Egyptian Academic Journal of Biological Sciences is the official English language journal of the Egyptian Society for Biological Sciences, Department of Entomology, Faculty of Sciences Ain Shams University .

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Citation: *Egypt. Acad. J. Biolog. Sci. (G. Microbiolog) Vol.9 (2)pp. 11- 20 (2017)*

Egypt. Acad. J. Biolog. Sci., 9(2): 11-20 (2017)

Egyptian Academic Journal of Biological Sciences
G. Microbiology

ISSN: 2090-0872
www.eajbs.eg.net

Studying of Physico-chemical and Biological characters of Qarun Lake, El-Fayoum – Egypt

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ARTICLE INFO
Article History
Received:13/7/2017
Accepted:17/8/2017

Keywords:
Qarun Lake
Physico-chemical Parameters
Phytoplankton

ABSTRACT

Lake Qarun is an inland lake occupies the lowest part of El-Fayoum depression. The sampling program during the studied period was carried out on monthly basis from May 2015 and continued till April 2016 (12 successive months). Physico-chemical analysis of Qarun Lake revealed that pH values recorded were on the alkaline side, values of Secchi disc indicated that the water of the lake concerned as a turbid water bodies. The alkalinity in Qarun Lake is characterized by increasing of bicarbonate values as compared with carbonate one. Nutrients analysis indicated increasing of ammonium, nitrate, nitrite, phosphate, silicate in the water of the lake especially in front of the drains. On the other hand a total of 89 species of phytoplankton belonging to six classes were recorded in the lake. The recorded classes were Bacillariophyceae, Cyanophyceae, Chlorophyceae, Euglenophyceae, Dinophyceae and Cryptophyceae,.The Bacillariophyceae were most diverse with 39 species, then Cyanophyceae with 18 species, Chlorophyceae and Euglenophyceae with 10 species for both, Dinophyceae with 9 species and Cryptophyceae with 3 species. Our study concluded that the increased nutrient level in the lake by time show an exacerbated problem of eutrophication which lead to economic effect on fish production.

INTRODUCTION

Qarun Lake is the only enclosed saline lake in Egypt. It is located in the western desert in the deepest part of El-Fayoum depression and lies at 83 km of south west of Cairo. It receives the agricultural drainage water from the surrounding cultivated land. This drainage water reaches the lake by two greatest drains namely, El-Batts and El-Wadi drains (Abou El-Geit *et al*., 2013). The lake has no connection to the sea; sustained directly by the Nile River through Bahr Yussef Canal (Abd El-Karim, 2012).The Lake is bordered from its northern side by the desert and by cultivated land from its south and southeastern side (Abdel-Satar *et al*., 2010). It has an elongated rectangular shape with average dimensions 45 km length, 5.7 km width and 4.2 m depth in average (Gohar, 2002), Flower *et al.* (2006) stated that Lake Qarun is currently saline, turbid (Secchi disc transparency usually <40 cm) and has no surface outflow.

Gradually increasing in salinity has accelerated reached 32–36 ‰ in 1975/76 (Boraey, 1980), then it was reached an average of about ~38 ‰ in the 1980s, being 45.31 ‰ in 1996 (Anonymous, 1997). In 2000, water salinity ranged from 41.04 to 45.79 ‰ (Abd El- Monem, 2001). Continuous water evaporation from such closed ecosystem increases concentration of salts, trace elements, pesticides and other pollutants is expected to change their quality and affect their food web. As a result this changes water quality and affects biology of the lake (Ali *et al*., 2008).

MATERIALS AND METHODS

Site description:

The lake is located between longitudes of 300 24` & 300 49`E and latitude of 290 24` & 290 33` N (Abou El-Gheit *et al*., 2012). The lake length from east to west is about 40 km, and the breadth at its widest point is about 6.7 km. It has a surface area of 243 km^2 and a volume of 924 million m^3 at 43 m below sea level (Anonymous, 1995).The deepest point (~8.3 m) is northwest of the island and the total water draining annually into the lake is about 395 million cubic meters (data supplied by the Irrigation Department, El-Fayoum), also approximately 4% of this drainage water is untreated sewage (Fathi and Flower, 2005).

Sampling stations:

The sampling program was carried out on monthly basis from May 2015 and continued till April 2016 (12 successive months). Four sampling stations were selected to cover the main difference in water quality of the lake that affected by the agriculture drainage water from El Bats at the east and El-Wadi drains at the middle of the lake (Figure1).

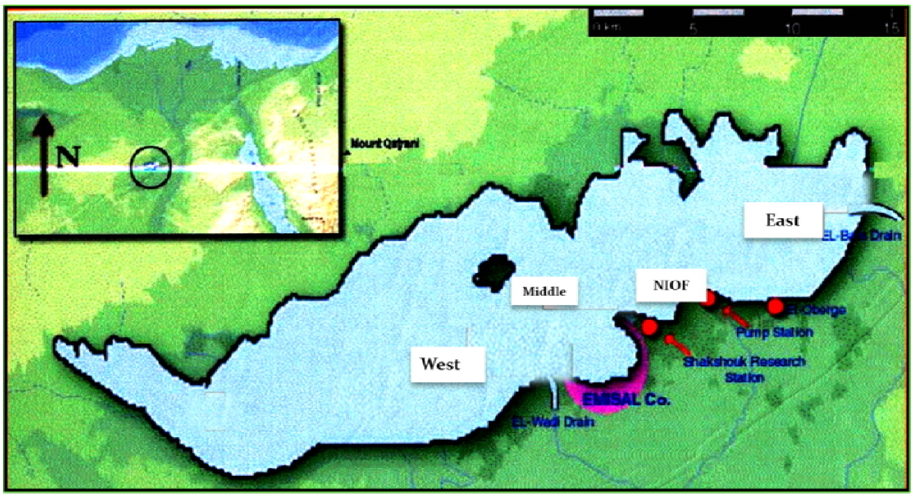

Fig. 1: Location of the Selected Stations at Lake Qarun, El Fayoum, Egypt.

Collection and Preparation of Samples:

Subsurface water samples were collected for physico- chemical parameters and biological characteristics from the four stations using Ruttner Sampler (1.5 L).

Physico-chemical parameters:

The physical and chemical parameters of water samples were determined according to the American Puplic Health Association standard methods (APHA, 1998). Air temperature was measured using thermometer. Water temperature, Electrical Conductivity, Total Dissolved Solids and Hydrogen Ion Concentration (pH) were measured using Hydrolab apparatus (Hydrolab model Orion Research Ion Analyzer 399A).Transparency was measured by standard Secchi disk (20 cm in diameter).

Ammonium concentrations (NH_4-N) were determined by the Phenate method. Nitrite (NO_2-N) was determined using colorimetric method. Nitrate (NO_3-N) was determined according to Mullin and Riley, (1956) method. Orthophosphate (PO_4-P) was measured according to stannous chloride method. Silicate was measured according to molybdosilicate method. Carbonate and bicarbonate alkalinity were determined by the titration method. Dissolved Oxygen (DO) was determined by Azide-Modification method**.**

Biological Parameters:

Standing crop and species composition::

Samples for quantitative (standing crop) and qualitative (species composition) analysis of the Phytoplankton communities were collected by 1.5L Ruttner Sampler and preserved immediately using 4% neutralized formalin. The preserved samples were transferred in a clean graduated cylinder of 1000 ml capacity and Lugols Iodine Solution was added until the samples changed to faint tea color. Phytoplankton counting was applied by a Drop Method, 0.5 µl of the reduced volume was placed in a counting chamber and examined at 10X eyepiece and 40X objective of inverted microscope (APHA, 1998). The main references used for identification of algal taxa were (Kofoid, 1907-1911; Kofoid and Swez, 1921; Geitler, 1925; Mills, 1933 – 1935; Hendy, 1964; Bourrelly, 1968; Prescott, 1978; Toini, 1986 and Lebour and Marie1930).

Statistical analysis:

The data were analyzed by one-way ANOVA and significant differences were determined by Duncan Waller Multiple Range Test at 5% level using SPSS Statistical Package Program (SPSS, 2008) 17, released version. The correlations between Physico-chemical Parameters and Physico-chemical Parameters with Biological Parameters were analyzed using the bivariate correlation coefficients of Pearson (SPSS, ver. 17).

RESULTS AND DISCUSSION

Air temperature showed a relative variation to water temperature. Their values varied from 20 ^oC to 41 ^oC and from17.4 ^oC to39.7 ^oC respectively. These data agree with Fathi and Flower (2005) and Tayel *et al.* (2013). Temperature has a direct effect on aquatic organisms and indirect effect through its influence on other environmental factors such as solubility of gases including oxygen (Abdel Gawad, 1993). Secchi disc readings varied from 18 cm to150 cm. The lower Secchi disc readings may be attributed to higher primary productivity (phytoplankton growth) (Saeed and Mohammed, 2012), also this data was confirmed by strong negative correlations with total phytoplankton at the NIOF and the east stations (r = - 0.677* and - 0.667* respectively).The electrical conductivity line showed a relative approximation to the total dissolved solids line and their values were 35.1- 44.7 ms cm^{-1} and 20.7 - 28.6 g l^{-1} respectively. The increase of total dissolved solids (TDS) is related to the increase of the electrical conductivity (EC) (Ibrahim and Ramzy, 2013). pH values ranged from 7.86 to 8.87.This result agrees with the data recorded by Sabae and Ali (2004) and Fathi and Flower (2005). The change in the pH values of the lake may be due to the stirring effect of the incoming flood from El-Batts drain that converged towards the lake resulting in the mixing of the poorly alkaline or acidic bottom water with alkaline surface water to decrease pH (Ibrahim and Ramzy, 2013).

Ammonium-N concentrations ranged from 2 µg $l^{-1}$to 257 µg l^{-1} .This data agrees with the range obtained by Sabae and Ali (2004) and Abdel-Satar *et al.* (2010). Ammonia accounted for the major proportion of total soluble inorganic nitrogen (Abou El-Gheit *et al.*, 2012). Nitrite concentrations were lower than nitrate concentrations and ranged from 0.7 µg l^{-1} to 132.4 µg l^{-1}. This result is in agreement with Abd Ellah (2009), Abou El-Gheit *et al.* (2012) and Tayel *et al.* (2013). The low values of nitrite may be due to the fast conversion of nitrite by nitrobacteria to nitrate (Tayel, 2007). However, the high nitrite level may be due to decomposition of organic matter present in the waste water where nitrosomonas bacteria oxidize ammonia to nitrite by denitrification (Saad *et* *al*., 2011). Nitrate-N Concentrations were higher than other inorganic nitrogenous compounds and their values varied from 178 µg l^{-1} to16404 µg l^{-1}, these values agree with the data recorded by Sabae and Ali (2004) and Fathi and Flower (2005). Phosphorus that enters the aquatic system by anthropogenic sources, e.g. fertilizer-runoff, potentially, might be incorporated into either inorganic or organic fraction (Abou El-Gheit *et al*., 2012). Orthophosphate concentrations ranged between 0.5 µgl^{-1} and110.2 µgl^{-1}.These values are in according with Sabae and Ali (2004), Fathi and Flower (2005), Ibrahim and Ramzy (2013) and Tayel *et al*. (2013). The highest concentrations of ammonium-N, nitrite, nitrate and orthophosphate were recorded at the west station due to the effect of El-Wadi drain which is loaded with agriculture drainage water.

Silicate values varied from 0.3 mg$l^{-1}$to 2.5 mgl^{-1} and a negative correlations were obtained between diatoms and silicate due to its consumption by them (r ranged from - 0.102 to - 0.455). This data agrees with Fathi and Flower (2005) who revealed that dissolved silica has a specific role in Bacillariophyceae growth and adequate silica supply is essential for diatoms. Bicarbonate concentrations were higher than carbonate concentrations at all the selected stations and their values ranged from105 to235 mgl^{-1} and from 31 to 96 mgl^{-1} respectively. These results are in agreement with the values recorded by Ibrahim and Ramzy (2013).The data of DO varied from 3.6 mg$l^{-1}$to 20 mgl^{-1}.These values agree with the data of Sabae and Ali (2004) and Tayel *et al*. (2013). On the other hand there was a negative correlation between DO and carbonate, bicarbonate and water temperature (Temp: r ranged from - 0.1 to - 0.746** ,CO_3^{-2}: r ranged from - 0.103, to - 0.399 HCO_3^-: r ranged from - 0.130 to - 0.399).This correlation is confirmed by Tayel *et al*. (2013) who cleared that DO showed negative correlations with water temperatures (r = - 0.642, P<0.05) and the depletion in DO may be due to its exhaustion for oxidation of huge content of organic matter discharged into the lake and Abou El-Gheit *et al*. (2012) who mentioned that when the DO concentration decreases CO_2 increase, leading to decrease in pH and increase HCO_3^- concentration**.**

Phytoplankton is highly sensitive to even slight fluctuations in water quality. Its high abundance is obtained when the physico-chemical factors are at optimum level (Fonge *et al*., 2015). A total of 89 species of phytoplankton belonging to six classes were recorded in the lake during the studied period. The Bacillariophyceae were most diverse with 39 species and the dominant species were Cyclotella operculata, C. meneghiniana, C. glomerata, Nitzschia acicularis and Navicula cryptocephala var.veneta . Cyanophyceae with 18 species, Synechocystis salina, S. aquatilis, Oscillatoria amphiba and Lyngbya limnetica were the most common. Chlorophyceae and Euglenophyceae with 10 species for both and Chlorella vulgaris, Euglena gracilis and E. clara were the most common respectively. Dinophyceae with 9 species and the dominant species were Exuviaella apora, Prorocentrum micans and Gymnodinium lantzschii. Cryptophyceae with 3 species and Chroomonas acute was the most common.

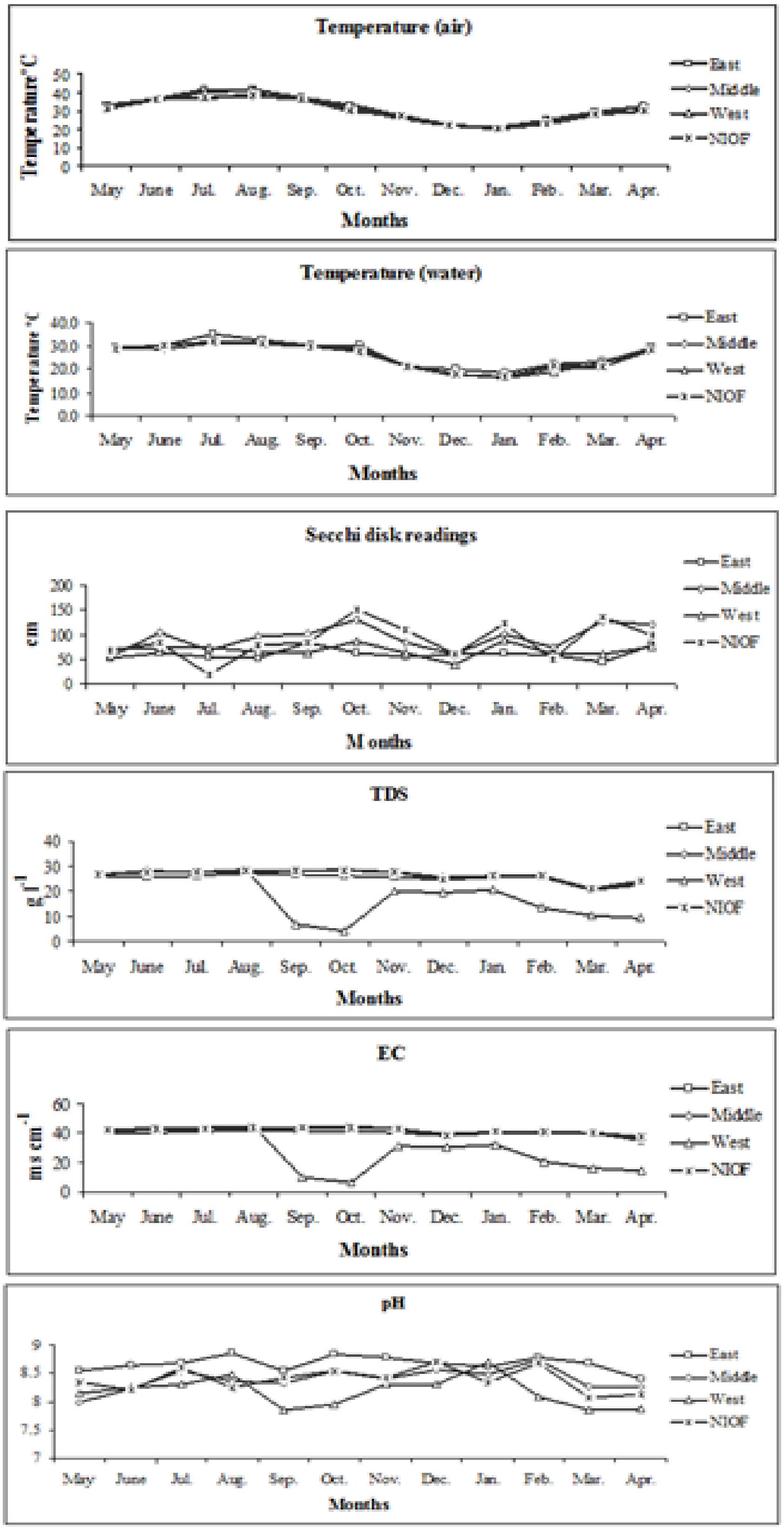

Fig. 2: Physical parameters of Qarun Lake during the period from May 2015 to April 2016.

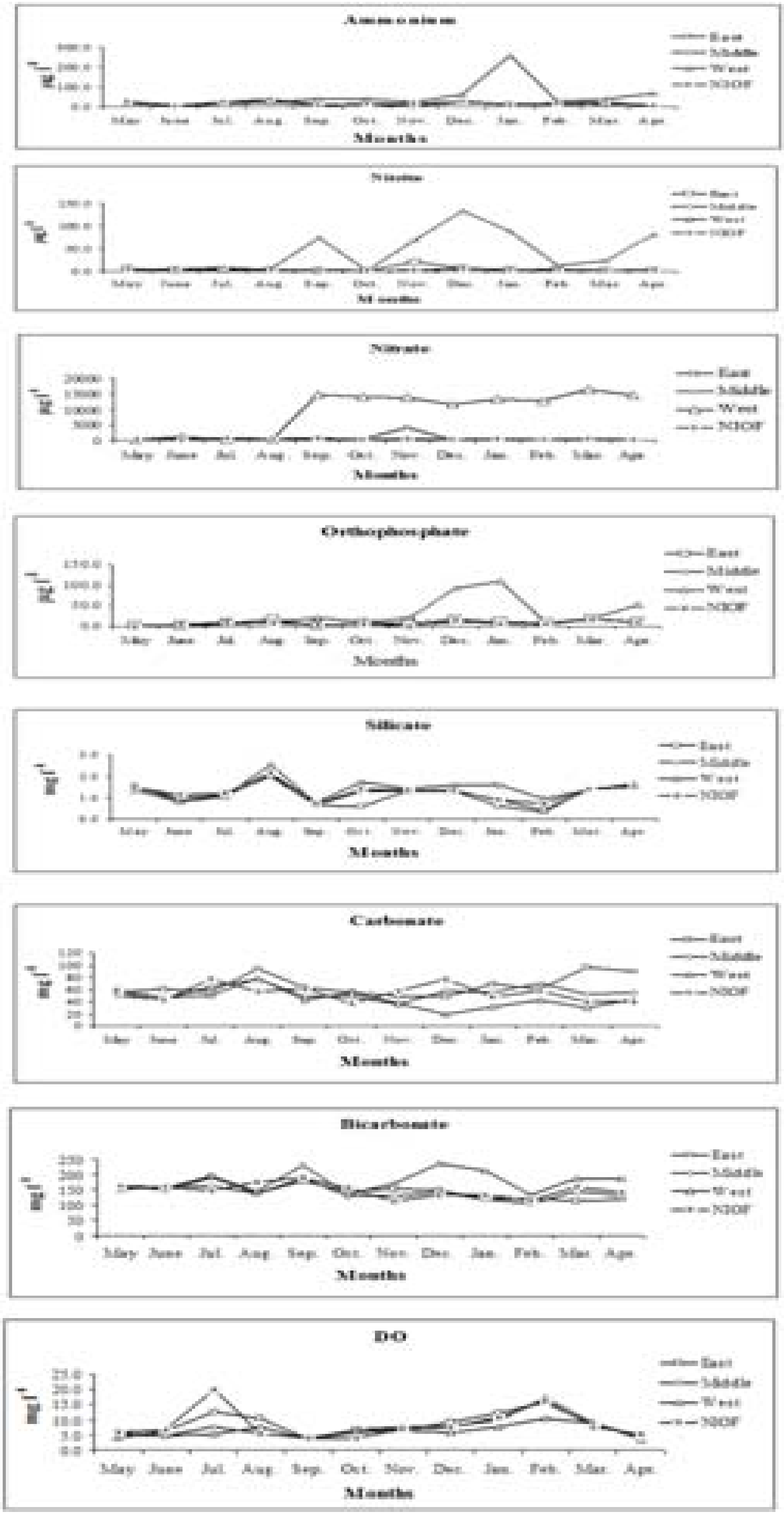

Fig. 3: Chemical parameters of Qarun Lake during the period from May 2015 to April 2016 .

Table 1: A list of phytoplankton species that recorded in Qarun Lake during the period from May 2015 to April 2016.

No.	Species	No.	Species
	Bacillariophyceae	47	*Oscillatoria tenuis f.tergestina Rabeenh*
1	*Navicula pupula Kutz*	48	*Oscillatoria geitleriana Elenkin*
2	*Navicula viridula Kutz.*	49	*Oscillatoria amphiba Ag.e.xGomont*
3	*Navicula cryptocephala var,veneta (Kutz) Grun.*	50	*Oscillatoria rubescens Dc ex Gomont*
4	*Naviculacryptocephala var,intermedia Grun*	51	*Lyngbya limnetica Lemmermann*
5	*Navicula anglica Ralfs*	52	*Gloeotrichia echinulata (J.E) Smithp.Richer*
6	*Navicula spicula (Dickie) Cleve*	53	*Dactylococcopsis pectinatellophila W.West*
7	*Navicula rosellata (Kutz.)*	54	*Synechocystis salina Wislouch*
8	*Navicula scoliopleuroides Qunt*	55	*Synechocystis aquatilis Sauvageau*
9	*Gyrosigma distorium (W.Smith) Cleve*	56	*Eucapsis minuta F.E.Fritsch*
10	*Pleurosigma salinarum Grun*	57	*Pseudanabaena constricta (Szafer) Lauterborn*
11	*Stauroneis anceps fo,linearis (Ehr) Cleve*		***Chlorophyceae***
12	*Amphiprora alata Kutz*	58	*Scenedesmus dimorphus (Turpin) Kuetzing*
13	*Neidium iridis var.ampliata (Her) Cleve*	59	*Scenedesmus obtusus Meyen*
14	*Nitzschia acicularis W.Smith*	60	*Scenedesmus quadricauda (Trupin)Brebisson*
15	*Nitzschia longissma (Brebisson)Ralfs*	61	*Ankistrodesmus falcatus Corda Ralfs*
16	*Nitzschia sublinearis Hust*	62	*Kirchneriella contorta (Schmidle) Bohlin*
17	*Nitzschia closterium (Ehr.)W. Smith*	63	*Volvox aureus Ehrenberg*
18	*Cymbella affinis Kutz*	64	*Asterococcus superbus, Sternen Kugel*
19	*Cymbella turgidula Grun*	65	*Chlorella vulgaris Beijerinck*
20	*Cymbella amphicephala Naegeli*	66	*Dactylococcus infusionum Naegeli*
21	*Cymbella cymbiformis(Agardh-Kutz)*	67	*Crucigenia tetrapedia (Kirchner) W.et G.S.West*
22	*Cymbella ventricosa Kutz*		***Euglenophyceae***
23	*Cocconeis pediculusEhrenberg*	68	*Euglena gracilis Klebs*
24	*Cocconeis placentula var. klinoraphis Geitler*	69	*Euglena clara Skuja*
25	*Cocconeis hustedtii Krasske*	70	*Euglena hemichromata Skuja*
26	*Synedra ulna(Nitzsch) Ehr.*	71	*Euglena spirogyra Schraubiges Augentier*
27	*Synedra ulna var.danica (Kutz) Grun*	72	*Euglena rubra Hardy*
28	*Tabellaria fenestratevar.asterionelloides Grunow*	73	*Euglena intermedia (Klebs) Schmitz*
29	*Chaetoceros gracilis Schut*	74	*Euglena proxima Dangeard*
30	*Cyclotella meneghinianakutz.*	75	*Euglena variabilis Veranderliches Augentier*
31	*Cyclotella operculatakutz.*	76	*Eutreptia viridis Perty*
32	*Cyclotella glomerata Bachmann*	77	*Colacium vesiculosum Ehrenberg*
33	*Cyclotella bodanica Eulenst*		***Dinophyceae***
34	*Melosira granulata (Ehr.) Ralfs*	78	*Prorocentrum micans Ehrenberg*
35	*Melosira granulata var. angustissmaMuller*	79	*Prorocentrum dentatum Stein*
36	*Melosira italica var.valida Grunow*	80	*Exuviaella apora Schiller*
37	*Melosira italic.subarctica Muller*	81	*Gymnodinium lantzschii Utermohl*
38	*Melosira italica var.tenuissima Muller*	82	*Gymnodinium aeruginosum Stein*
39	*Coscinodiscus lacustris Grun*	83	*Amphidinium sp*
	Cyanophyceae	84	*Peridinium pusillum (Penard) Lemmermann*
40	*Anabaena flos- aquae Brebisson*	85	*Peridinium sp*
41	*Anabaena f.fertillissima Prasad*	86	*Gonyaulax grindleyi Reinecke*
42	*Anabaena volzii Lemma*		***Cryptophyceae***
43	*Anabaena vaginicola f.fertillissima Prasad*	87	*Cryptomonas phaseous Skuja*
44	*Anabaena variabilis Kutzing ex Born.etFlah*	88	*Chilomonas paramecium, Bogenei Belflagellat*
45	*Anabaena lutea Gardner.Myx.*	89	*Chroomonas* acuta Utermohl
46	*Raphidiopsis mediterranea Skuja*		

On the other hand a negative correlations were obtained between total phytoplankton and nutrients due to the nutrient consumption by phytoplankton as follow (NH_4: r ranged from - 0.109 to - 0.385 NO_2: r varied from - 0.101 to - 0.507 NO_3: r ranged from - 0.129 to - 0.679* PO_4: r varied from - 0.056 to - 0.438). This view is confirmed by Abd Ellah and Konsowa (2002) who mentioned that the inverse correlation might be due to consumption of nutrients during phytoplankton growth, also a positive correlation was obtained between the total phytoplankton crop and DO specially at the NIOF station due to the high numerical densities of phytoplankton (r ranged from 0.128 to 0.766**). This data is supported by Ibrahim and Ramzy (2013) who mentioned that the excess concentration of dissolved oxygen recorded might be attributed to light intensity rather than photosynthetic activity of phytoplankton and decreased turbidity during dry month.

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ARABIC SUMMARY

دراسة الخصائص الفيزيائية والكيميائية والبيولوجية لبحيرة قارون ، الفيوم- مصر

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١- قسم النبات- كلية العلوم- جامعة دمنهور- مصر
٢- المعهد القومى لعلوم البحار والمصايد – فرع المياه الداخلية وتربية الأحياء المائية – ١٠١ شارع القصر العينى – القاهرة – مصر

بحيرة قارون هي بحيرة داخلية تحتل الجزء الأدنى من منخفض الفيوم. في هذه الدراسة تم تنفيذ برنامج أخذ العينات على أساس شهري من مايو ٢٠١٥ واستمر حتى أبريل ٢٠١٦ (١٢ شهرا متتالية). التحليل الفيزيائي والكيميائي لبحيرة قارون أوضح أن قيم الرقم الهيدروجيني سجلت على الجانب القلوي، وتشير قيم قرص الشفافية أن مياه البحيرة كجسد مائى عكر كما تتميز القلوية في بحيرة قارون بزيادة قيم البيكربونات بالمقارنة مع قيم الكربونات وأشار تحليل المغذيات إلى زيادة الأمونيوم والنترات والنيتريت والفوسفات والسيليكات في مياه البحيرة خاصة أمام المصارف. من ناحية أخرى، تم تسجيل ٨٩ نوعا من العوالق النباتية في البحيرة التي تنتمي إلى ست مجموعات وهى الدياتومات، الطحالب الخضراء المزرقة، الطحالب الخضراء، السوطيات، الطحالب السوطية الكاذبة ، Cryptophyceae وكانت الدياتومات أكثر تنوعا حيث سجلت ٣٩ نوعا، ثم الطحالب الخضراء المزرقة ١٨نوعا يليها الطحالب الخضراء والسوطيات ١٠ انواع لكل منهما، ثم الطحالب السوطية الكاذبة ٩ انواع و Cryptophyceae ٣ أنواع. أشارت الدراسة إلى أن ارتفاع مستوى المغذيات في البحيرة بمرور الوقت سيظهر مشكلة تفاقم الإغناء بالمغذيات مما يؤثر اقتصاديا على إنتاج الأسماك.