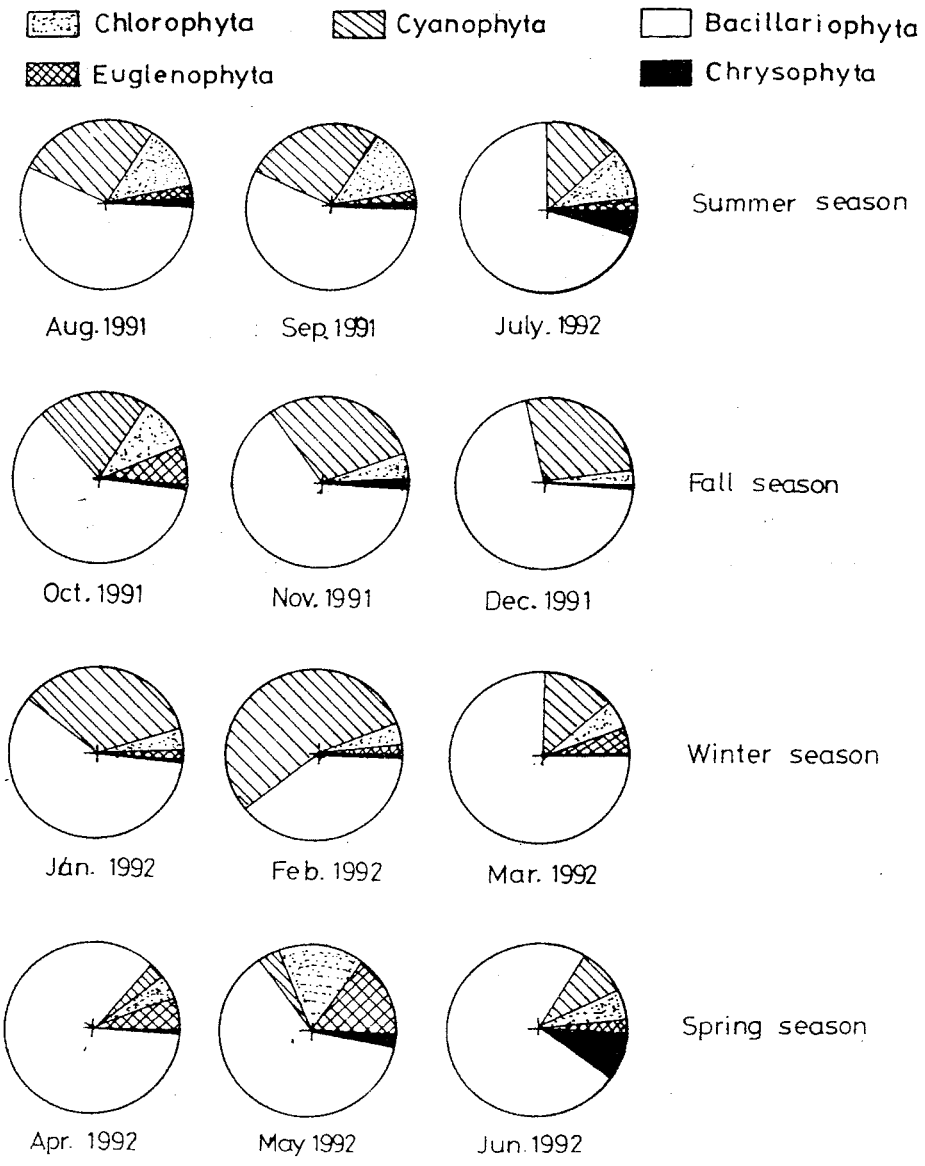

Fig. 4. : Percentage distribution of different algal groups at various seasons.

Where :

$\hat{H}$ = (max/S) and $\hat{H}$ (min/S) are maximum and minimum values of H^{1} at given S. These parameters summarize the properties of species numbers and samples types.

The information measurements of species diversity and redundancy for the five algal groups Tables (1 & 2) show that the highest diversity was observed in green algae (range 1.8 to 2.9) indicating the presence of many species of green algae. The lowest diversity was in May 1992 due to the dominance of *Oocystis* sp. However, the redundancy was low during the whole year.

In addition, diatoms exhibited high diversity values during the investigated period. Its value ranged between 1.3 and 2.7, indicating the presence of diatoms in high number of species. The lowest value was observed during December 1991 because of the dominance of *Cyclotella*.

The diversity of blue-green algae ranged between 0.9 to 1.9. The low diversity value was only observed at November 1991 which its redundancy was 1.0 (Table 2). This is mainly due to dominance of blue green alga, *Oscillatora*.

In contrast, motile algae exhibit low diversity during different seasons and reached to 0.0 during February, June and July 1992 in Euglenophyta. During this time Euglenophyta exhibited high redundancy value that reached 1.0.

Generally, phytoplanktonic diversity of river Nile at Edfu district was very high during the investigated period indicating the good water quality of river at Edfu district. Shehata and Badr (1985), and Badr (1990) found that the diversities of green algae, diatoms, and blue-green algae in the river Nile at Cairo district were 1.22, 0.84 and 0.45 respectively.

Table (1) Monthly Changes in Phytoplankton Diversity of Nile Water at Edfu District During the Period 1991 - 1992.

Date	Chlorophyta	Euglenophyta	Cyanophyta	Bacillariophyta	Chrysophyta
August, 1991	2.54	0.60	1.36	2.70	0.27
September	2.49	0.38	1.54	2.54	0.41
October	2.87	0.48	1.28	1.83	0.81
November	2.55	0.69	0.92	1.57	0.69
December	2.28	0.61	0.99	1.29	0.66
January, 1992	2.01	0.56	1.24	1.51	0.60
February	2.35	0.00	1.06	1.84	0.60
March	2.13	0.66	1.76	1.65	0.50
April	2.49	0.77	1.80	2.14	0.66
May	1.77	0.08	1.89	2.01	0.47
June	2.64	0.00	1.36	2.64	0.64
July	2.28	0.00	1.57	2.21	0.69

Table (2) Monthly Changes in Phytoplankton Redundancy of Nile Water at Edfu District During the Period 1991 - 1992.

Date	Chlorophyta	Euglenophyta	Cyanophyta	Bacillariophyta	Chrysophyta
August, 1991	0.29	0.22	0.55	0.00	1.00
September	0.34	0.51	0.37	0.12	0.74
October	0.00	0.38	0.63	0.62	0.00
November	0.29	0.10	1.00	0.81	0.22
December	0.53	0.20	0.93	1.00	0.28
January, 1992	0.78	0.27	0.68	0.85	0.39
February	0.47	1.00	0.86	0.61	0.39
March	0.67	0.13	0.13	0.75	0.58
April	0.34	0.00	0.10	0.40	0.28
May	1.00	0.89	0.00	0.49	0.62
June	0.20	1.00	0.55	0.04	0.31
July	0.54	1.00	0.34	0.35	0.22

Variation in phytoplankton Pigment :

The results showed that chlorophyll "a" content ranged from 1.96 to 13.8 $\mu g.L^{-1}$. The highest concentration of chlorophyll "a" was recorded during December 1990 due to the dominance of filamentous forms e.g. *Melosira* which form high value of chlorophyll "a". Talling (1965) found that the large Kavirondo Gulf is highly eutrophic with 20 mg. m^{-3} chlorophyll "a". The total concentration of chlorophyll "a" in the offshore surface water of Lake victoria is not large and ranged between 1.2-5.5 mg. m^{-3} (Talling, 1966). However, chlorophyll "a"content in Nile water at Cairo district during 1978 was 5 and 37 mg. m^{-3} (Shehata & Badr, 1985) and in 1990 it ranged from 8.4 to 23.6 $mg.m^{-3}$ (Badr, 1990). Good relationship was observed between phytoplankton counts and chlorophyll "a" content (Fig. 5). Karlstrom and Backlund (1977) also, observed a significant relationship between algal cell counts and chlorophycll "a".

Nutrient in Relation to Phytoplankton :

Chemical analysis of the major phytoplanktonic nutrients, namely nitrate, phosphorus and silica showed clear trends in the variations of phytoplanktonic density. Total phosphorus content ranged between 0.03 $mg.L^{-1}$ and 0.4 $mg.L^{-1}$ PO_4. The highest value occurred during blooming season while the lowest value was detected when phytoplankton counts were low. The results obtained are in agreement with the results of Pieterse & Toerien (1978); Shehata & Badr (1985) and Badr (1990) showed significant correlation exist between phosphorus content, algal counts, and chlorophyll content.

Concentration of nitrate fluctuated between 0.0 - 0.25 mg. $L.^{-1}$ N. Fayed and Shehata (1979) showed that phytoplankton growth in the waters of river Nile at Cairo district was primarily limited by nitrogen and also by phosphorus.

Silice is an important nutrient in Nile water because diatoms dominate the phytoplankton assemblages. Concentration of dissolved silica fluctuated between 7.8 and 11 mg. L^{-1}. The lowest values were associated with high numbers of diatoms. Owens (1970) stated that without silica diatoms cannot compete with other groups of algae, particularly greens and blue-greens. Kilham (1979) found that the presence of *Melosira granulata* is generally associated with concentration of silica.

Physico-chemical Characteristics :

Results of physico-chemical characteristies of Nile water at Edfu district during the investigated period showed no clear variation between different months. The minimum and maximum values of physico-chemical characteristics are recorded in Table (3). The temperature ranged between 16.5°C and 28°C. The relatively low temperature was detected during winter season, while high value was recorded during summer. However, temperature influences the activity of photosynthesis as well as the distribution pattern of algal group (Fig. 6). From the biological point of view temperature and solar radiation occupy an important role in the life of plankton. Temperature changes not only affect physiological processes of cell but also influence the kind of life to be present in water. Generally, diatoms reach its maximum growth during winter when the temperature is low (Fig. 3d). Patrick (1969) found that temperature is an important factor in controlling the succession of freshwater algae and that low temperature favour diatom growth. As temperature increased the algal group with the highest growth rate changed from diatoms to green and blue-green algae (Canale and Vogel, 1974).

The turbidity level ranged between 2 and 6 NTU during the investigated period. The highest value was recorded during December due to the presence of high numbers of suspended diatoms (Fig. 5).

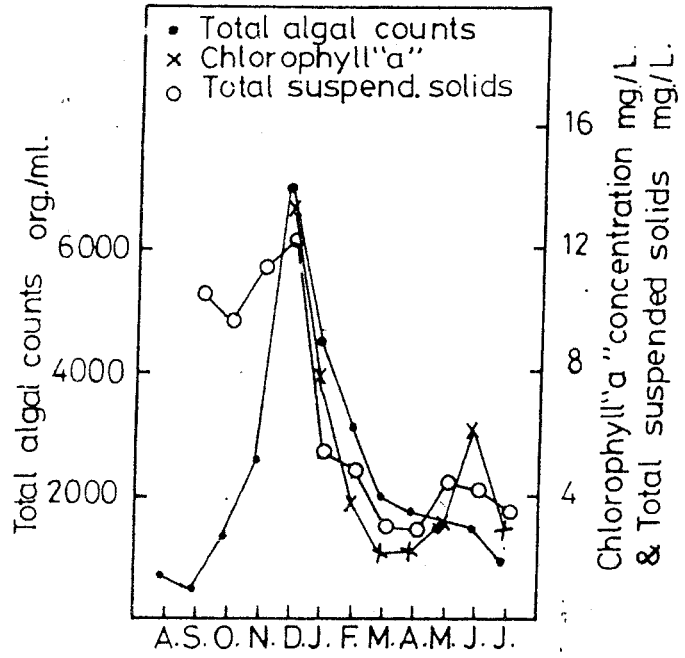

Fig. 5. : Relationship between algal counts chlorophyll a and suspended solids.

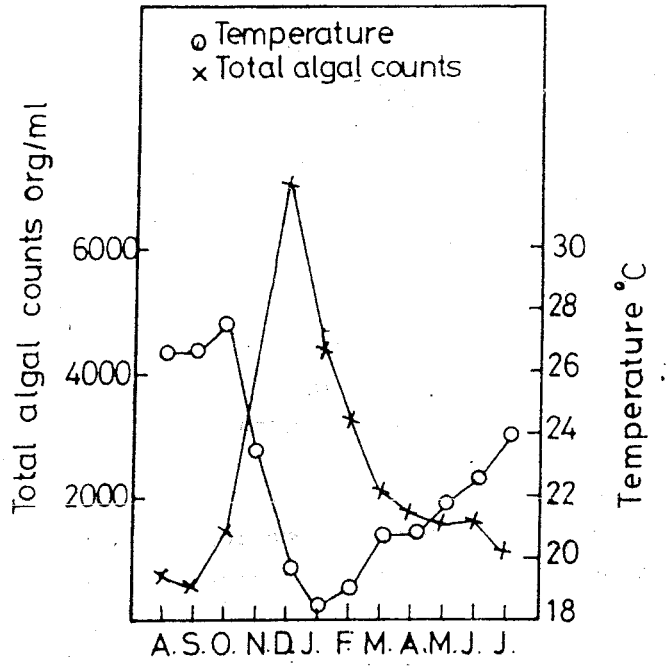

Fig. 6. : Relation ship between temperature and total algal counts.

Table (3) : Physico-chemical Characteristics of Nile Waters at Edfu District.

Characters	Characters	Results	
		min.	max.
Temperature	°C	16.50	28.00
Turbidity	NTU	2.00	6.00
pH		7.13	8.67
Conductivity	µs/cm	249.00	338.00
Total dissolved solids	mg/L	136.00	210.00
Suspended soilds	mg/L	3.00	12.20
Total Alkalinity	mg/L as $CaCO_3$	106.00	128.00
Total Hardness	mg/L as $CaCO_3$	93.00	124.00
Calcium Hardness	mg/L as $CaCO_3$	56.00	77.00
Magnesium Hardness	mg/L as $CaCO_3$	37.00	47.00
Chlorides	mgCl/L	6.00	14.00
Sulfates	$mgSO_4$/L	12.00	13.00
Ammonia	mgN/L	0.00	0.01
Nitrite	mgN/L	0.00	0.01
Nitrate	mgN/L	0.00	0.03
Phosphate	$mgPO_4$/ L	0.03	0.40
Iron	mgFe/L	0.00	0.10
Silica	$mgSiO_2$/L	7.80	11.00
Dissolved Oxygen	mgO_2/L	7.10	12.3

The pH level attained a maximum value of 8.67 and minimum value of 7.13. The highest value was recorded when algal biomass reached its maximum. Algae use carbon dioxide in their photosynthetic activity and reduce free carbon dioxide concentration, thus affecting its equilibrium concentration with bicarbonate in water with the result that carbon dioxide can be extracted for algal growth, both from bicarbonates and carbonates. Thus algal growth tends to cause a shift in the forms of water alkalinity from bicarbonate to carbonate or even hydroxide leading to increase in pH.

From biological point of view the phytoplankton density has a strong influence upon the concentration of dissolved oxygen. In addition, temperature change interacts with the saturation levels of oxygen. Therefore, oxygen supersaturation (123%) was detected during winter season with abundant phytoplankton. Pre-High Dam construction slight supersaturation developed during the winter season and values were above 70% saturation throughout the year (Ramadan, 1972). In contrast after construction oxygen supersaturation (116%) was observed during winter season when phytoplankton were abundant (Shahata and Badr, 1985).

The variation in salinity is indicated by specific conductivity, which ranged between 249 and 338μs/cm and by dissolved solids which ranged from 136 to 210 mg. L^{-1}. The concentration of alkalinity was closely correlated with conductivity and total dissolved solids, total alkalinity ranged between 106 and 128 mg $CaCO_3L^{-1}$. Total hardness (expressed as $CaCO_3$) fell within the range of 93-124 $mg.L^{-1}$. These results confirm that Nile water at Edfu district was well buffered.

The two major anions Cl^- and SO_4^- maintained its level between 6 - 14 mg. L^{-1} for Cl^- and 12 - 13 mg. L^{-1} for sulphate.

CONCLUSION

The most important results findings from this study are :

1. The water quality of the river Nile at Edfu district is definetly clean, and is not polluted.

2. The high diversity of phytoplanktonic composition at all different investigated sites indicated that Nile water at this district is oligotrophic.

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مجتمعات الطحالب وعلاقتها بنوعيه مياه النيل عند أدفو - مصر

د. سلوى شحاته ود. صباح بدر ، جميله على
قسم تلوث المياه - المركز القومى للبحوث

تناول البحث دراسات على التوازن العددى والنوعى لطحالب مياه نهر النيل وعلاقتها بالتغيرات الطبيعية والكيماويه عند مدينه أدفو ، خلال متابعه شهريه منتظمه بدءا من أغسطس ١٩٩١ حتى يوليو ١٩٩٢ بهدف تحديد مأخذ محطه مياه الشرب الجديده بالمدينه .

ويمكن ايجاز أهم النقاط التى توصلت اليها الدراسه فيما يلى :

١ - يتميز نهر النيل بوجود أنواع مختلفه من الطحالب تنتمى لخمس مجاميع رئيسيه هى الطحالب الخضراء والطحالب السوطيات والطحالب الخضراء المزرقه والدياتومات والطحالب البنيه الهدبيه .

٢ - أثبتت النتائج أن مجموعة الدياتومات سادت على المجاميع المختلفه عدديا خلال الشهور والمواسم المختلفه حيث كانت متواجده طوال السنه وكان كل من طحالب Cyclotella and Melosira يمثل العدد الاكبر وكذلك الطحالب الخضراء المزرقه ممثله فى طحلب Oscillatoria and Cylindrospemum. تراوحت النسبه المئويه للدياتومات مابين ١ر٤٠٪ - ٤ر٨٧٪ من العد الكلى للطحالب يلى ذلك الطحالب الخضراء المزرقه حيث تراوحت النسبه لمئويه لها مابين ٥ر٢٪ إلى ٨ر٥٣٪. أما الطحالب الخضراء فكانت النسبه المئويه لها ما بين ١ر٢٪ - ٩ر١٨٪. هذا وتعتبر الطحالب الهدبيه أقل نسبه مئويه حيث تواجدت بنسبه ٢ر٠٪ إلى ٥ر١٦ ٪ خلال مده الدراسه .

٣ - تراوحت التغيرات العدديه للطحالب فى مياه نهر النيل عند منطقة أدفو مابين ٩ر٤× ١٠^{٥} - ٧ × ٦١٠ طحلب لكل لتر. هذا وتوجد علاقه وثيقه بين المحتوى الكلوروفيللى (٩٦ر١ - ٨ر١٣ ميكروجرام/لتر) والعد الكلى للطحالب .

٤ - أكدت التحاليل الكيماويه لنهر النيل بمنطقة أدفو أنها على درجة عاليه من النقاوه .

والخلاصه تعتبر منطقه الدراسه لنهر النيل عند مدينه أدفو وفى جميع المواقع المختلفه تظيفه وصالحه كمدخل لمحطه مياه الشرب بالمدينه .