Primary Productivity of Lake Manzalah, Egypt, using C^{14} technique

by

Mohamed A. Ibrahim

Institute of Oceanography & Fisheries, Anfoushy, Alexandria, Egypt

and

H. A. El-Reheim

ABSTRACT

The hydrographical and chemical conditions of Lake Manzalah, Egypt, are influenced by the surging in of saline water from the Mediterranean sea and are by no means stable. The average of the parameters studied during the month of February 1976 were as follows: chlorosity 0.957g/1, pH 7.82, dissolved oxygen 8.572 ppm, total alkalinity 204 ppm, and average productivity 182.5 $gC/m^3/h\pm$ (98.7).

الانتاجية العضوية الاولية لبحيرة المنزلة المصرية مقدرة بالكربون المشع

محمد أمين ابراهيم
قسم علوم البحار
جامعة قطر

حسين احمد عبد الرحيم
قسم علوم البحار
جامعة تكساس

ملخص

تعتبر بحيرة المنزلة من أكبر واهم البحيرات المصرية اذ ينتج منها حوالي ٥٠ بالمائة من كمية الاسماك المصادة في مصر .

وتبلغ مساحة البحيرة حوالي ١٢٠٠ كيلومتر مربع ومتوسط عمقها يبلغ ١٢٠سم . ونتيجة لاتصال البحيرة بكل من البحرين الأحمر والمتوسط واحاطتها بالاراضي الزراعية لذلك فالظروف البيئية في البحيرة تختلف من وقت لآخر نتيجة لتدفق المياه المالحة اليها من البحر المتوسط وكذلك مياه الصرف من الاراضي الزراعية المجاورة لها .

وبالرغم من أهمية هذه البحيرة للمصايد المصرية الا ان نصيبها من الدراسات العلمية الخاصة بالعلوم البحرية كان محدوداً جداً . لذلك فهذا البحث يهدف الى دراسة الظروف البيئية والانتاجية العضوية الاولية لهذه البحيرة كخطوة اولى نحو اجراء دراسة بيئية متكاملة عليها .

وقد استخدمت الطرق العلمية القياسية لقياس بعض العوامل الفيزيائية والكيميائية وكذلك استخدام الكربون المشع لقياس الانتاجية العضوية الاولية للبحيرة .

وقد اظهرت نتائج البحث ان الكلورة ٠,٩٥٧ جرام/لتر وان تركيز ايون الايدروجين هو ٧,٨٢ وان تركيز الاكسجين الذائب في الماء هو ٨,٥٧٢ جزء في المليون وان القلوية الكلية هي ٢٠٤ جزء في المليون . ولكنه يجب الاخذ في الاعتبار ان جميع القياسات السابقة تتغير في حدود ضيقة من وقت لآخر تبعاً للظروف المناخية .

وقد أظهرت نتائج تحليل ٢٥٣ عينة معالجة بالكربون المشع وكذلك عينات الاكسجين الذائب ان متوسط الانتاجية العضوية لهذه البحيرة يبلغ حوالي ١٨٢,٥ ملليجرام من الكربون/م٣/الساعة ـ مما يدل على ان البحيرة المذكورة تعتبر من البحيرات العالمية وفيرة الانتاجية مما يحتم زيادة الاهتمام بها من الناحية العلمية والاقتصادية ومقاومة اية محاولة لتغيير بيئتها او تجفيف اجزاء منها .

Introduction

Lake Manzalah is the largest of the Nile Delta lakes in Egypt. It covers some 1,200 square kilometers and is rectangular in shape. It is transversed by numerous islets dividing the lake into several basins. The lake is bordered to the north by the Mediterranean sea, to the south by cultivated land, to the east by the Suez Canal and to the west by the Damietta branch of the Nile river.

The chemical and hydrographical conditions of the northern region of the lake are subject to short-term changes due to the surging in of saline water through the connections of the lake with both the Mediterranean sea and the Suez Canal which are under the influence of wind and tidal actions. The southern region is affected by drainage water from cultivated land. Being shallow (1.2 m average depth), the lake does not show thermal stratification.

While the lake is a very important fishing ground, contributing about 50% of the annual total fish catch in Egypt, few hydrobiological and chemical studies had been carried out prior to the hydrographical and chemical investigations of El-Wakeel [1], and Wahby *et al.* [2]. The present study is an attempt to estimate the primary productivity of Lake Manzalah using the radioactive C^{14}.

Materials and Methods

Hydrographical and chemical conditions of the lake were investigated by El-Wakeel [1], who divided the lake into 14 stations covering its main basins. The same stations were occupied by the present authors during the month of February 1976, each station being occupied for only one day, as in Fig. 1.

At each station surface water samples were incubated in BOD bottles suspended from a horizontal rope. The BOD bottles were suspended evenly at four equal distances from the surface down to the bottom of the water column. At each depth level three light and two dark BOD bottles containing the carbon isotope solution, as well as three light and two dark oxygen bottles, were likewise suspended from the rope for a period of 5-6 hours around midday.

At the end of each *in situ* incubating period dissolved oxygen in the oxygen bottles was immediately fixed, while the radioactive-containing samples were fixed by 5% neutralized formalin for filtration in the land-based laboratory after 2-3 hours of fixation.

Chlorosity of the water samples was determined by the Mohr method, pH by a portable pH meter accurate to the nearest 0.05 units, and transparency by a standard Secchi disk. Primary productivity was measured *in situ* according to Strickland and Parsons [3], using both the dissolved oxygen and the radioactive C^{14} technique, where dissolved oxygen was measured by the classical Winkler method. C^{14} activity was measured by both Geiger Muller counter and liquid scintillation techniques. Total alkalinity was determined volumetrically using phenolphthaline and methyl orange-bromcresol green indicators.

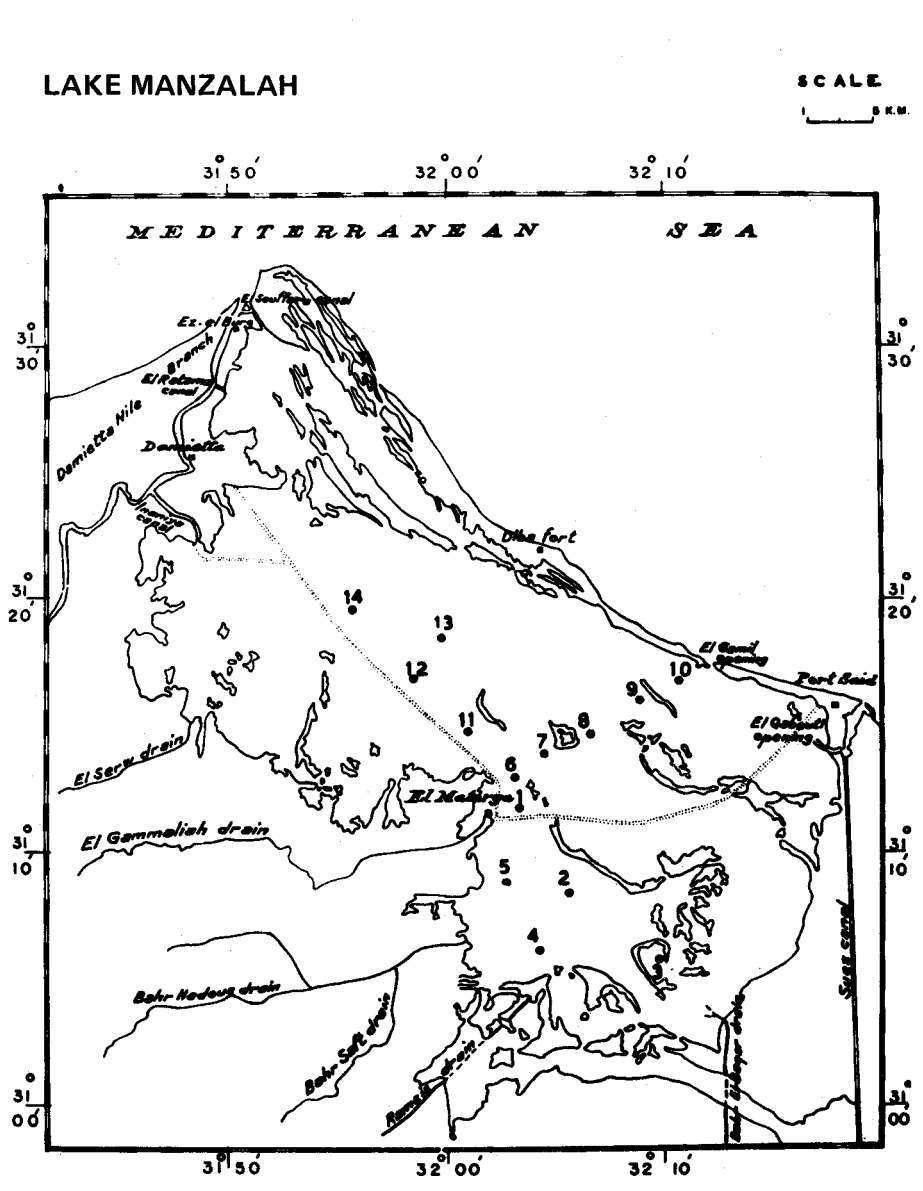

Fig 1: Position of the stations occupied during February 1976 (after El-Wakeel, 1970)

TABLE 1
Hydrographical and Chemical Conditions of Lake Manzalah, Egypt, during February 1976

Station Number	*Chlorosity (gm/l)*	*pH*	*Dissolved Oxygen (ppm)*	*Total Alkalinity (ppm)*
1	0.788	7.80	7.76	210
2	0.640	7.65	8.75	188
3	0.338	7.60	8.70	194
4	0.419	7.50	8.68	184
5	0.565	7.65	9.60	172
6	1.291	7.80	8.20	206
7	1.131	7.90	8.25	236
8	1.063	7.85	9.12	237
9	1.871	7.95	9.73	168
10	1.907	8.05	8.08	255
11	1.365	7.95	9.92	150
12	0.564	8.00	7.41	214
13	0.870	7.90	7.93	236
14	0.583	7.90	7.88	212
Mean	0.957	7.82	8.572	204
St. D.	0.505	0.16	0.782	31
St. error	0.135	0.043	0.209	8.285

Results and Discussion

Table 1 represents some of the hydrographical and chemical parameters of the lake. The values presented in the Table do not represent a stable picture for future years because most of the parameters are subject to sudden changes due to wind and tidal action, especially at Station Nos. 9 and 10.

The average chlorosity of Lake Manzalah during the month of investigation was 0.957 gm/1, ranging from 0.338 at Station No. 3 to 1.907 gm/1 at Station No. 10. The pH values ranged between 7.50 at Station No. 4 to 8.05 at Station No. 10, with an average of 7.82 for the 14 stations investigated.

El-Wakeel in his study [1] showed a slight difference between surface and bottom waters of the lake. In the present study no significant difference was noticed in this regard probably because of the complete mixing of the water column during the winter months of the year due to wind action. The same finding holds for dissolved oxygen and total alkalinity, where they averaged 8.572 ppm and 204 ppm respectively.

TABLE 2

Productivity of Lake Manzalah, Egypt, during February 1976 as Estimated by Three Techniques

Station Number	Productivity (mg C/m³/h)		
	Geiger Muller Counter	Liquid Scintillation	Dissolved Oxygen
1	51.022	63.101	138.014
2	104.991	102.044	106.887
3	136.811	157.861	103.848
4	74.963	53.781	171.515
5	131.111	144.192	162.165
6	157.643	168.213	177.231
7	305.100	380.898	419.198
8	346.146	499.003	148.744
9	181.132	244.998	201.545
10	295.324	251.111	230.222
11	110.124	204.899	122.777
12	150.103	125.051	186.214
13	232.411	255.989	226.913
14	110.632	115.643	106.321
Mean	170.537	198.270	178.757
St. D.	90.591	124.520	81.060
St. error	24.211	33.279	21.664

Productivity Measurement

Out of 300 water samples incubated with the carbon isotope solution, only 253 were used to calculate the values shown in Table 2. Each water sample was filtered through three membrane filters to avoid clogging by silt.

The activity on each filter was measured first by the Geiger Muller counter and then by the liquid scintillation technique. The average activity for the respective stations was obtained from all water samples at the different depth levels. Then the productivity was calculated according to Strickland and Parsons [3].

Variance Analysis

The standard statistical methods for comparing two groups of equal sizes at 0.05 probability level were applied on Table 2 to compare the productivity values estimated by the three techniques, namely liquid scintillation, Geiger Muller, and dissolved oxygen. When comparing the liquid scintillation values against those obtained from the dissolved oxygen method the following results were obtained:

$$\text{Pooled variance} = \frac{124.52 + 81.06}{26} = 7.907$$

$$\text{Standard error} = \sqrt{\frac{2\,(7{,}907)}{14}} = 1.063$$

$$t = \frac{198.27 - 178.757}{1.063} = 18.357$$

The high value of (t) indicates that the values obtained from the liquid scintillation technique are 10.90% higher than those obtained from the dissolved oxygen method.

Likewise, when comparing the values obtained from the liquid scintillation technique against those from the Geiger Muller counter, a (t) of 25.513 was obtained, indicating that the values obtained by the first technique were 16% higher than those of the second method. It was also found that the values obtained from the oxygen method were 4.8% higher than those of the Geiger Muller counter due to a (t) of 8.465.

The productivity data presented in Table 2 indicate that the minimum values obtained by the three techniques are those of Stations 1, 3, and 4. This is most likely due to the nearness of land masses which increase turbidity and decrease light penetration. On the other hand, Stations 7 and 8 showed the maximum productivity. This is probably due to the fact that they are situated in a transitional zone between water masses of high and low salinity and the fact that they are less affected by turbidity than the previously mentioned stations.

Conclusion

Lake Manzalah is affected by the surging in of saline water which has an effect on its hydrographical and chemical conditions. These effects are by no means stable, depending on the tidal and wind actions and the drainage of fresh water from nearby cultivated land. The average chlorosity of the lake is 0.957 g/l, the average pH is 7.82, and the average total alkalinity is 204 ppm. The mean productivity obtained from the three methods is 182.5 $mgC/m^3/h$, with a standard deviation of ± 98.70 indicating that Lake Manzalah is a highly productive lake.

Summary

Lake Manzalah is the largest of the Nile Delta lakes in Egypt, covering 1,200 square kilometers, and it has no thermal stratification. It contributes about 50% of the annual fish catch in Egypt. Even so, few hydrobiological studies have been carried out on the lake. It is affected by the surging in of saline water from the Mediterranean sea which interferes with its hydrographical and chemical conditions.

The present study gives the following averages for the parameters studied during the month of February 1976: chlorosity 0.957 ppm, pH 7.82, dissolved oxygen 8.572 ppm, total alkalinity 204 ppm and average productivity 182.5 $mgC/m^3/h\pm$ (98.7).

The results showed that the estimates of productivity obtained from the liquid scintillation analysis were 11% higher than those by the dissolved oxygen method, while the former was 16% higher than those of the Geiger Muller counter.

REFERENCES

1. S. K. El-Wakeel and S. Wahby, 'Hydrography and Chemistry of Lake Manzalah, Egypt', Arc. Hydrobiol., *67*, (2), 173-200 (1970).
2. Saad D. Wahby, Samy F. Youssef and Nabila F. Bishara, 'Studies on the Hydrography and Chemistry of Lake Manzalah', Bull. Inst. Ocn. & Fish., Cairo, *2*, 399-422 (1972).
3. J. D. H. Strickland and T. R. Parsons, 'A Manual of Sea-Water Analysis', Bull. Fish. Res. Bd., Canada, *125*, 311 (1965).