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ECOLOGICAL STUDIES ON PHYTOPLANKTON IN CLOSED LAKES OF WADI-EL-NATRON

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ABSTRACT

Ecological study was carried out on the four closed Lakes Located at Wadi-El-Natroun, Behera Governorate. Water samples were collected during the four seasons of a year. Physical properties of water in the four lakes were measured in situ, while the other chemical and phytoplanktons determinations of the four lakes were carried out at N.R.C.

Considering the chemical properties of the four lakes under study: pH was alkaline. Alkalinity was different for the different seasons in the four Lakes; the volume of water body never dries up in Humra and Gaar Lakes while dried completely in El Beida Lake at summer season. The nitrogen forms in water of these closed lakes were relatively higher, as ammonia and nitrate was high reached maximum in El-Khadra and El Gaar Lakes.

The obtained results showed that the highest total count of phytoplankton was found in El-Khadra Lake., followed by El-Oida lake then El-Gaar lake, and it was higher in the winter and autumn. Diatoms were the dominant phytoplanktons in El-Gaar and El-Oida Lake, while blue-green-algae were dominant in El-Khadra Lake.

The N_2-fixing blue green alga *Spirulina sp.* was dominant in El-Khadra closed lake, with high tolerence to salt stress, as well as high content of crude protein and low content of heavy metals. This organism can be recommended to be used as a good biofertilizer for virgin sandy soil, during its reclamation.

Introduction

The most important function of phytoplankton is its primary productivity, using solar energy and CO_2 in the synthesis of biologically useful carbohydrates by the process of photosynthesis. Two major factors influence the distribution of phytoplankton primary production according to Arao & Yamada (1989).

Light and inorganic mironutrient supply are absorbed as it penetrates water, at the depth where the light intensity has dropped to about 1% of its intensity surface, the rate of algal photosynthesis drops below the level needed to sustain cell growth (Harborne, 1973). The importance of micronutrients required by the phytoplankton include the following: nitrogen (as nitrates or ammonium), silicon (required in quantity only by diatoms for their silicaceous cell walls), and various metals such as iron and copper in trace amounts. Nitrogen and phosphors are in the shortest relative supply in most waters, and their relative lack sets the limit on phytoplankton growth (Binnerup *et al.*, 1992).

The aim of this paper is to evaluate the effect of ecological factors dominating at wadi-El-Natroun desert region on the phytophanktonic growth in the closed lakes of wadi-El-Natroun.

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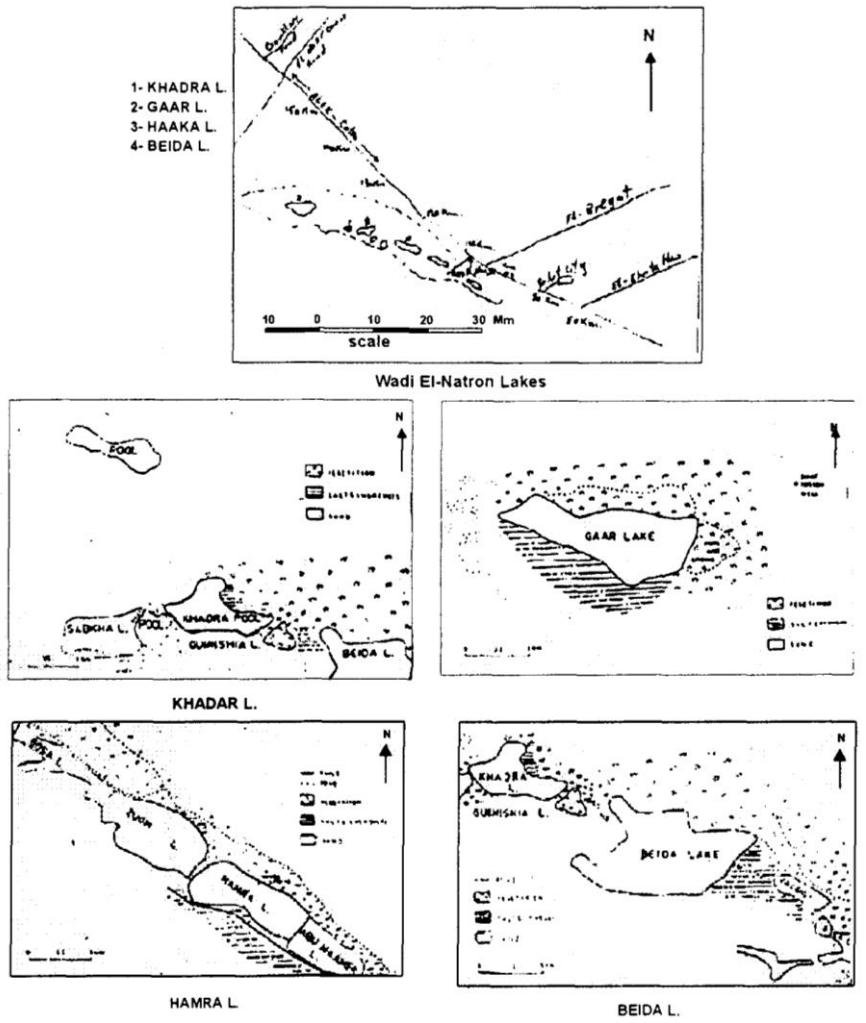
Materials and Methods

Water samples ware collected seasonally from four closed lakes at wadi El-Natroun El-Behera Governorate. Namely: El-Khadra, El-Gaar, El-Hamra and El-Beida lakes during the four seasons of the year 1998 – 1999. These water samples were collected below the surface (30 cm) at the mid-lakes. Two separate major groups of water samples were collected from each location of study; the first group was collected in sterilized plastic bottles of 2 LTRs for detemination of pH, E.C. and phytophusktons count. The other water sample group 5 LTRs were colected for chemical analysis.



Wadi El-Natron Lakes

A – Microbiological determinations:

1- phytoplankton counts were conducted using of fein – optik haemocytometer method (A.B.H.A., 1992).

2- phytoplankton types were identified microscopically according to Homes & Whitton (1981a).

B- Physical analysis:

1- Temperature: by using glass thermometer. According to Allen *et al.* (1974) .

2- Opacity by using Scecki disk (25. Cm in diameter), according to Allen *et al.* (1974).

C- Chemical analysis:

1- pH value was measured using a Beckman protable pH meter (A.P.H.A., 1992).

2- Electrical – conductivity was determined by means of portable conductivily meter (A.P.H.A., 1992).

3- Ammonical nitrogen was determined colorimetrically using Nessler's Reagent (A.P.H.A., 1992).

4- Nitrate was determined colorimetrically by spectrophotometer (420 Mμ wave length). According to Binnerup *et al.* (1992).

5- Total Nitrogen was determined by the micro – kjeldahl method (A.B.H.A., 1992).

D- Determination of the Mass production of *Spirulina sp.*

1- Crude protein: Protein was determined according to Coombs *et al.* (1987).

2- Total carbohydrates: Total carbohydrates were determined after the complete acid hydrolysis of 0.1 gram air – dired homogenized samples (Fischer & Dorfel, 1955).

3- Total lipids: Lipids were extracted with chloroform and methanol (2:1 v/v) in a soxchlet apparatus. The solvent was evaporated in a rotatory evaporator. The dried residue was considered as the total lipid and expressed as percentage of dry weight (Holme & Hazel, 1983).

4- Total minerals content: The minerals content was determined by ignition of one gram dry matter in electric muffle furnace at 600 °C. according to Abd EL-Shafy (1992).

E- **Heavy metals ofdry algal mass:** Algal mass were determined using the flame photometer (A.P.H.A., 1992).

Results & Discussions

Physical properties of closed lakes

The tabulated results of water temperature and opacity of the four closed lakes under study (Table1) show that the water temperature of the lakes varied during the four seasons of the year. It reached maximum (28-30°C), during the summer season, while the lowest was during the winter season as it reached 15-16°C.

Table 1. Physico-chemical analysis of Wadi-El-Natroun closed lakes from October 1998 to the end of 1999.

Biological determination / Locations		PH Value	E.C. m.moh/Cm	N-NH_4 Mg/L	N-NO_3 Mg/L	Total-N Mg/L	Temp. °C	Opacity Cm
El-Khadra lake	Aut.98	7.3	8.1	0.42	0.16	0.85	24	100
	Win,99	7.0	8.5	0.50	0.24	0.98	16	85
	Spr.99	8.1	10.1	0.33	0.36	0.76	25	165
	Sum.99	8.6	11.8	0.68	0.35	0.84	27	190
ElGaar lake	Aut.98	9.0	7.95	0.21	0.80	0.40	23	300
	Win,99	9.3	7.10	0.32	0.70	0.56	16	350
	Spr.99	9.28	7.20	0.35	0.80	0.65	24	320
	Sum.99	9.32	7.23	0.37	0.29	0.73	28	270
El-Hamra lake	Aut.98	8.8	0.85	Nil	Nil	0.01	23	280
	Win,99	8.7	1.25	Nil	Nil	Nil	16	295
	Spr.99	8.5	0.46	Nil	Nil	Nil	19	300
	Sum.99	8.7	0.68	0.02	Nil	0.05	28	265
El-Beida lake	Aut.98	12.2	152.4	Nil	Nil	Nil	26	90
	Win,99	10.5	110.8	Nil	Nil	Nil	18	100
	Spr.99	11.35	140.0	Nil	Nil	Nil	22	35
	Sum.99	Dry	Dry	Dry	Dry	Dry	Dry	Dry

The opacity of the water body of the four lakes is indication of light penetration in water. The highest figure of opacity was recorded at winter (350Cm) in the El-Gaar closed lake, the lowest figure of opacity was 85 Cm recorded in El-Khadra Lake.The results of chemical analysis of water samples collected from the four closed lakes under study are shown in table 2. The pH of the water bodies of the four lakes varied greatly from one to another according to the salts load of the lakes.

The highest pH-value was recorded in El-Baida lake, during autumn season; as it reached 12.2, while the lowest value of pH (7.0) was recorded at El-Khadra lake during winter season.

The total Soluble Salts (TSS) of the water body of the four lakes were determined. It was found that the highest figure of T.SS was recorded in El-Baida lake during autumn, reached 152.4 m mohs / cm at 25°C; while the lowest figure was found in El-Khadra lake, reached during spring season, recorded 0.46 m mohs/Cm.

It is worthy to mention here that in El-Baida lake, during summer, high salinity in this lake was recorded and marshed were accumulated on the surface of the dried lake during summer .

The nitrogen transformations in the four lakes varied greatly according to the ecological, chemical and biological activity in the water body. It was found that the high salt content were in the lakes of El-Baida and El-Hamra lake. This high salinity lowered biological activity; as well as the N_2-fixing algae. The highest figure of ammonia in the water of the four lakes were recorded during the summer season in El-Khadra lake as it reached 0.68 ppm, (table 1) while the lowest figure was 0.21 ppm in El-Gaar lake during autumn season. As for as the nitrate content of the water body of the four lakes, it could be noticed that it was higher in each of El-Khadra and El-Gaar Lakes reached maximum of 0.8 ppm during autumn. The other two lakes have not any traces of nitrates, otherwise, El-Beid lake was dried completely during summer. The same trend was recorded concerning the total netrogen in the water body of the four lakes under study. These results are in accordance with the findings of Smith and Young (1953).

Table 2. Seasonal variations of Phytoplankton in Wadi-El-Natron Lakes from 1998 to end of 1999 (cell x $10^3 ml^{-1}$)

Biological determination / Locations		Diatoms	Green algae	Blue green algae	Total phytoplankitons
El-Khadra lake	Aut.98	0.38	0.24	3.45	4.50
	Win,99	0.45	0.25	3.25	4.80
	Spr.99	0.25	0.24	3.95	4.15
	Sum.99	0.20	0.28	2.85	4.95
ElGaar lake	Aut.98	1.20	0.30	1.00	2.80
	Win,99	2.70	0.60	1.80	3.46
	Spr.99	1.80	0.40	0.90	2.90
	Sum.99	2.90	0.70	1.60	3.50
El-Beida lake	Aut.98	2.00	0.20	0.30	2.50
	Win,99	2.90	0.30	0.50	3.70
	Spr.99	180	0.40	0.50	2.70
	Sum.99	1.70	0.20	0.20	2.10
El-Hamra lake	Aut.98	0.05	0.02	0.01	0.11
	Win,99	0.06	0.03	0.01	0.12
	Spr.99	0.05	0.03	0.02	0.11
	Sum.99	Dry	Dry	Dry	Dry

The results of seasonal variations of phytoplankton in wadi-El-Natroun lakes are shown in table (2). From this table, it could be noticed that the higher phytoplanktonic counts were recorded in two lakes only, namely El-Khadra and El-Gaar lakes, as the counts of total phyoptankion reached the highest of 4.95 and 3.5 x 10^3 cells ml^{-1}, at the summer season of the year 1999 in the two previously mentioned two lakes; respectively.

As far as the Diatoms counts, they reached the highest counts in El-Hamra lake, other than the three lakes under study. The highest figure in this lake 2.9 x 10^3 ml^{-1} was recorded during winter, 1999. On the other hand, the other lakes showed lower counts of these organisms. The lowest figure of Diatom (0.05 x 10^3 ml^{-1}) was recorded during spring,1999.

From the table (2), the green algae was found in all four lakes under study all over the year round, but the highest counts of these organisms were found in El-Gaar lake (0.70 x 10^3 cells ml^{-1}) during summer 1999. The lowest activity of these organisms were found in El-Beida lake reached the minimum (0.02 x 10^3 cells ml^{-1}) during autumn season of 1998. Concering the counts of blue – green algae in this lake (table 2), the highest activity of these organisns were found in lake El-Khadra reached maximum of 3.95 x 10^3 cells ml^{-1} during spring 1999, while the lowest acivity of these organism were found in El-Beida lake, as their counts not increased than the range of 0.01 – 0.02 x 10^3 cells ml^{-1} all over the year.

From the previous results of the types of phytoplanktion in the four lakes it was found that the blue – green algae (BGA) were the more active algae in El-Khadra lake. The identification of these organisms, indicated that *Spirulina sp.* was the dominant BGA.

Table 3. Chemical characteristics of *Spirulina platenses* Isolated from El-Khadra Lake

No	Detremenation	Results
1	Protein	63%
2	Carbohydrates	14%
3	Lipids	6%
4	Minerals	6%
5	Moisture	11%

(Table 4) Heavy Metals of *Spirulina* sp. (mass production) per ppm

No	Heavy metals	Results
1	Cadmium (cd)	0.04
2	Zink (zn)	0.08
3	Lead (pb)	0.01
4	Cupper (cu)	Nil

It is obvious from table (3), that the chemical characteristics of *Spirulina sp.*, the dominant BGA in El-Khadra lake, show that this organism has great ability to persist the stress of salt and drought environment in El-Khadra closed lake. Therefore this organism can fix atmospheric nitrogen, as the collected dry mats contains 63% crude protein as well as 6% lipids. Futhermore the collected mass of this BGA contains 14% carbohydrates and 6% minerals. These results are in agreement with the fading of the analysis of heavy

metals content in the dry matter of *Spirulina* mats (Table 4) show that these metals were very low than the permissable levels. This organism is dominant in El-Khadra lake, with high tolerence to salt stress in this lake and drought in this region of the western desert, with high content of protein and minerals.

Therefore, it could be recommended the use of this organism as biofertilizer because of its high content of protein as well as low content of toxic heavy metals. Thus it can be used in this region for reclamation of deseret sandy soils in Wadi-El-Natroun.

References

Abdel-Shafy, H.I. 1992. Concentration of metals in Little Mourrah Lake. *Intern.J. Environ. Studies,* **40: 99-101.**

Allen, S.; Grimshay, H.M; Parkinson, J. A. and Quarmbt, C. 1974. Chemical analysis of ecological materials *(Blackwell, Oxford)* **pp. 565 .**

American Public health Association (APHA) 1992. Standard Methods for Examination of Water and Wastewater. 16th Ed. AWWA WPCF. Washington.

Arao, T. and Yamada, M. 1989. Positional distribution of fatty acids in galactolipids of algae. *Phytochem.*, **28:805-810.**

Binnerup, S.J, Jensen, L.P., Revsbech, N.P., Jensen, M.H. and Soerensen, J. 1992. Denitrification, dissimilatory reduction of nitrate to ammonium, and nitrification in a bioturbated estuarine sediment as measured with 15N and microsensor techniques. *Appl. Environ. Microbiol.* **58: 303-313.**

Coombs, J., Hall, D.O., Long, S.P. and Scurlock, J.M.O. 1987. Techniques in Bioproductivity and Photosynthesis. Printed in great britain by A. Wheat on and Co. Ltd.

Harborne, J.B. 1973. Phytochemical Methods. A guide to modern techniques of plant analysis. *Chapman & Hall, London.* **pp. 288.**

Fischer, F.G. Dorfel, H. 1955. Die polyuronsouren der Braunalgen. Hoppe. *Seyler's Z. Physiol. Chem.* **302: 186-203.**

Homes, N.T.H. and Whitton, B.A. 1981a. phytoplankton of four rivers, the tyne, wear, tees and swale, dept. of Botany, University of Durham, Durham DHL 3LE, Great Britain.

Holme, D.J. and Hazel, P. 1983. Analytical Biochemistry 1st ed.: Longman, London & New York, **pp. 424.**

Smith, D.W. 1993 Ecological actions of sulfate reducing bacteria. In: Odom J.M., Rivers Singleton Jr (eds) the sulfate reducing bacteria: Contemporary perspectives. Brock/Springer press. New York. **Pp. 161-188.**

Smith, D.G. and Young, E.G. 1953. The nitrogenous constituents of *Fucus vesiculosus. J. Biol. Chem.*, **217: 845-853.**

دراسات بيئية على الهائمات النباتية فى بحيرات وادى النطرون المغلقة

محمد سعد على

المركز القومى للبحوث – قسم الميكرو بيولوجيا الزراعية – الدقى - القاهرة

أجريت دراسة بيئية على أهم أربعة بحيرات مغلقة موجودة فى منطقة وادى النطرون – محافظة البحيرة – ولذلك تم جمع عينات دورية من مياه هذه البحيرات الأربعة على مدار فصول السنةالاربعه وعلى عمق ٣٠ سم من السطح وقد تم أخذ التقديرات الفيزيقية على مياه البحيرات فى الموقع بقياس درجات الحرارة بترمومتر منوى والعتومة باستخدام قرص سيكى ونقلت باقى العينات للتحليل الكيميائى والميكرو بيولوجى إلى المعمل بقسم الميكروبيولوجيا الزراعية بالمركز القومى للبحوث.

أوضحت نتائج التحليل الميكروبيولجى لعينات المياه المأخوذة أن أعلى أعداد للهائمات النباتية وجدت فى بحيرة الخضراء تليها بحيرة الحمراء ثم الجعار وبلغت أعلى الأعداد لتلك الهائمات خلال فصلى الخريف والشتاء، كما لوحظ أن الدياتومات كانت سائدة فى بحيرات الجعار والحمراء، بينما سادت الطحالب الخضراء المزرقة فى بحيرة الخضراء فقط.

هذا وأوضحت التحاليل الكيميائية لمياه البحيرات تحت الدراسة والتى شملت رقم الأس الهيدروجينى والتوصيل الكهربى (E.C) وصور الأزوت المختلفة بهذه البحيرات أن تركيزات الأمونيا والنترات مرتفعة فى بحيرتى الخضراء والجعار مصحوبة بنشاط عالى من الهائمات النباتية والميكروبية.

وقد أوضحت الدراسة المستفيضة على بحيرة الخضراء لما بها من نشاط حيوى عالى وخاصة لطحلب الأسبريولينا الذى أظهر التحليل الكيميائى له إرتفاع محتواه من النيتروجين الكلى وبالتالى البروتين الخام بالإضافة لمحتواه العالى من الكربوهيدرات والدهون مع إنخفاض محتواه من العناصر الثقيلة السامه مما يمكننا بأن ننصح بتنمية هذه الهائمات النباتية فى أحواض محكمة بالموقع لإنتاج هذا الطحلب على مستوى تجارى يستخدم فى التسميد الحيوى للأراضى الصحراوية المجاورة للبحيرة بمنطقة وادى النطرون بمحافظة البحيرة.