PRIMARY PRODUCTIVITY AND BIOMASS OF LAKE MANZALAH, EGYPT

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Abstract: The monthly distribution of C^{14} primary production and chlorophyll a standing crop of phytoplankton population in lake Manzalah (Egypt) were studied during the period from December 1981 to June 1982. The results showed that the lake is highly productive. The average primary productivity ranged from 42.83 to 127.03 mg $C/m^3/h$. The average chlorophyll a in the surface water of the lake varied between 12.66 mg chl/m^3 and 32.38 mg chl/m^3.

INTRODUCTION

Lake Manzalah is economically the most important delta lake in Egypt. On account of its large surface area (about 1200 km^2) and its high productivity, the total fish catch from the lake comprises more than 50 % of the total catch from the Nile delta lakes. The lake occupies the north eastern area between Damietta branch of the Nile and the Suez Canal (see chart Fig. 1). The lake is shallow, average depth about 1.25 m. It is traversed by numerous sandy and clayey islets which renders water circulation difficult and divides the lake into several nearly isolated basins (Fig. 1).

On the northern side, the lake is connected to the Mediterranean Sea through El-Gamil outlet, near Port Said and to the Damietta estuary by El-Souffara and El-Ratama canals near Damietta; through these outlets, the exchange of water and biota between the lake and the adjoining Mediterranean Sea is rendered possible, many of the marine fishes enter the lake for feeding. In the southern and eastern sides of the lake open several agricultural drains and freshwater canals which convey about 6650 x 10^6 m^3 annually into the lake. The major part of this amount i.e. 78 % is discharged by Hadus, Ramses and Bahr El-Baqar drains. The water of the latter drain is heavily polluted by sewage and industrial wastes. On the western side, El-Inaniya canal discharges 156 x 10^6 m^3 of Nile water i.e. 2.3 % of the total discharge into the lake. Previous work on the primary production and chlorophyll biomass in lake Manzalah is completely lacking; the present paper deals with the spatial and monthly variations of chlorophyll biomass and C^{14} primary production in the lake. This work is part of a research project on "Fishery Management of Lake Manzalah" sponsored by the U.S. Agency for International Development.

MATERIAL & METHODS

Throughout the period from December 1981 to June 1982 chlorophyll a was determined monthly from about 50 station while C^{14} experiments were made on a maximum of 25 station in each month [1]. Chlorophyll a was determined spectrophotometrically[2] on the acetone homogenate of 500 ml of surface lake water filtered on Millipore filters (0.45 u). Primary production was determined by the C^{14} method using a deck-tube incubator at natural day light (simulated in situ) the activity of the

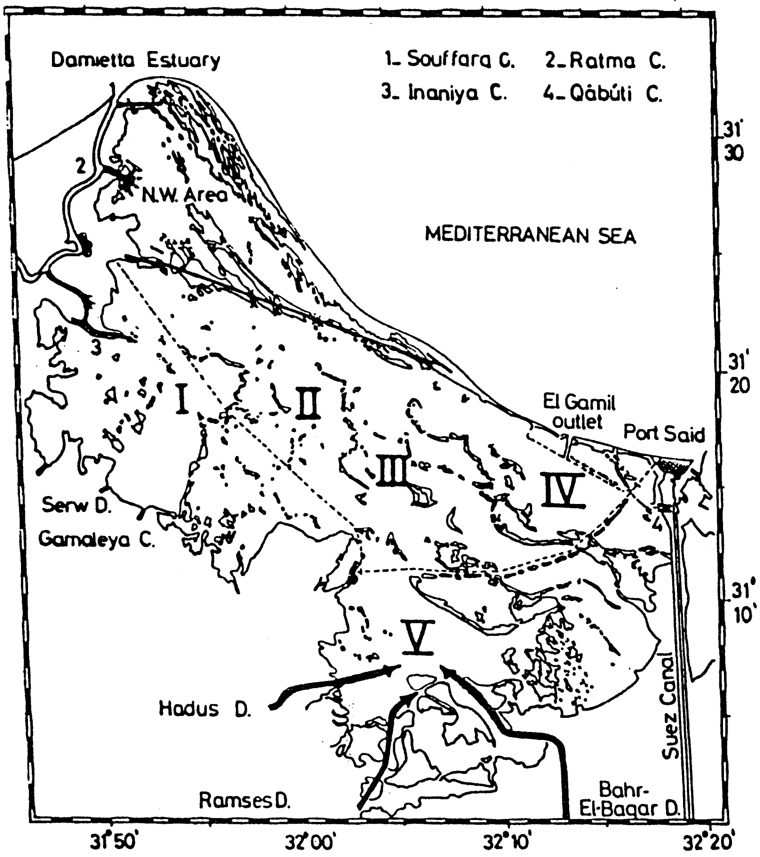

Figure 1- Map of lake Manzalah

Millipore filters (0.45 µ) was measured using a Packard Liquid Scintillator (Model 3255 TRI. CARB. L.S.).

In the present study the lake is treated as two distinct regions which are well defined physiographically i.e. the north western region and the lake proper; the latter comprises the greater part of the lake and is subdivided into five ecological zones according to the relative effect of fresh, brackish and marine water, each of these zones may be defined by the presence of more or less continuous rows of islets.

RESULTS AND DISCUSSION

Table 1 summarizes the monthly average concentrations of chlorophyll a and the important physicochemical characters prevailing in the north western region of the lake. As clear from the salinity variations this environment represents a truely marine habitat in which periods of high salinity, probably caused by evaporation of marine water, alternated with periods of lower salinity caused by the northward flow of brackish water from the lake proper.

The average chlorophyll biomass in that region (Table 1) is significantly lower than that of lake proper (Table 2). It seems that the

Table 1: Monthly averages of Salinity, Phosphate, Nitrate, Ammonia and Chlorophyll a in the North Western region of the lake.

	Dec.	Jan.	Feb.	March	April	May	June
Salinity %	41.56	45.15	43.26	37.56	35.43	32.40	38.57
PO_4-P	3.71	3.62	5.83	2.36	0.13	0.22	0.17
NO_3-N	6.76	3.92	0.66	13.54	2.04	0.08	0.05
NH_3-N	4.85	0.18	3.65	1.19	3.03	1.81	2.12
Chlorophyll a	8.53	16.86	4.6	1.38	3.42	2.04	27.85

high salinity in this region does not favour the development of high phytoplankton crop. Furthermore, the major supply of dissolved inorganic nutrients in that region is mostly derived from autochthonous regeneration from bottom sediments. The dynamics of this process seems to be highly complicated in that system. The maximum chlorophyll standing crop (27.85 mg chl/m^3) was recorded in June. This peak occured under conditions of minimum phosphate and nitrate concentrations. A winter rise is also observed in January and coincided with the period of high salinity, high phosphate and nitrate concentrations. The dynamics of phytoplankton bloom in this region and its relation to the ambient conditions are highly complicated and need further investigation.

The average salinity of the lake proper is much lower than that in the north western region and represents brackish water environment where the extreme salinity values varied between 0.81 % and 7.47 % . Furthermore, spatial and monthly variations in salinity were much less pronounced; the average values varied between 2.06 % in April and 2.7 % in February.

Table 2: Monthly average chlorophyll a mg/m^3 in the different zones of the lake proper.

	I	II	III	IV	V	Mean
December	5.8	12.02	21.72	17.38	17.47	14.88
January	7.54	12.23	17.51	11.39	14.65	12.66
February	19.40	14.49	62.13	27.86	44.02	32.38
March	7.54	4.46	41.56	27.89	42.98	24.88
April	8.58	13.91	34.52	24.70	44.32	25.20
May	12.94	7.08	17.17	9.29	33.19	15.93
June	4.42	3.75	11.60	29.35	66.26	23.07
mean chl a	9.46	9.70	29.45	20.26	37.55	21.248
mean PO_4-P	3.53	3.35	4.06	4.23	6.76	4.386
mean NO_3-N	4.88	3.92	9.48	3.28	7.57	5.826

Table 2 summarizes the average values of chlorophyll a recorded in different zones of this region during the period of study. The mean chlorophyll a biomass amounted to 21.248 mg chl/m^3. A pronounced peak (average 32.38 mg chl/m^3) was recorded in February; high values were also recorded in March, April and June. During these months the concentration of dissolved inorganic nutrients were also high. In December and January, on the other hand, although the concentration of nutrients were also relatively high, the chlorophyll biomass was remarkably low. The low phytoplankton crop during this period is mostly due to intensive grazing by filter feeders. In December the rate of C^{14} assimilation was relatively high (Table 3) and the average assimilation number was 5.4 which represents the maximum value recorded during the period of study. The average chlorophyll a concentration in the lake proper varied widely in the different zones. Zone I and II assumed the lowest averages. The highest values were, on the other hand, recorded in zones III and V as shown in Table 3. These variations may be correlated with the corresponding variations in the concentrations of disolved inorganic phosphate and nitrate.

Table 3: Monthly average C^{14} primary production mg $C/m^3/h$ in the different zones of the lake proper

	I	II	III	IV	V	mean
December	20.97	60.26	141.3	145.14	30.53	80.24
February	9.51	15.35	232.22	58.13	319.93	127.03
March	4.25	14.05	102.36	51.07	99.19	54.18
April	16.38	26.85	48.64	16.06	106.26	42.83
May	23.06	12.24	34.08	9.53	259.20	67.62
mean	14.83	25.75	111.72	55.98	163.02	74.38

The average results of C^{14} assimilation are shown in Table 3. During the period of study the average rate of C^{14} uptake in the lake proper amounted to 74.38 mg $C/m^3/h$. A remarkable peak (average 127.03 mg $C/m^3/h$) was recorded in February and coincided with the chlorophyll peak observed in the same month.

The average primary productivity in zone I was remarkably lower than in the other zones (Table 3). On the other hand the maximum average of C^{14} assimilation was recorded in zone V. Zones III and IV also assumed high values. Comparing the mean zonal values shown in tables 2 & 3, it is obvious that the pattern of the variations in the chlorophyll biomass generally follows corresponding variations in C^{14} uptake. However the average assimilation number varies widely in the different zones being higher in zones V, III and IV respectively.

The present study revealed that the eastern part of the lake comprising zones III, IV and V is the most productive region. The average C^{14} uptake in this region amounted to 1320 mg C/m^3/day, the corresponding average rate of C^{14} assimilation in zones I, II was 243.5 mg C/m^3/day. In other words the eatern region is five times more productive than the western region. As a matter of fact most of the fishery of Lake Manzalah is concentrated in the eastern part (zones III, IV and V). The remarkable decrease in the biomass and primary production in the western region (zones I & II) is probably due to the low concentrations of available nutrients. The Nile water discharge to that region through Inaniya Canal is poor in disolved inorganic phosphate and nitrate. Furthermore, the drain water reaching that part may contain certain pollutants (Pesticides and herbicides) which may suppress the development of high phytoplankton crop.

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