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CARBOHYDRATE CONTENT OF SEDIMENTS IN SOME AQUATIC HABITATS (EGYPT)

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ABSTRACT

The present work on Khor-Kalabsha, Lake Edku and Port-Said provides information on organic matter and carbohydrates in sediments of different habitats. The carbohydrates at Khor Kalabsha are mainly derived from autochthonous organic matter. High levels were found in winter and are related to remains of macrophytes, while plankton is the source in summer. Carbohydrates in the sediments of Lake Edku have a heterogeneous origin consisting of the remains of aquatic plants and planktonic organisms. High levels of organic matter and carbohydrates were observed in winter, and are related to the presence of major components of organic matter as autochthonous products. In Port-Said region, the source of the major organic matter and carbohydrates are considered to be allochthonous coming from Lake Manzalah and sewage, except in station VII, which is considered as autochthonous organic matter.

INTRODUCTION

The aquatic organisms and organic detritus when reaching the sediments of Lakes are easily degraded to carbohydrates and amino acids. This leads to increasing of eutrophication in the lakes. To evaluate the environmental factors, three different groups of sediments have been obtained from fresh, brackish and marine habitats.

There are many studies concerning the analysis of sediments (El-Sarraf, 1976; Elewa, (1980); El-Sarraf and Olah, 1982; El-Dardir, 1984; Iskaros, 1988; Elewa et al., (1990); Moussa and El-Sayed, 1991; and Shata et al., 1993).

The purpose of this study is to compare the sediment carbohydrates in three different water bodies according to Halobian system. Also, it is of interest to study a relatively virgin area (Khor Kalabsha) which lies far from the impact of pollution resulting from industrial and sewage effluents.

Description of areas investigated

Lake Nasser lies within latitudes 23° 58' and 20° 27'N and longitudes 30° 07' and 33° 15'E. It is considered as the second largest man-made lake in the world. Lake Nasser was formed after the construction of the High Dam in the southern part of Egypt. Lake Nasser has numerous side branches called Khors. The chlorosity values ranged between about 1.1 and 7.6 mg Cl dm^{-3}. There are 175 Khors connected to the lake which differ in shape, length, width, topography and bottom deposits. The longest khors are El-Allaqi on the east and Kalabsha on the west side of the lake.

The present study deals with khor Kalabsha which lies about 50 Km south of the High Dam. It has a length of 47.0 km and a mean width of 13.1 km. The surface area is of about 620 km^2 with a mean depth 10 m. The bottom sediments vary from very fine sand to sandy mud and sandy silt, which is characterized by a relatively high organic matter content (Shata et al., 1993). In khor Kalabsha there are some small patches of macrophytes near the shores such as Potamogeton pectinatus, Potamogeton crispus, Ceratophyllum demersum, Najas minor and N. armata, (Figure 1A).

Lake Edku lies at latitude 30° 15' N and longitude 31° 15' E. It extends for about 17 Km in an east-west direction. The lake is connected to the Mediterranean through a short channel called "El-Boughaz".

The nature of the bottom sediments varies from sandy to silty-clay according to the locality (El-Sarraf 1976). The particulate detrital organic matter input to the lake comes from allochthonous sources mainly fresh water drains, and from autochthonous sources through the decomposition of aquatic organisms in the lake. The lake is shallow, brackish and favours the growth of macrophytes which spread almost all over the lake as Potamogeton pectinatus L., Potamogeton crispus L., Ceratophyllum demersum L. Floating aquatic plants were also recorded such as Lemna gibba, Spirodela polyrrhiza, Eichhorina crassipes. This eastern region receives drain water from several drains (Figure 1 B).

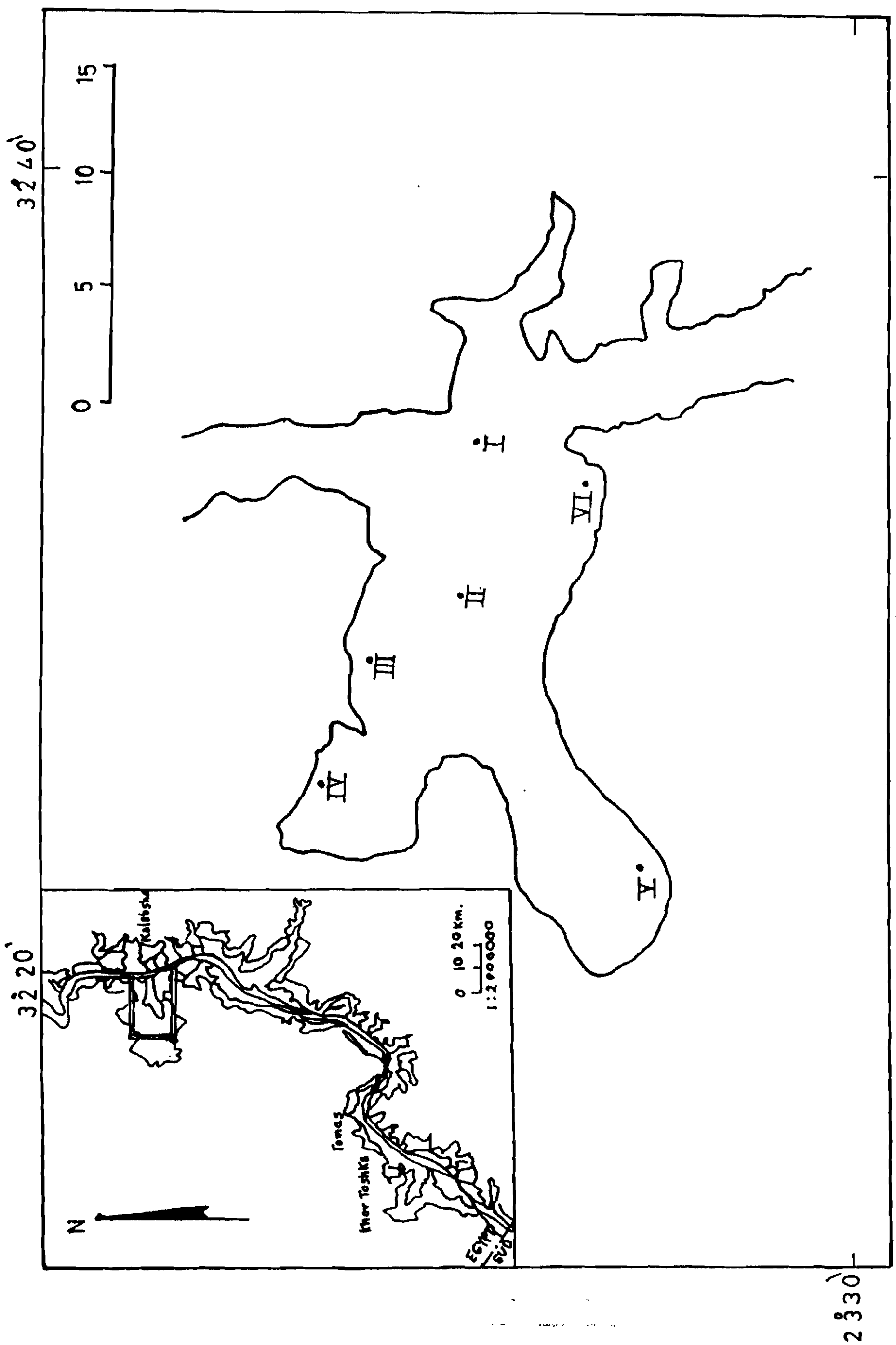

Figure 1A: Location of sampling stations in Khor Kalabsha (Aswan).

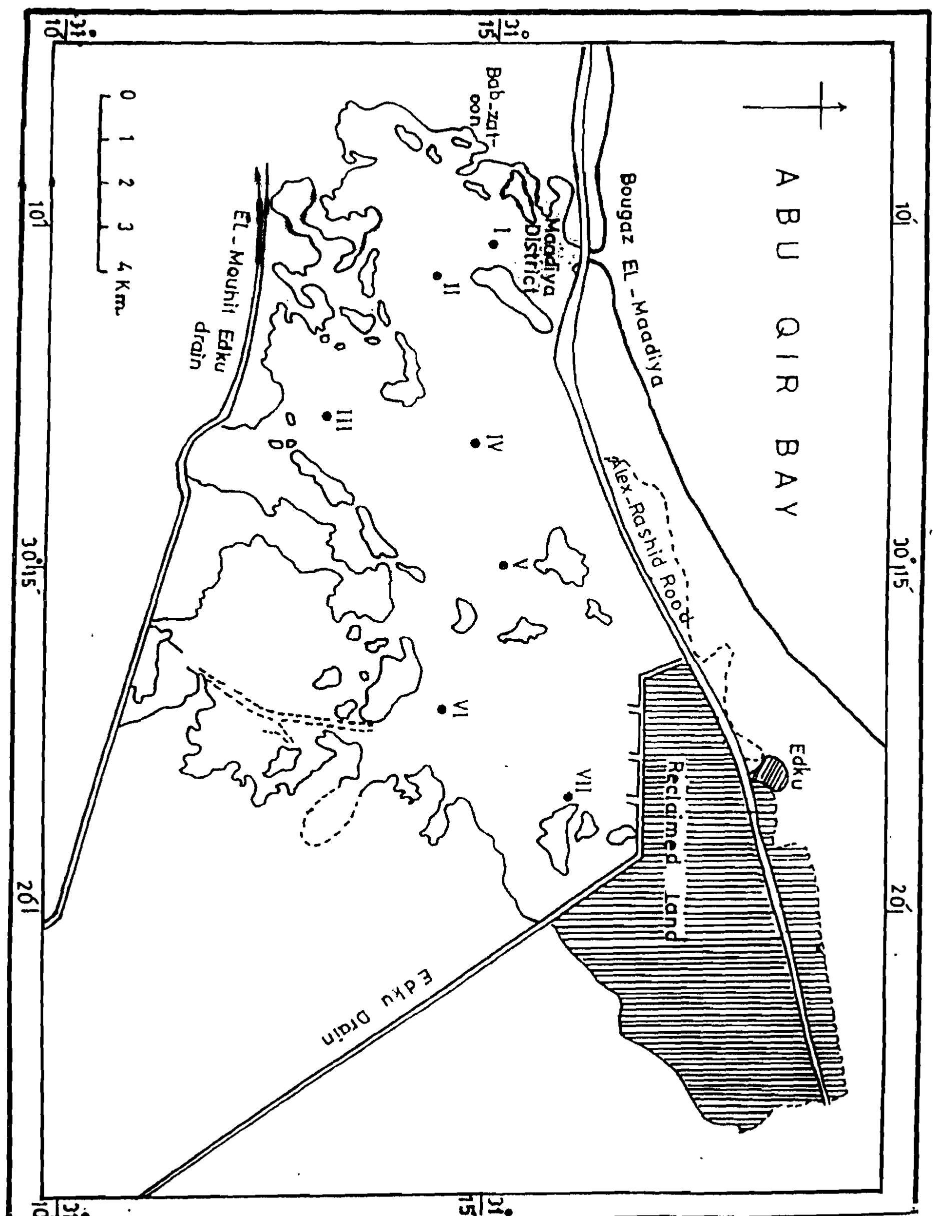

Figure 1B: Location of sampling stations in Lake Edku.

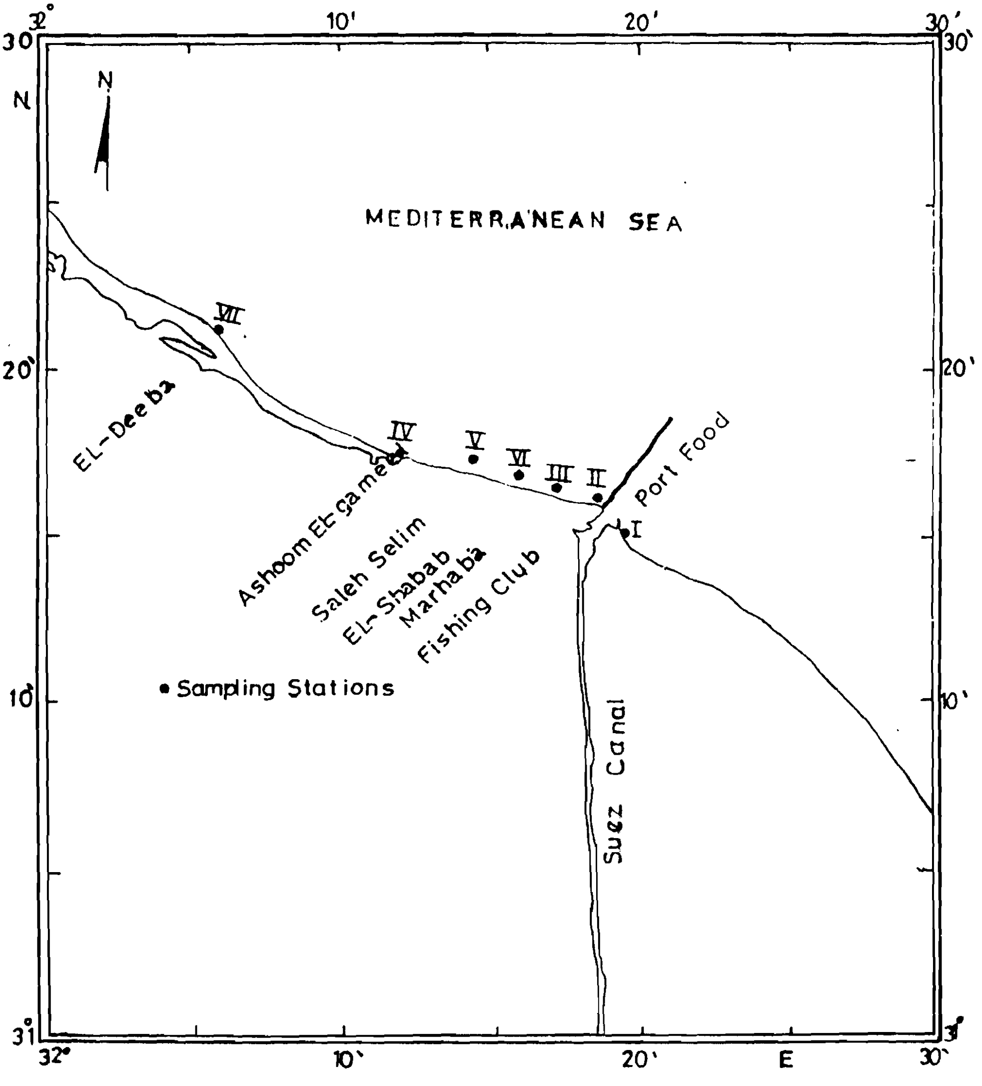

Figure 1C: Location of sampling stations in Port-Said Region.

Port-Said region

Port-Said region is the third area of study. It extends from Port-Said in the east to El-Deeba in the west. It extends to about 8 Km. along the peach. This area is shallow with a maximum depth about 3m. The salinity fluctuates from 20.61 to 38.6 $\%_o$, (Figure 1C).

MATERIAL AND METHODS

The surface sediments were collected by Ekman bottom sampler. The dried sediments were ground to powder after removal of shells.

Sediments of khor Kalabsha were collected during different seasons of 1990, two stations were selected one in the main channel of Lake Nasser I, while the other lies in the central part of the khor (II), four stations are distributed along the peripheries. The depth at which the samples were collected ranged from 2 m to 28 m.

Sediments of Lake Edku were collected from seven stations, representing the Western section including stations I, II, III and IV, and Eastern (stations V, VI and VII) parts. The sediments were collected during different seasons of 1992.

Sampling stations at Port-Said were chosen to cover the area from Port-Foad in the east to El-Deeba in the west during September 1992.

The organic matter and carbonate carbon were determined by dry combustion in a Muffel furnace at 550 and 1100°C, respectively. The total carbohydrates (TCHO) fractions were estimated by the phenol-sulphuric acid method of Dubois et al., (1956), modified by Gerchakov and Hatcher (1972). The soluble (SCHO) and insoluble (ICHO) carbohydrate fractions were isolated according to Compiano and Romano (1988). The soluble and insoluble carbohydrate concentrations as expressed in D-glucose equivalents, were determined using Shimadzu Double Beam Spectrophotometer UV - 150 - 02 at 485 nm.

RESULTS AND DISCUSSION

Bottom sediments of the investigated areas comprise sand or silty-clay. Sandy sediments are known to store little organic matter, while silty-clay sediments usually contain high levels of organic matter.

1 - Khor Kalabsha :

At station I the organic matter is low (2.7%) and carbonate carbon is 1.12%. The soluble (S) and insoluble (I) carbohydrates (CHO) were found to be 0.108 and 0.372 mg g^{-1} dry weight of sediment respectively. In station II, the organic matter and carbonate carbon were higher than in station I and amounted to 3.3% and 4.4% respectively, while SCHO and ICHO were 0.1 and 0.602 mg g^{-1}. The low concentration at station I nearby the main channel is due to continuous removal of organic detritus also, the sediments contained the natural organic matter from plankton and detrital material. (Fig 2). station II is - characterized by the presence of organic matter and the water is more or less stagnant with reduced currents.

Figure (2) shows the seasonal changes in organic matter, carbonate carbon, soluble (SCHO) and insoluble (ICHO) carbohydrates.

In stations III and VI, during autumn and winter values of each of these variables were higher than those during spring and summer Figure (2). There is a general increase from autumn to winter and a decrease during spring and summer. Concentrations of both carbohydrate and organic matter remained significantly higher in bottom sediment of stations III and VI than stations IV and V, where low levels were found in autumn and winter but an increase during spring and summer was observed.

In station III, the high concentrations of soluble, insoluble and total carbohydrates amounted in winter to 1.43, 3.99 and 5.50 mg g^{-1} respectively while low levels were observed in spring 0.58, 1.47 and 2.06 mg g^{-1}. The high concentration of carbohydrates may be related to macrophytes remains in the sediments, and their degradation by microorganisms. Hellebust (1974) mentioned that free and combined sugar constitute large fractions up to 80% in macrophytes. The main bulk of organic content in macrophytes is considered as carbohydrates, which ranges between 58.1% and 71.7% of dry weight (El-Sarraf 1976). Station IV, is characterized by relatively low organic matter. High levels were recorded in summer (7.3%), while lower concentrations were observed in autumn (6.2%).

High values of SCHO, ICHO and TCHO are 0.65, 1.29 and 1.94 mg g^{-1} were recorded in summer, while the low levels were found in winter are (0.46, 0.85 and 1.31 mg g^{-1}). The higher or / lower concentrations may be related to the phytoplankton blooming, which is high in spring and summer and decreased during autumn and winter.

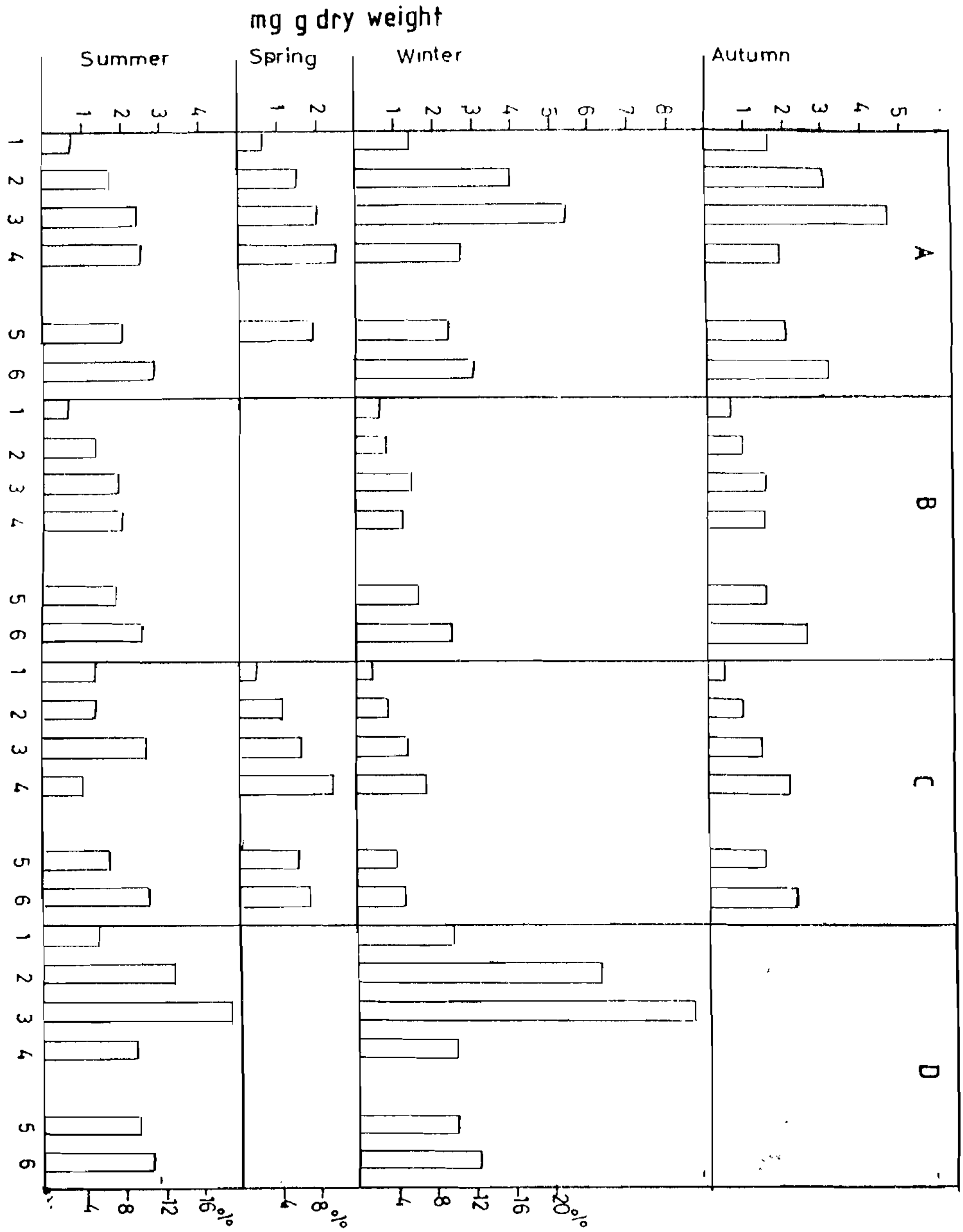

Figure 2: The pattern of seasonal distribution of (1) soluble carbohydrate, (2) insoluble carbonate, (3) total carbohydrate in mgg^{-1}, (4) ration l/s, (5) organic matter and (6) % carbonate carbon in Khor Kalabsha.

station V, is similar to station IV, where the higher concentrations of SCHO, ICHO and TCHO were found in summer (1.29, 1.35 and 2.64 mg g^{-1} respectively and lower values (0.46, 0.86 and 1.31 mg g^{-1}) were observed in winter.

In station VI, high concentrations of SCHO, ICHO and TCHO were 2.46, 6.23 and 8.69 mg g^{-1} respectively, with high organic matter (10.3%) in winter. The level of carbohydrates in summer is about half the value in winter (1.41, 3.35 and 4.76 mg g^{-1}), with organic matter of 9.6 %. The organic matter content of stations IV and V may be attributed to planktonic organisms and organic detritus in the khor. Latif (1974) showed that the khors are rich in zooplankton as a result of reduced current and that blue green algae dominated the phytoplankton community. Ochiai et al., (1986) found that, carbohydrate content of sediments was 22.0 ug mg^{-1} in Lake Haruna.

The carbonate carbon ranged from 1.12 % in station I to 12.5 % in station III. Calcium carbonate was found to be proportional to carbonate carbon where values ranged between 2.5 % and 28.4 % for the same locations. The calcium carbonate is derived from the fresh water gastropods as Bulinus truncaties, Physa acuta, Valvata nilotica and Melanoides tuberculata (Iskaros, 1988).

General overview of Khor Kalabsha shows that stations III and VI have high content of organic matter due to the presence of aquatic plant remains especially during winter season. Stations IV and V, on the other hand, have moderate organic matter which depends on allochthonous materials especially during flood season.

2- Sediment of Lake Edku :

The predominant types of sediments in the eastern and western regions of the lake are the silty-clay and the complex type silty-clay-sand, respectively. The sediment of station I is entirely composed of sand (92%) and is mainly composed of gastropod shells Fig. (1B).In addition, the lake is shallow and brackish, favouring the occurrence of rooted macrophytes. the particulate detrital organic matter input to the lake comes from allochthonous sources mainly with fresh water drains and from autochthonous sources through the decomposition of aquatic organisms inside the lake.

The seasonal variation of organic matter content in sediments ranged from 1.9 to 26.8% dry weight (station IV in summer and station V in autumn, figures 3 and 4). The organic matter at station I is relatively low in winter compared to higher levels during spring and summer . EL-Sarraf et al (1989) showed that the low values of organic carbon and carbohydrates were found near El-Boughaz of Lake Burollus. Station III is characterized by high concentrations of organic matter during autumn and winter, with relatively low values during spring and summer. Surprisingly the soluble and insoluble carbohydrates are low and are not proportional to the values of organic matter during autumn and winter, this may be related to shallow water and oxygen deficiency favouring the sulpher bacteria population. Degens and Mopper (1976) reported that, owing to the low bacterial activity, the organic carbon in reducing sediment is not as thoroughly consumed as in oxidizing sediment, this is reflected in the generally high total organic carbon content of reducing sediment.

station IV, which has a depth of about 150 cm, and is affected by the fresh water from drains and sea water from El-Boughaz lacks any form of aquatic plants. The organic carbon is found with low values. The macrophytes in this area, are mainly confined to the shore, whereas the central part of the lake is barren. Figure (3) shows that, the organic matter and carbohydrates are higher in the eastern than in the western region. This could be related to the large variation of marcophytes with abundant growth due to sheltering conditions.

The accumulation of marcophytes material on the lake bottom may alter the type of sediments present (Welch, 1952). The deterioration of these hydrophytes releases new material into the lake (sediment / water) that become available to microorganisms (El-Sarraf, 1976). The ratio of insoluble (I) and soluble (S) carbohydrates decreases eastwards with increasing total organic matter (Figs. 3 and 4). On the other hand, I/S ratio increases during autumn and winter. The soluble carbohydrate content has a higher level in the sediments in the eastern region of the lake than in the western part.

Soluble carbohydrates are usually associated with fresh material (Handa et al., 1972), and the degree of degradation of organic carbon by microbial activity in the sediment. The variation of organic matter and carbohydrate contents of stations I and IV during different seasons has increased or decreased according to the water inflow, current and wind direction.

Carbonate carbon fluctuated from 3.9% at station I in summer to 11.3% at station IV in winter. High concentration of carbonate carbon in lake sediment is related to the broken shells. Also, the surface carbonate values are attributed to precipitation of calcium carbonate from carbon dioxide liberated by the decomposition of organic matter ((Kemp et al., 1972). The carbonate distribution is affected by the presence of shells and their movements over the surface sediments (Moussa 1984).

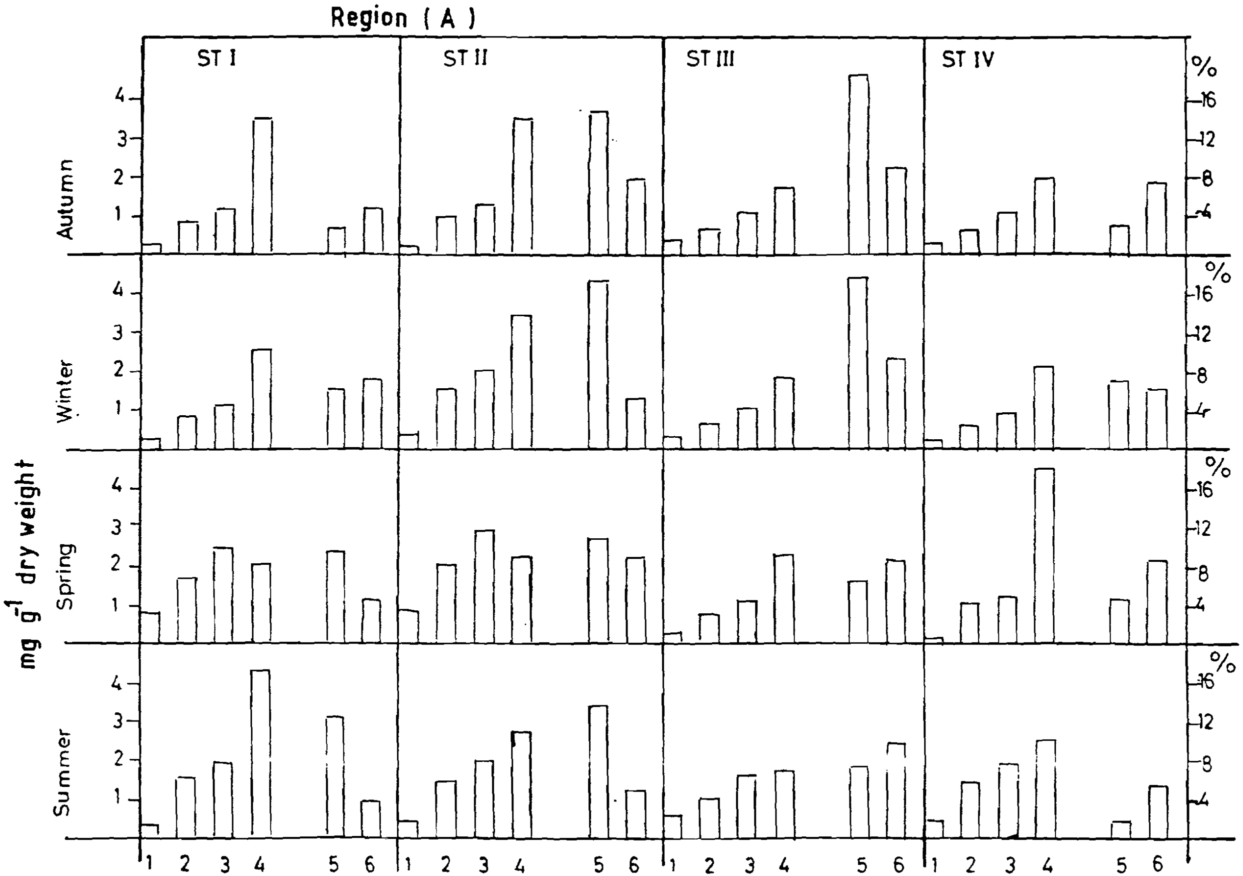

Figure 3: The pattern of seasonal distribution of (1) soluble carbohydrate, (2) insoluble carbonate, (3) total carbohydrate in mgg^{-1}, (4) ration l/s, (5) organic matter and (6) % carbonate carbon in region (A) of Lake Edku.

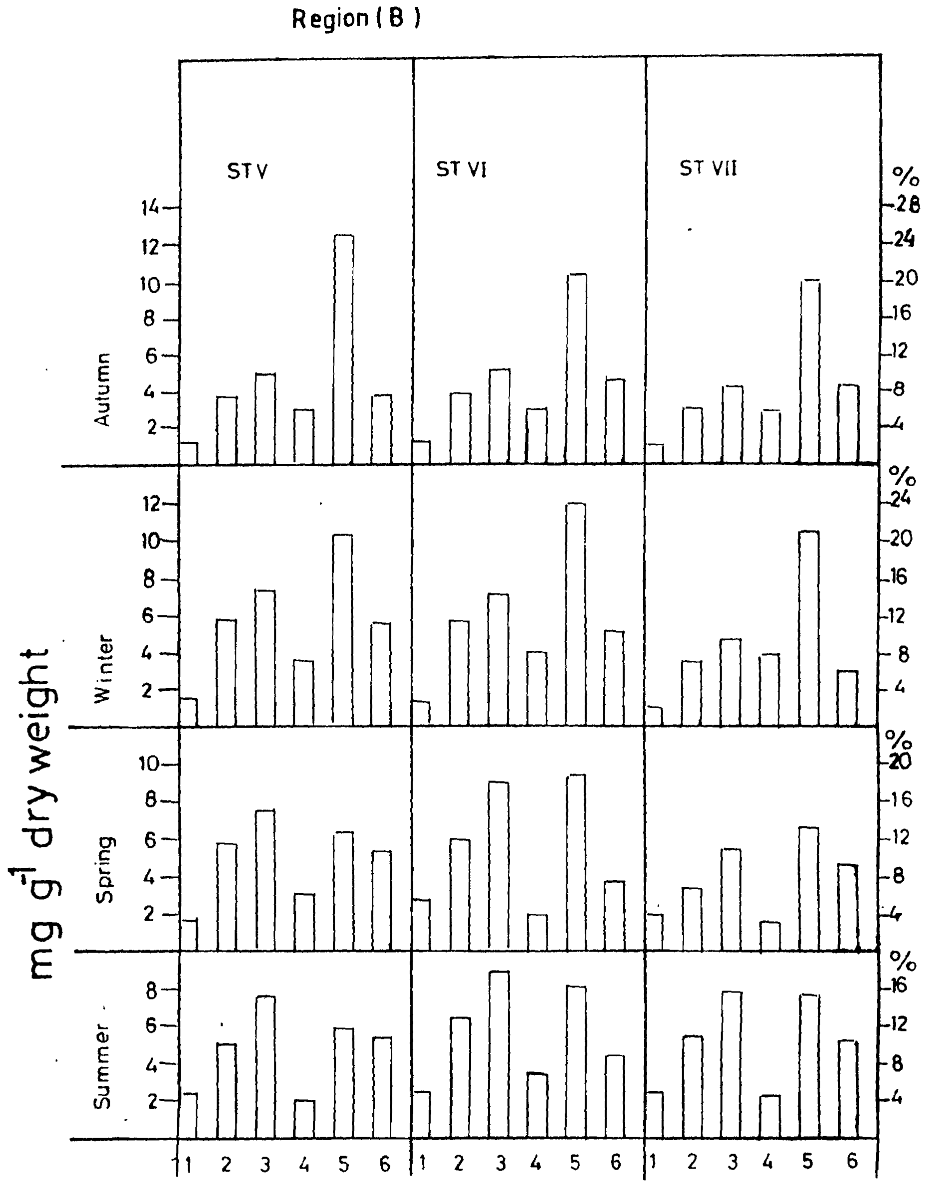

Figure 4: The pattern of seasonal distribution of (1) soluble carbohydrate, (2) insoluble carbonate, (3) total carbohydrate in mgg^{-1}, (4) ration l/s, (5) organic carbon and (6) % carbonate carbon in region (B) of Lake Edku.

3. Sediments of Port-Said region

The sediments contain minor amount of organic matter, as expected from the type of the sediment which is mostly sand. The lower values of organic matter were recorded at station III, while the highest value was at station V. Generally organic matter shows an increase from the eastern stations towards the western ones (Figure 5). On the other hand, the western stations are affected by inflow sewage and drain water from Lake Manzalah (stations V and VI).

The level of soluble carbohydrates at each station ranges between 0.126 mg g^{-1} at station VII & 0.529 mg g^{-1} at station VI. The minimum value of insoluble carbohydrate varies from 1.3 mg g^{-1} at station VII to 2.573 mg g^{-1} at station VI. The lowest values of stations I and VII may be attributed to the location of these two stations far away from the source of pollution (the city) and the direction of the current which is east-bound (Figure 1c). High values could be due to the impact of sewage and brackish water from the lake. In the station VII (El-Deeba) the major organic matter and carbohydrate levels are considered to be autochthonous. Degens and Mopper (1975) showed that carbohydrates in several sediments have the values 45.9-250 u moles g^{-1} in Black Sea, 6.6 u moles g^{-1} in New York Bight, 3.2-4.2 u moles g^{-1} in Cariaco Trench. Artem'Yev (1969) found that the carbohydrates in bottom sediments of the Kuril-Kamchatka Trench ranged from 1.33% to 8.8% Gerchakov and Hatcher (1972) recorded that, the carbohydrate of Bermuda surface sediment varied between 0.01% to 13.18%. Nessim, (1994) postulated that the carbohydrates content in the recent sediments of the Western Harbour of Alexandria is 0.73 and 4.09 mg g^{-1}, while the carbohydrates level in the sediments of the Eastern Harbour of Alexandria is 2.43 and 6.28 mg g^{-1}. The ratio of I/S carbohydrates in Port-Said region emphasizes the importance of sedimentation as an indicator for the organic matter reaching the sediment which may be related to the impact of pollution. The majority of insoluble carbohydrate is not susceptible to biological activity. The ratio of I/S ranges from 4.8 at station VI and 17.5 at station II, its values differ from those of the lakes.

The carbonate carbon in surface sediment fluctuated from 8.9% to 14.7%, accordingly calcium carbonate varied from 20.0% to 33.4%.

In this study, it is suggested that:

1- The values of carbohydrates are attributed to the decomposition of organic matter.

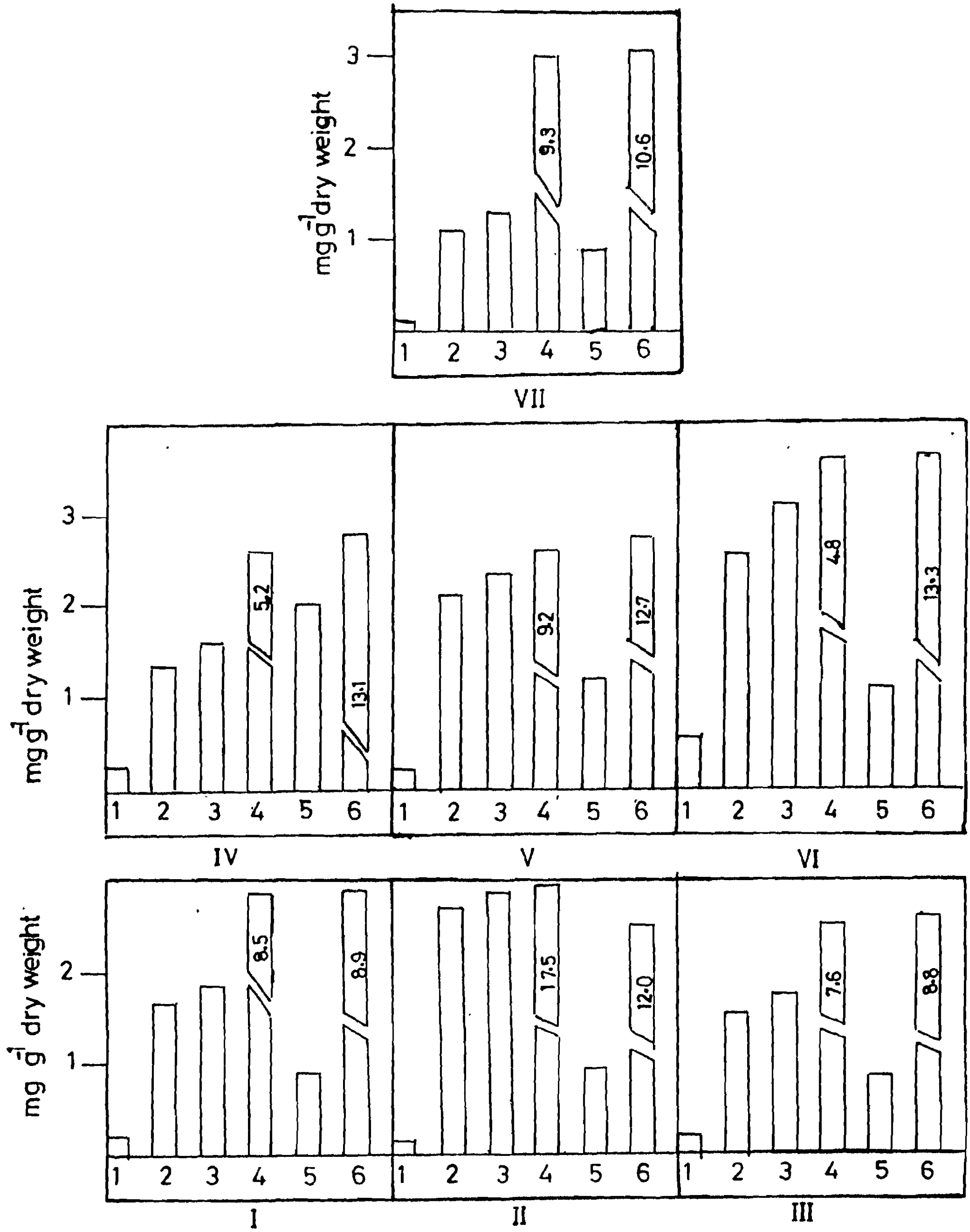

Figure 5: The pattern of seasonal distribution of (1) soluble carbohydrate, (2 insoluble carbonate, (3) total carbohydrate in mgg^{-1}, (4) ration l/s, (5 organic matter and (6) % carbonate carbon in Port-Said region.

2- The wide fluctuations in carbohydrate concentration are usually associated withseasonal variations of aquatic plants and blooming of phytoplankton and also, are related to the degree and type of organic matter content which precipitates on the bottom sediment. It can be considered that the autochthonous organic content formed the major part of carbohydrates.

3- The carbohydrate concentration of the fresh and brackish water bodies is related to eutrophication, which is in the marine sediment, the carbohydrate concentration may be attributed to pollution and other factors.

4- The marine surface sediments are low in organic content and carbohydrates, which are related to the presence of high concentration of inorganic matter.

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