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RELATION BETWEEN SEDIMENT CALCIUM CARBONATE, ORGANIC MATTER AND PRODUCTIVITY IN ASWAN HIGH DAM RESERVOIR.

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ABSTRACT

The purpose of the survey of the Newly-formed Aswan High Dam Reservoir is to indicate a basis for a determination of calcium carbonate and organic matter in the bottom sediments and its effects on the reservoir productivity. This has been executed by correlating the calcium carbonate, organic matter, plankton content, fish population and bottom fauna at three selected sectors (northern, middle and southern) that almost represent the whole reservoir. The results have shown enrichment in productivity in the middle area of the lake. There was a significant correlation between calcium carbonate concentration in the bottom sediments with the reservoir productivity.

INTRODUCTION

The present work deals with the organic matter and calcium carbonate in the sediments of the Aswan High Dam Reservoir, Chlorophyll "a" and the bottom fauna. Thirty sediment samples representing the area under investigation in the three cross sections, viz. El-Birba, 10 Km; Amada 200 Km and Adindan 300 Km, south of the High Dam, respectively.

MATERIAL AND METHODS

The present investigation covered the period from March 1981 to March 1983. During this time the studies included some chemistry of the sediments, bottom fauna, and chlorophyll "a". These studies were made at three sections representing the various parts of the reservoir (Fig. 1). Sampling was carried out at seasonal intervals; the Ekman dredge, was used for sediment collection. The organic matter was determined by oxidation with chromic acid as described by Hanna (1965). The calcium carbonate was determined, using the method given by Jackson (1958). Chlorophyll "a" was determined according to Lind (1974).

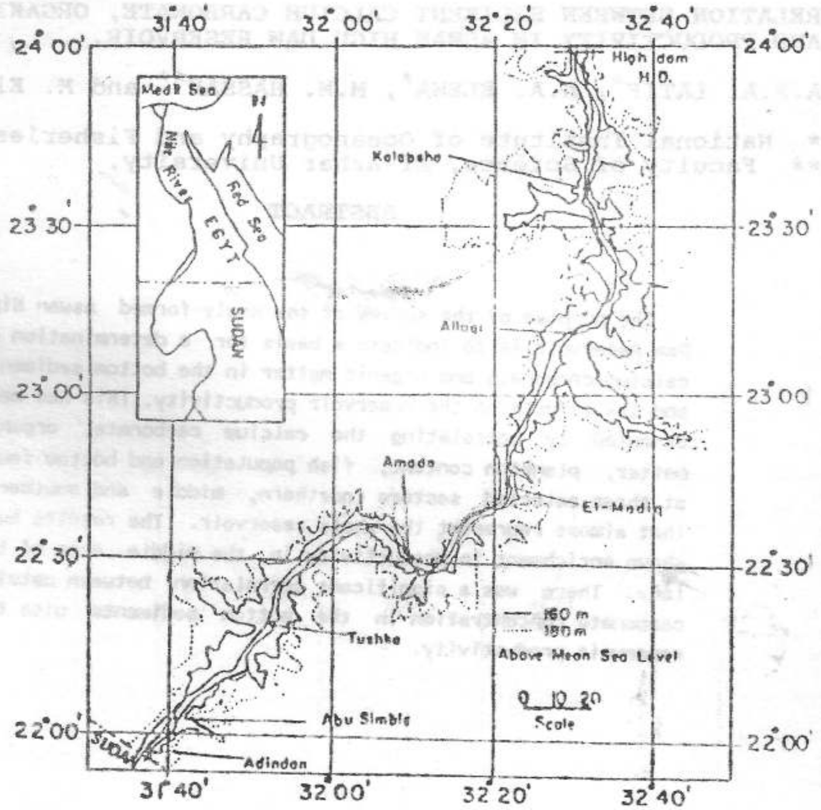

FIG. 1
Location of stations in Aswan High Dam Reservoir

RESULTS

Chlorophyll "a":

As given in Table 1 and Fig. 2 B, Amada water shows the highest values of chlorophyll "a" (11.1 ug/l for the winter and 11.7 ug/l for spring) as compared with 6.1-6.7 ug/l in the periods (autumn and the summer). Again the lowest value is recorded in summer at El-Birba.

Zooplankton:

The zooplankton concentration in Lake Nasser increased southwards. At the same time its highest frequency was recorded in the spring, followed by the Autumn (Table 2). The least frequency was confined to reworkers in the summer and autumn at El-Birba and in the winter at both Amada and El-Birba (Fig. 3).

Table 1
Chlorophyll "a" concentration (ug/l) in Aswan High Dam Reservoir during 1981-1983

Location	Seasons			
	Spring	Summer	Autumn	Winter
El Birba	3.8	0.95	4.7	5.5
Amada	11.7	6.1	6.7	11.1
Adindan	2.8	3.5	3.3	2.0

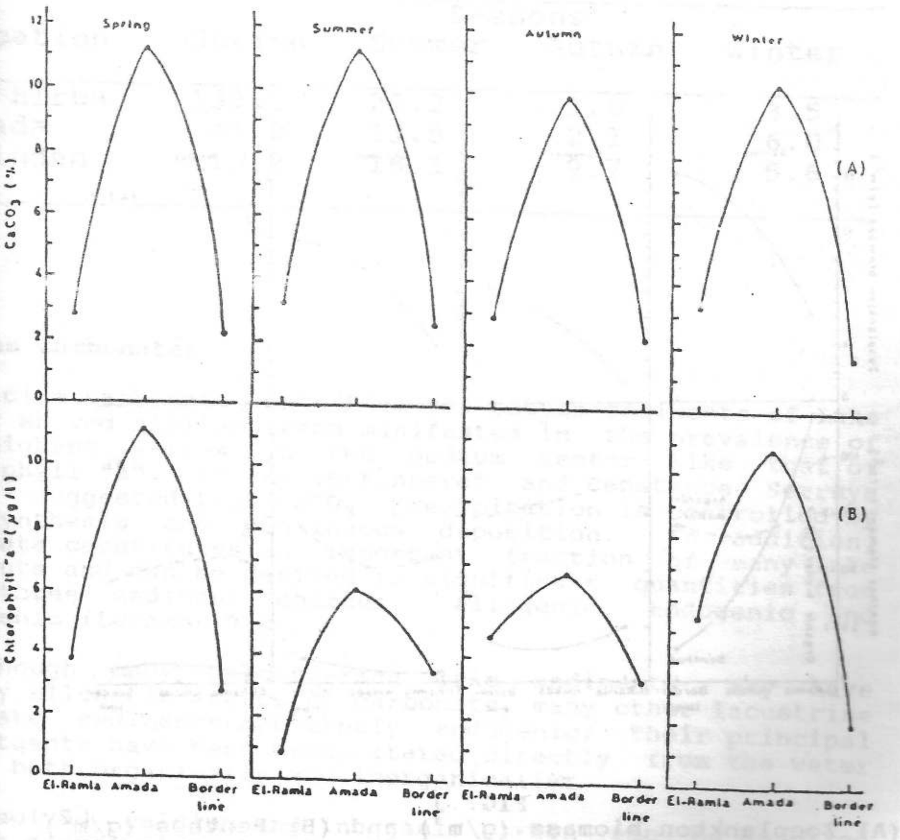

FIG. 2
Caicium carbonate in the bottom sediment (A) and chlorophyll "a" (B) in Lake Nasser water

Table 2
Zooplankton biomass (g/m^3) in Aswan High Dam Reservoir during 1981-1983

Location	Seasons Spring	Summer	Autumn	Winter
El Birba	6.1	1.5	4.1	3.2
Amada	13.3	5.9	9.7	4.8
Adindan	16.4	8.3	11.8	5.5

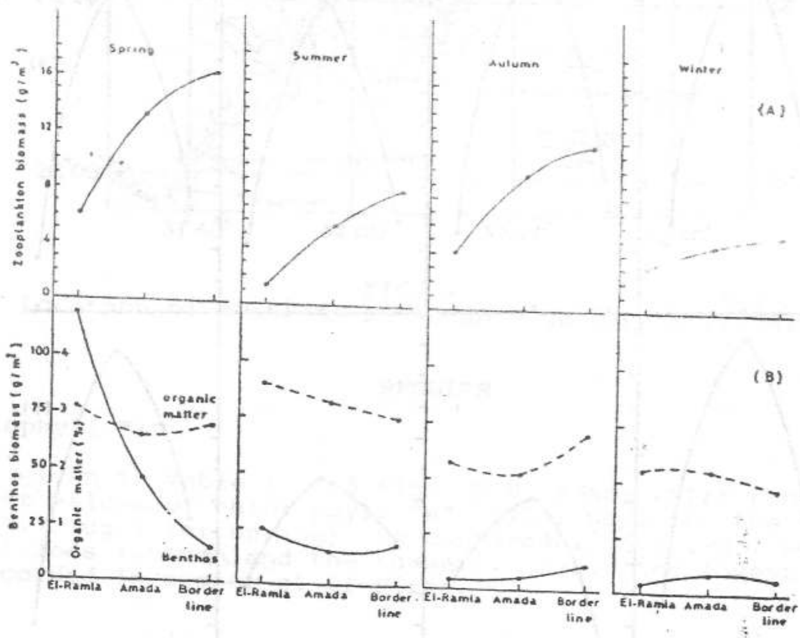

FIG. 3
(A) Zooplankton biomass (g/m^3) and (B) Benthos (g/m^2) and organic matter (%) in the sediments of Lake Nasser

enthos:

The benthic animals in the sediments of Lake Nasser nclude mainly oligochaete, worms, larvae of insects and ivalve molluscs. As shown in Table 3 and Fig. 3, the ncentration of the benthos in the spring was much more undant at El-Birba than either at Amada or at Adindan. In tumn, the highest benthos biomass prevailed at Adindan llowed by Amada, while the least value was recorded at -Birba.

Table 3
Benthos biomass (g/m^2) in Aswan
High Dam Reservoir Sediment (1981-1983)

Location	Seasons			
	Spring	Summer	Autumn	Winter
El Birba	139.5	25.2	1.0	3.5
Amada	44.0	13.8	2.1	6.0
Adindan	13.2	16.1	9.7	5.6

lcium carbonate:

Calcium carbonate content of the bottom sediments of Lake sser showed similar trend manifested in the prevalence of e highest values in the medium sector like that of lorophyll "a". In Lakes Kinneret and Constance, Serruya 971) suggested that $CaCO_3$ precipitation is controlled by otosynthesis and continuous deposition. In addition, rbonate constitutes an important fraction of many lake diments and can be derived in aignificant quantities from e three sediment sources; allogenic, endogenic and thigenic (Lerman 1978).

Although many calcite-rich lake sediments may have rgely allogenic source of carbonate, many other lacustrine rbonate sediments are truely endogenic; their principal nstituents have been precipitated directly from the water lumn both organically and inorganically.

Dissolved calcium and inorganic carbon can be supplied rough dissolution of older carbonate rocks in the drainage ea, or by hydrolysis/carbonation reactions with calcium aring silicates.

Besides requiring a source of sufficient calcium and dissolved carbonate for precipitation, numerous factors within the Lake can affect the solubility and thus precipitation of carbonate. Both organic and inorganic mechanisms are believed responsible for carbonate precipitation. Inorganically, the effect of temperature and CO_2 on solubility of the calcite was noticed by Kindle (1929). Higher water temperature, characteristic of shallow water favors precipitation through decreased solubility of both $CaCO_3$ and CO_2. In Lake Nasser, Elewa (1976) mentioned that no carbonate could be detected in the bottom water in the warm and hot months of April and July, while concentration of 11.6 and 8 mg/l were recorded in cold seasons viz. November and January.

In the Aswan High Dam Reservoir sediments, the highest values of $CaCO_3$ were recorded at Amada (9.99 - 11.27 %) compared with 1.71 - 2.61 % and 2.81 - 3.37 % at Adindan and El-Birba, respectively. Generally, the $CaCO_3$ content in the sediments was higher during winter and spring than in autumn and the summer (Table 4 & Fig. 2). Thus, according to Lerman (1978), the relative role of organic and inorganic processes in determining the nature of lacustrine carbonate has not been entirely sorted out. *Plants and planktonic algae are well known* for their ability to extract CO_2, raise pH and thus promote precipitation of carbonate. Phytoplankton production can be a major factor in the precipitation of calcium carbonate. Among others, Wetzel (1966) referred to colloidal carbonate precipitation resulting from organic productivity.

According to Golterman (1975), carbonate from the sinking dead material is partially converted into CO_2. Furthermore, when the oxygen is depleted, fermentation processes may occur yielding organic compounds. Finally, part of the carbon may even be reduced to methane. On the other hand, the CO_2 produced will lead to a lower pH value which may cause dissolution of $CaCO_3$. In Lake Nasser, the free CO_2 in the bottom water fluctuated between 0.0 - 3.3, 0.95 - 2.4, 0.0 - 3.2 and 0.0 - 1.7 mg/l during April, July, November and January, respectively compared with the zero value in the surface layers. At the same time, the pH values of Lake Nasser varied for the bottom water from 7.96 - 8.16, 7.58 - 7.58, 7.58 - 7.85 and 7.73 - 8.16 for the above months, respectively compared with the surface water (8.33 - 9.25, 8.45 - 9.13, 7.85 - 8.98 and 7.85 - 8.42, respectively). In addition, in calcium rich waters calcium carbonate may precipitate as the pH rises during photosynthesis. The precipitate will sink untill it reaches the layers at the bottom with lower pH values resulting from CO_2 release, where it will dissolve again. The process may take place near the mud and can not therefore be distinguished from direct dissolution of $CaCO_3$ from the mud. Finally, the mediam part is known by its high productivity (Feed, Personal communication). The lowest value of the northern part may have been resulted from the fact that it is the deepest part of the Lake and characterized by the presence of the least thick oxygenated layer in the summer.

Table 4
Calcium carbonate (%) in the sediment of Lake Nasser

Location	Seasons			
	Spring	Summer	Autumn	Winter
El Birba	2.81	3.28	2.97	3.37
Amada	11.26	11.27	9.99	10.44
Adindan	2.22	2.61	2.23	1.71

Needless to mention that the maximum value of $CaCO_3$ in Lake Nasser is much lower than that of the shallower more productive natural lakes of Egypt, as Lake Maruit where $CaCO_3$ content ranges from 14.8 to 68.8 % (El-Wakeel and Wahby, 1970).

Organic Matter:

In the marine sediments, the organic carbon ranges between less than 0.1 % and 30 % and is used as an index of the amount of food available to benthic animals or as an indication of the amount and type of food setting to the sediments from the water column (Ballinger and Mckee, 1971 and Byers et al., 1978). At the same time, Round (1958) showed that Ca, pH and organic matter of the sediments could be used as nutrient index. Decomposition of organic material exerts oxygen demand, releases nutrients and contributes with H_2S and methane to water (Sylvester & Anderson, 1964). Thus, decomposition of the organic matter and the attendant oxygen demand are the result of the microbiological activity. Zobell (1946), distinguished between reducing intensity (measured by the redox potential) and reducing capacity (the rate of O_2 uptake).

The activities of animals in the deposits are often overlooked. Many invertebrate groups are represented with insect larvae, Mollusca and Oligochaete worms quantitatively predominant. Like earthworms, their feeding activities result in a through "working" of the sediments, help to break down organic matter and account for the absence of stratification in many deposits (Alsterberg, 1922).

Only a few specialized species (e.g. some chironomid larvae and Tubifex) can adapt themselves to the low oxygen content prevalent at the mud surface in shallow lakes in summer.

The distribution of species, numbers and weights with water depth is closely related to plant cover, particle size, and organic content of the deposit and the oxygen conditions in the hypolimmion. As with plankton production, high productivity is generally only found in shallow lakes. These bottom organisms form a part of food of the fish.

In Lake Nasser sediments, the organic matter fluctuated between 1.96 % and 2.23 %, 2.68-3.11, 3.03-3.62 and 2.18-2.87 % in spring, summer, autumn and winter, respectively. Generally, the highest values of organic matter recorded in the northern section were followed by or decrease towards the south (Table 5).

In conclusion, only the calcium carbonate concentration in the bottom sediment of Lake Nasser can be indirectly helpfull in prognosing the primary productivity of the lake.

Table 5
Organic matter (%) in the bottom sediments of Lake Nasser during 1981-1983

Location	Seasons			
	Spring	Summer	Autumn	Winter
El Birba	2.23	3.11	3.62	2.36
Amada	2.22	2.68	3.39	2.18
Adindan	1.96	2.85	3.03	2.87

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