STUDY OF THE CORE SEDIMENTS OF THE NOZHA HYDRODROME, NEAR ALEXANDRIA, EGYPT

By

Massoud A.H. Saad

Department of Oceanography, Faculty of Science, Moharem Bey, Alexandria, Egypt.

with 4 figures and 1 table in the text

SUMMARY

A simple core sampler was devised to obtain seven short cores from the Hydrodrome. The core samples were subjected to some physical and chemical investigations in order to know the vertical variations in the quantitative composition of the deposits after they have been buried for a long period.

The studied components of the sediments were found in all sediment samples ranging from very high to very low values. The water content of the cores gave a wide range of variations. The bottom samples of most cores were hard and gave minimum values of water. Contrary to water content, the density of the wet mud increased with depth in most cores.

The organic matter, the calcareous substances, the allochthonous materials and the diatom-silica were deposited down in variable amounts at various depths of the cores. They gave irregular higher and lower values with a considerable wide range of variations. The quantitative distribution of these components in the core sediments was found to depend principally upon certain factors which were discussed.

INTRODUCTION

The fish production in Egypt depends principally on the inland water bodies of the country. The Nozha Hydrodrome, an artificial and almost fresh water pond, was subjected to relatively more limnological studies than the other Egyptian lakes. It was chosen as an experimental pond, since it has certain distinctive features which make it well suited for certain types of investigations. A teamwork from the scientific staff of the Hydrobiological Institute at Alexandria together with some experts from the FAO started the study of the Hydrodrome in 1954 (Elster & Jensen, 1960). Some limnological characteristics of the water body were studied by Saad (1973).

The surface sediments of the Hydrodrome were subjected to few investigations. Ezzat (1959) made ecological studies on the bottom living Amphipods of this pond. Elster and Jensen (1960) gave a rough index of organic matter of the Hydrodrome sediments. El-Wakeel (1964) made some mechanical, mineral, and chemical studies on a composite sediment sample from the Hydrodrome.

Saad (1972 a) made some investigations on the surafce sediments of the Hydrodrome. The quantitative distribution of diatom-silica in the deposits of the Hydrodrome was studied by Saad (1971).

It was found necessary to study the subsurface sediments of the Hydrodrome in order to know the vertical variations in the quantitative composition of the deposits after they have been buried and preserved for a long period. Accordingly, seven cores have been taken out from different localities of the Hydrodrome bottom in order to gain information on this specific study.

DESCRIPTION OF THE HYDRODROME

In 1939, the Hydrodrome was completely isolated by an embankment from Lake Mariut, a shallow brackish - water basin situated along the Mediterranean Coast of Egypt south of Alexandria The sides of this embankment, which is 9 kilometers in length, are steep and reinforced with concrete.

The Hydrodrome has an area of 504 hectares, and an average water depth of about three meters. It receives Nile water from the Mahmoudiah Canal through the inlet, which is diametrically opposite to the outlet. Such continuous supply of the fresh Nile water has greatly decreased the chlorosity of the Hydrodrome. Saad (1973) gave chlorosity values for this pond, ranging between 0.12 and 0.48 g/1.

The bathymetric chart of the Hydrodrome, presented by Elster & Jensen (1960), shows that the bottom is slightly inclined southwards, but with slight differences in depth (Fig. 1). The bottom of the Hydrodrome is composed principally of the former Mariut deposits, the allochthonous Nile sediments entering the Hydrodrome continuously with the Nile water, and the autochthonous organic production of the lake. Shells and shell fragments of calcareous organisms accumulate on the Hydrodrome bottom in considerable amounts, especially at the central region.

COLLECTION OF CORE SAMPLES

Different types of core samplers were devised to obtain cores from shallow and deep water lakes. The Kullenberg and the Jenkin samplers (Kullenberg 1947, Jenkin *et al.*, 1941) both use heavy weights to drive the apparatus into the sediment. A piston sampler, which is similar in principle to the Kullenberg sampler but is pushed into the sediment by hand by means of a long jointed rod, was described by Livingstone (1955). A pneumatically operated core sampler, which does not use heavy weights, was devised by Mackereth (1958).

A simple core sampler was devised by the author to obtain short cores from the shallow-water Egyptian lakes, which have a water depth ranging from 70 to 240 cm. Seven cores were sampled by this instrument from different localities of the Hydrodrome to carry out the present investigation (Fig. 1).

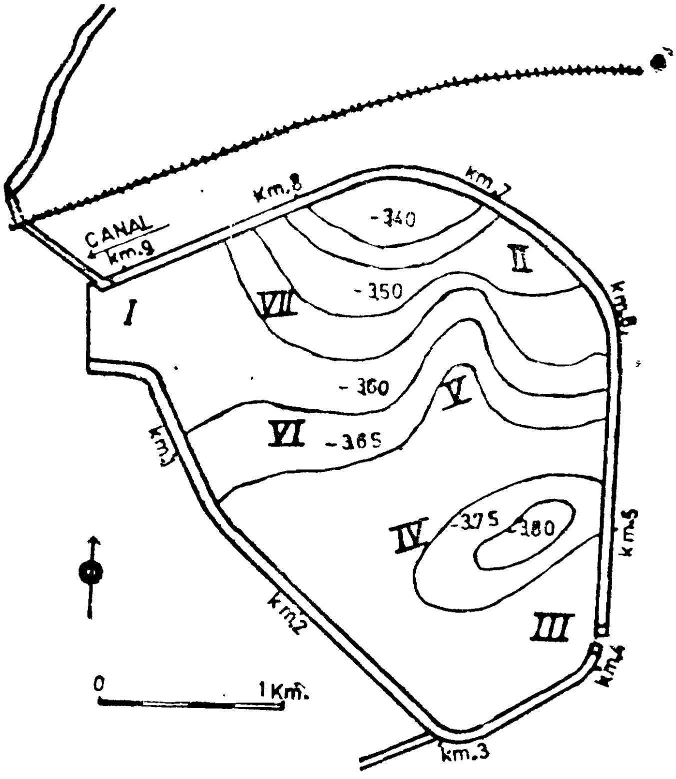

Fig. 1. Bathymetric chart and location of cores

As shown from Fig. 2 (A & B), the core sampler consists of a heavy iron head (a) and an open-ended sampling plastic pipe (b). The weight of the head alone is usually sufficient to penetrate the sediment and to fill the pipe completely, especially when the deposit is soft. The pipe is one meter long and 5 cm in diameter. It is composed of two halfs fixed together tightly and attached firmly at their upper end with the head of the apparatus. The edge of the lower end of the pipe is sharp to help it to penetrate into the sediment, and enclose a deposit sample of a considerable length. A rubber hose (c) emerges from a rubber plug, which closes the upper end of the pipe, in order to allow the lake water to pass through it when the apparatus is lowered down.

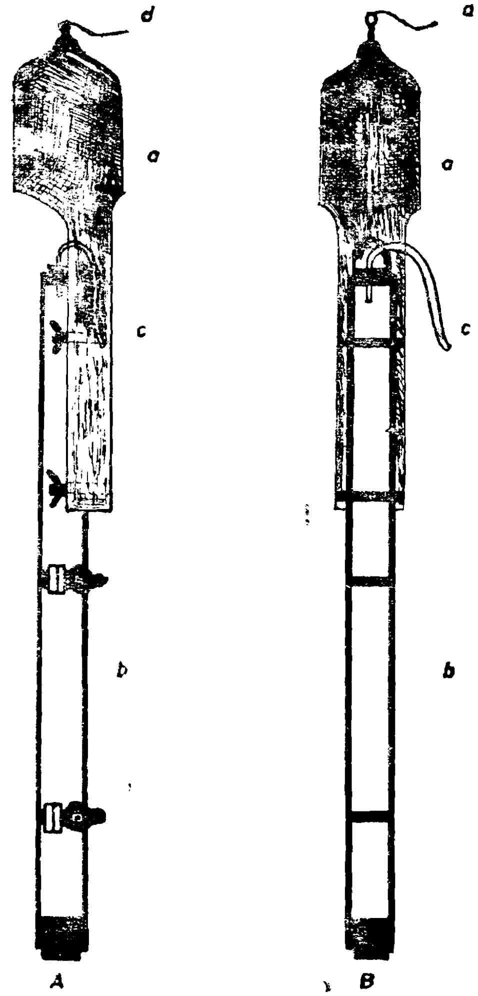

Fig. 2. Diagrammatic illustration of the core sampler

The sampler is lowered by means of a strong rope (d) from a small rowing boat. The instrument is pulled up, after taking the core, and its lower end is closed by a rubber plug before it reaches the water surface. The two halfs of the plastic pipe are washed from the outside and separated from each other. The mud samples were collected from different depths of the lake deposits and kept in clean and labelled containers.

METHODS

The determination of the wet density of sediment samples was carried out on the same day of collection by means of a pyknometer. The density of the dry mud was calculated from the density of wet mud and the water content (Saad, 1970). The wet mud was dried in an oven at 105°C to calculate the amount of water content.

The determination of organic matter was carried out by igniting about 500 mg dry mud in a Muffel furnace at 525°C from 4 to 5 hours (Ungemach, 1960).

The HCI-soluble and insoluble parts of the deposits were determined by adding 12.5% HCI to the remaining inorganic fractions of the sediments in conical flasks, which were heated for one hour on an electric hot plate. The solutions were filtered using ashless filter paper. The dissolved fractions of the deposits are considered as calcareous substances. The undissolved parts of the sediments represent the allochthonous materials plus diatom shells.

The carbonate-soluble (diatom)-silica was determined photometrically using the method described by Mullin and Riley (1955), and modified by Tessenow (1964).

RESULTS

The values of the different components of the cores are represented as percentages per dry mud in order to give a good picture for comparing these percentages at different depths of each core and with those at the corresponding depths of the other cores (Fig. 3). These values were also calculated in kg per m^2 wet mud in order to give a clear idea about their quantitative distribution at different regions of the lake bottom and at various levels of the cores. The silica content was calculated in g per m^2, due to its low value (Table 1). The average values of the different components for all depths of the cores were calculated and presented graphically in Fig. 4.

The dry density gave maximum values at the surface of cores I, IV, V and VII. The minimum values of these cores, however, were recorded from the subsurface sediments. The maximum value of core II was found at 15 cm and that of cores III and VI at their bottom. The average values of the dry density ranged from 3.37 to 2.30 g/cm^3 in cores II and V, respectively.

The water content of the cores showed a wide range of variations. It varied from an absolute maximum of 79.07% (core II) to an absolute minimum of 36.10% (core VI). The minimum values of water content were found at the bottom of the cores. The maximum values, however, were recorded from the surface samples of most cores. Generally, the amount of water decreased with depth in most cores. This is much more pronounced in core V, where the difference between the surface and bottom samples reached 1.4 kg/m^2. Fig. 4 shows that the highest averages value of water content of 9.0 kg/m^2 was calculated from core II, and the lowest of 6.1 kg/m^2 was found in core V.

In general, the density of the wet mud increased with depth in most cores. This increase is clear in core III, where the difference between the subsurface and bottom samples reached 0.33 g/cm^3. The density of wet mud gave an obvious inverse correlation with water content. The calculated average values of the wet density varied from 1.61 to 1.19 g/cm^3 in cores VI and I, respectively.

The values of the organic matter showed a relatively wide range of variations. They ranged from an absolute maximum of 15.31% at 10 cm of core VII to an absolute minimum of 6.42% at the bottom of core VI. As shown from Fig. 3, the curves of the organic matter gave irregular higher and lower values on passing downwards. The amounts of organic matter deposited per m^2 wet mud at different depths of core III and VII gave a relatively pronounced variation than those of the other cores. A difference of

0.4 kg/m^2 was found between the highest and lowest values of these two cores. The maximum average value of the organic matter (0.8 kg/m^2) was found in core VII, whereas the minimum average of 0.4 kg/m^2 was calculated from cores I and II (Fig. 4).

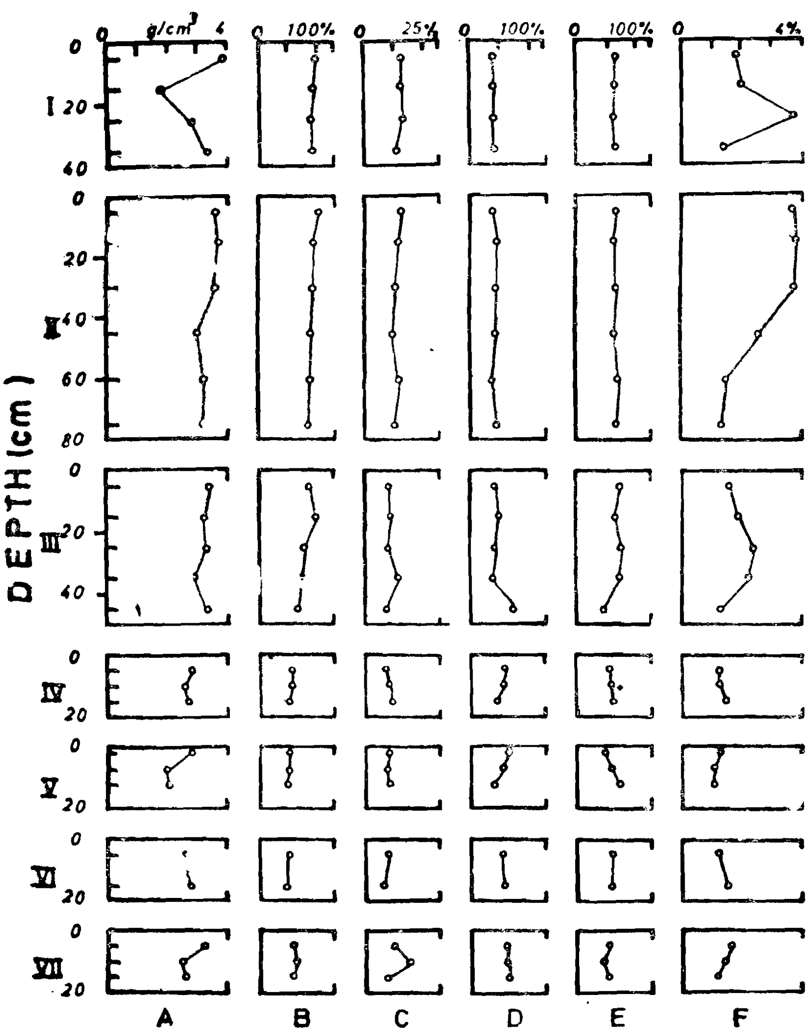

Fig. 3. Density of the dry mud, as well as the percentages of some constituents of the Hydrodrome sediments

A=density of dry mud, B=water content. C=organic matter, D=calcareous substances, E=allochthonous, materials, F=SiO_2.

TABLE 1. **Density of wet mud, as well as amounts of some constituents deposited down on one m^2 wet mud**

Sample No.	Water depth (cm)	Sediment depth (cm)	g/cm^3 density wet mud	kg/m^2					g/m^2
				Water	Dry matter	Org. matter	Calc. subst.	Alloch. materials	Si
I_1		5	1.20	9.3	2.7	0.4	0.9	1.38	20
I_2	330	15	1.12	8.4	2.8	0.4	1.0	1.37	30
I_3		25	1.22	8.8	3.4	0.5	1.1	1.74	60
I_4		35	1.23	9.0	3.3	0 4	1.1	1.78	20
II_1		5	1.18	9.3	2.5	0.3	0.8	1.36	40
II_2		15	1.24	9.1	3.3	0.4	1.2	1.64	60
II_3	280	30	1 23	9.1	3.2	0 3	1.1	1.74	60
II_4		45	1.24	8.8	3.6	0.4	1.3	1.86	40
II_5		60	1.24	8.9	3.5	0 4	1.1	1.98	20
II_6		75	1 31	8.6	4.5	0.5	1.6	2.37	30
III_1		5	1 31	8.7	4.4	0.4	1.5	2.47	30
III_2		15	1 20	9.1	2.9	0.3	1.1	1.47	30
III_3	350	25	1.41	8.2	5.9	0.5	1.8	3.53	70
III_4		35	1.42	7.8	6.4	0.7	2.0	3.63	70
III_5		45	1.53	7.8	7.5	0 5	4.1	2 85	50
IV_1		5	1.56	6.9	8.7	0.6	4.0	4.05	50
IV_2	270	10	1.56	6.5	9.1	0.7	3.9	4.45	50
IV_3		15	1.61	6 4	9.7	0.9	3.6	5.13	70
V_1		2	1.57	6.9	8.8	0.7	4.5	3.55	50
V_2	185	7	1.41	5.8	8.3	0.6	3.6	4.06	40
V_3		12	1 48	5.5	9.3	0.8	3.1	5.35	50
VI_1		5	1.52	6.8	8.4	0.7	3.5	4.15	50
VI_2	175	15	1.69	6.1	10.8	0.7	4.8	5.22	80
$VIII_1$		5	1.56	7.4	8.2	0.8	3.8	3.54	60
VII_2	165	10	1.42	7.2	7.0	1.0	3.4	2.56	40
VII_3		15	1.53	6.7	8.6	0.6	4 2	3.75	50

The values of the calcareous substances in core III gave a marked variation than those of the other cores. They varied from 53.99 to 30.49% at 45 and 35 cm, respectively. These percentages represent the absolute maximum and minimum values recorded from all cores. The calcareous matter had irregular higher and lower values at various levels of most cores. The amounts of calcareous materials deposited on a unit area at different depths of core III gave a remarkable variation than those of the other cores. They ranged from a maximum of 4.1 kg/m² at the bottom of the core to a minimum of 1.1 kg/m² at 15 cm. The highest average value of 4.2 kg/m² was calculated from core VI, whereas the lowest average of 1.0 kg/m² was found in core I (Fig. 4).

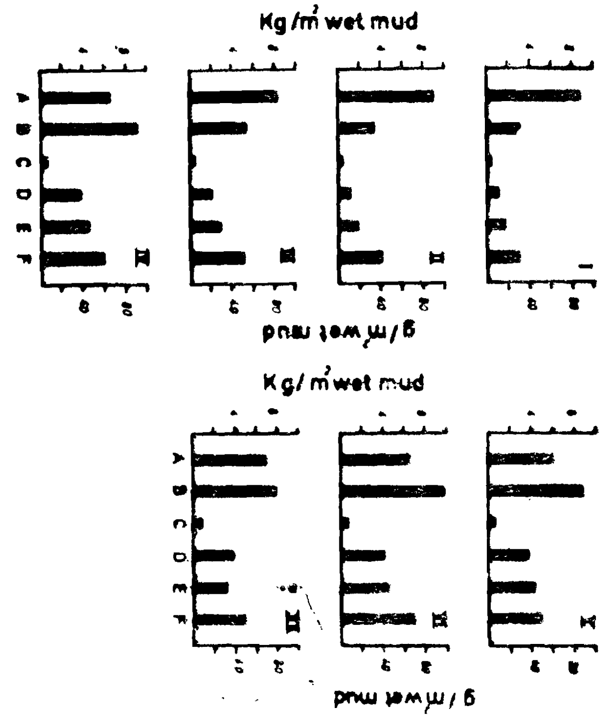

Fig. 4. Average values of the different components for all depths of the cores. A = water content, B = dry matter, C = organic matter D = calcareous substances, E = allochthonous materials, F = Si.

The percentages of the allochthonous materials varied markedly. They gave values ranging between an absolute maximum of 59.73% at 25 cm of core III to an absolute minimum of 34.87% at 10 cm of core VII. The allochthonous materials were precipitated in variable amounts at different depths of the cores. The amounts deposited per m^2 at various levels of core III had a pronounced variation than those of the other cores. They varied from a maximum of 3.63 kg/m^2 at 35 cm to a minium of 1.47 kg/m^2 at 15 cm. The calculated average values of the allochthonous materials fluctuated between 4.68 and 1.56 kg/m^2 in cores VI and I, respectively (Fig. 4).

The silica content of the cores ranged from an absolute highest value of 3.83% at 15 cm of core II to an absolute lowest value of 1.11% at the bottom of core V. The SiO_2-percentages of the samples of cores I and II showed a relatively wide rang of variations. The difference between the maximum and minimum values of these two cores reached 2.31 and 2.50%, respectively. The amounts of carbonates-soluble (diatom) silica deposited at various depths of the cores per m^2 wet mud fluctuated between 80 and 20 g Si. Between these maximum and minimum values, variable amounts of diatom-silica were precipitated on one m^2 at different levels of the cores (Table 1). The calculated average values of the silica ranged from 70 g Si/m^2 in core VI to 30 g Si/m^2 in core I (Fig. 4).

DISCUSSION

The quality and quantity of the materials deposited on the lake bottom depend mainly on the internal and external events. In case of the Hydrodrome, the external event has a considerable effect on the nature and composition of the lake sediment. The Nile water, entering the Hydrodrome more or less continuously, supplies the lake with additional sediments, since it is enriched with silt and clay particles.

No definite conclusion could be given in the present investigation regarding the age of the cores. It is always hoped to determine the age of the Egyptian coastal lakes and to study their developmental history. This problem can be solved by taking longer cores from different regions of these lakes. However, Aleem (1959) gave a

1972 a) The rate of aerobic mineralization of organic matter was found to increase in localities rich with mineral matter (Saad 1970).

The bottom of the Hydrodrome is characterized by the great accumulations of calcareous shells and shell fragments of dead bivalves, especially *Cardium* species and empty calcareous tubes of the serpluid worm *Mercierella enigmatica*. The calcareous substances showed, generally, irregular higher and lower values at different depths of most cores. The higher values can be attributed mainly to the abundance of calcareous shells (El-Wakeel, 1964 and Saad, 1974 and in press). This evidence is very clear in core III where the bottom sample, enriched with calcareous shells, gave an absolute maximum value. The lower values of calcareous substances, on the other hand, coincide with the scarcity of the calcareous shells. This may occur in certain sediment samples due to the unfavourable ecological conditions necessary for the growth of the calcareous organisms. The increase in the rate of supply of noncalcareous materials via Nile water must be also considered. In addition, the solution of calcium carbonate, which may occur after death of the organisms, decreases the amount of calcareous substances in the sediments.

The Hydrodrome receives its allochthonous materials mainly from the Nile water. These materials were deposited in variable amounts at various levels of the cores. This may be attributed principally to the variations in the amounts of these materials introduced into the lake via Nile water.

The allochthonous minerogenic materials entered the lake were distributed on the bottom and covered the autochthonous organic sediments or mixed with them. According to Ohle (1960, 1962, 1964), Ungemach (1960), and Saad (1970), the exchange of materials between the sediments and the free water must be greatly reduced under this condition.

The values of the carbonate-soluble (diatom)-silica in the samples of some cores gave a relatively wide range of variations. The higher values of diatom-silica found in certain samples reflect the richness of these samples with diatom shells (Saad 1971). The abundance of diatom frustules in the sediments depends principally on ; 1) the favourable environmental conditions at the time of deposition ; 2) the high degree of preservation of diatom frustules ; 3) the decrease in the rate of the release of silica from the sediment into the free water. On the other hand, the low amounts of silica were found in sediment samples poor in diaton shells. The scarcity of diatom frustules in these samples may be due mainly to the occurrence of unfavourable ecological conditions necessary for the growth of the diatoms, or the richness of these samples with minerogenic materials which destroyed the diatom shells (Saad, 1970, 1971 and 1972 b). The increase in the rate of the release of silica from these sediments must be also considered.

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