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Natural and propagated algal flora isolated from El-Fayum Governorate

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Abstract

A total of 98 taxa (69 aquatic, 29 edaphic) of algae were isolated and identified from water and soil samples collected in El-Fayum governorate. Aquatic taxa were made up of Bacillariophytes (33 taxa), Cyanophytes (20) and Chlorophytes (16), while soil taxa consisted of Cyanophytes (16 taxa), Chlorophytes (8), Bacillariophytes (4) and one euglenoid taxon. Diversity increased under culturing and propagation with artificial nutritive media, particulary cyanophytes (by 18 taxa) and chlorophytes (by 7 taxa). Bacillariophytes dominated in Qarun Lake, perhaps because of the high silicate content; Qarun Lake had low diversity of chlorophytes and cyanophytes, perhaps because of the high levels of electrical conductivity and Na^{+}. The greatest numbers of chlorophytes were associated with high Mg^{++} content. Edaphic pH values were slightly alkaline to alkaline. Soil algal flora were commonest in samples from the Wadi El-Rayan road, characterized by high silt and clay fractions.

Keywords: Qarun lake; Wadi El-Rayan; Egypt.

Introduction

El-Fayum is a circular depression in the western desert situated immediately west of the Nile valley, about 100 km south-west of Cairo. In the lowest northern section of this depression is Lake Qarun, while in the south west is the Wadi El-Rayan depression (Abd El-Aal 1984; Sewedan 1986). The depression of Wadi El-Rayan has been filled artificially by two lakes at different elevations, 43-64 m below sea level; the first lake is a circular shape of 56 km^2 (47.3 x 10.4 km), and the second is 58 km^2 (15.7 x 4.5 km): the whole area is enclosed in Wadi El-Rayan Protected Area (Zahran 1971; Mostafa *et al.* 1988; El-Bayomi 2006).

There are some accounts of the algae of the El-Fayum governorate: the ecology of aquatic systems was studied by Gad (1992), and soil algae by Abd El-Rahman *et al*. (2004); Abd El-Hameed *et al.* (2007) investigated correlations between algal taxa and physico-chemical parameters in Wadi El-Rayan PA.

This study has three aims: first, to establish whether culturing aquatic samples on nutritive artificial media increases recorded biodiversity; second, to study the edaphic algal flora of the region; and third, to determine the relationships between ecological physico-chemical characteristics and the aquatic and edaphic algal flora.

Materials & Methods

Water and soil samples were collected from areas in El-Fayum governorate in late April 2007. Aquatic samples were collected from Lake Qarun, the first lake of Wadi El-Rayan, and from the drainage water of Wadi El-Rayan Protected Area. Edaphic samples were collected from Wadi El-Rayan road, the soil of water drainage banks in Wadi El-Rayan Protected Area, and the reclaimed soil of the post-graduate youth project of Wadi El-Rayan. Samples were collected in sterilized clean air-tight glass and plastic jars (for water samples), and in sterilized clean air-tight plastic bags (for soil samples). Both samples were collected in three random replicates, then brought to the laboratory to investigate the physico-chemical characters as well as culturing and isolation of algae.

Physical and chemical properties of the waters and soils were carried out according to Richard *et al.* (1954) (for available cations, anions, electrical conductivity, available phosphorus, nitrogen and micronutrients); Jackson (1958) for pH; Brouach & Barthokur (1997) for the mechanical analysis of soil; and Tan (1996) for silica content.

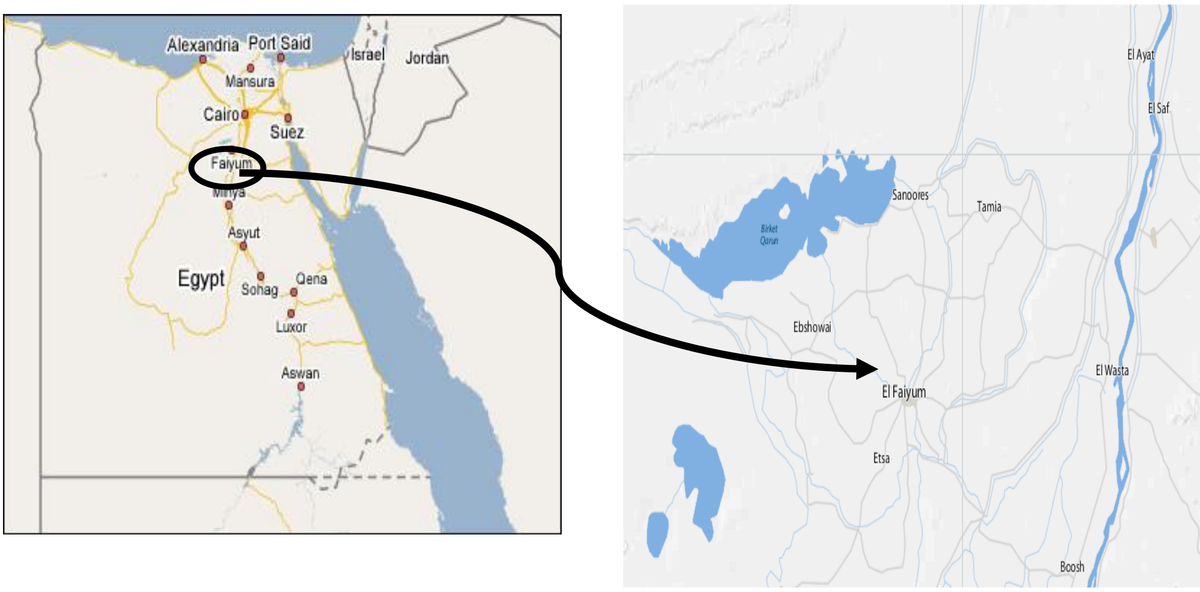

Fig 1: Study area in El-Fayum Governorate

Under aseptic conditions, cultivation and isolation of algae from the samples was done by inoculating them in liquid and solid (produced by addition of 20 gm of agar-agar/l) nutritive Chu's No. 10 (Stein 1979) and Allen's media (Allen 1968). Both were incubated under natural laboratory conditions (room temperature, natural daylight). Microscopic examination used a one-fifty Reichert binocular microscope, and algae were identified using Zabelina *et al. (*1951), Gollerbakh *et al. (*1953), Kiselov *et al. (*1953), Korsanov *et al. (*1953), Popova (1955), Dedesenko *et al.* (1959), Desikachary (1959), Philipose (1967), Komarenko and Vasileva, *(*1975 and 1978). Monocultures of certain identified common algal species were produced using plating and serial dilution procedures recommended by Jurgensen & Davey (1968).

Results

The water of the aquatic samples were alkaline, ranging from 8 - 8.2 (Table 1). Water samples were generally saline to hypersaline. The highest electrical conductivity values were recorded in Qarun lake, and the lowest from the drainage water of Wadi El-Rayan. Soluble cations and anions dominated (Table 1), with high NaCl values in all the investigated aquatic samples, especially in Lake Qarun samples. The only exception was for Mg^{++}, which recorded its lowest value in Lake Qarun lake. Soluble CO_3^- was entirely absent in all aquatic samples. The percent silica varied from 21.2 – 22.3%, with highest value in Lake Qarun.

Mechanical analysis of soil samples (Table 2) show that the soil texture varied considerably from one sample to another. The road soil showed high values of electrical conductivity. All soils were slightly alkaline.

The dissolved cations and anions (Table 3) showed that NaCl dominated the road soil, while sulphates (of calcium and sodium) were the dominant salts in the other two soils. Available nitrogen and organic matter were greatest in the road soil. Fe and Mn dominated the micronutrients in all soils.

Table 4 shows the 69 identified taxa in the aquatic samples, belonging mainly to the Bacillariophycophyta (33-48%), Cyanophycophyta (20–29%) and Chlorophycophyta (16–23%). Bacillariophytes dominated in all the aquatic samples, and were most numerous in Lake

Qarun. Algal diversity increased (particularly cyanophytes and chlorophytes) with culturing and propagation. Cyanophytes increased by 18 taxa, and chlorophytes by 7 taxa.

Table 1: Physico-chemical characteristics of water samples collected from the three sites. All values are in m.eq per litre except pH (scale), electrical conductivity (m.mohs/cm) and silca content (in %)

Parameters		Sites		
		Lake Qarun	Wadi Rayan first Lake	drainage water of Wadi Rayan
Physical parameters	**pH**	8.2	8	8.1
	Electrical conductivity	43.3	5.3	4.14
Soluble cations	Ca^{2+}	4.31	4.6	4.2
	Mg^{2+}	6.14	7.9	8.4
	Na^{+}	396.5	24.1	23.6
	K^{+}	5.48	0.9	0.86
Soluble anions	CO_3^{2-}	0	0	0
	HCO_3^{2-}	3.8	3	2.8
	Cl^{-}	385	18.8	17.5
	SO_4^{2-}	105.91	17.5	16.78
Silica content	SiO_3 %	22.3	21.2	21.9

Table 2: Physical properties of soil samples. EC = Electrical conductivity (m.mohs/cm).

	mechanical analysis %			texture	pH	EC
Localities	**sand**	**silt**	**clay**			
road	10.5	30.9	60.2	Clay - loam	7.4	63.20
drainage banks	89.9	6.1	1.3	Sand	7.2	1.93
reclaimed soil	63.0	21.0	47.1	Clay - sand	7.2	3.64

Table 3: Chemical characteristics of the soil samples

Parameters		Localities		
		road	drainage banks	reclaimed soil
Soluble cations (meq./l)	Ca^{++}	67.0	9.3	10.0
	Mg^{++}	73.0	3.1	8.4
	Na^{+}	570.0	10.0	12.7
	K^{+}	12.7	0.4	0.6
	CO_3^{--}	-	-	-
Soluble anions (meq./l)	HCO_3^{-}	1.4	0.4	0.3
	Cl^{-}	700.0	8.6	14.0
	SO_4^{--}	21.3	10.3	17.1
Organic matter %		1.05	0.54	0.70
Available macronutrients (ppm)	**Nitrogen**	90	40	60
	Phosphorus	23	24	24
Available micronutrients (ppm)	**Fe**	5.8	5.2	5.8
	Cu	0.62	0.40	0.44
	Zn	1.0	0.5	0.7
	Mn	2.24	4.2	4

Table 4: Aquatic algae identified in natural and cultured samples.

	Lake Qarun			**Wadi Rayan first lake**			**Drainage water of Wadi Rayan PA**		
Aquatic taxa		**Cultured**			**Cultured**			**Cultured**	
	Natural	**liquid**	**solid**	**Natural**	**liquid**	**solid**	**Natural**	**liquid**	**solid**
Cyanophytes									
Synechocystis minuscule Woronich			+						
Microcystis aeruginosa Kutz.emend. Elenk.				+	+		+	+	
Microcystis pulverea (Wood) Forti emend. Elenk					+	+		+	+
Aphanothece clathrata W .et. G. S. West	+	+							
Gloeocapsa minuta (Kutz.) Hollerb. Ampl.					+	+			
Gloeocapsa turgida (Kutz.) Hollerb. emend.			+	+	+		+	+	+
Gomphosphaeria aponina Kutz.				+			+		
Merismopidia puncita Meyen	+			+	+				
Merismopedia tenuissima Lemm.							+	+	
Anabaena variabilies f. rotundospora Hollerb.			+			+			
Oscillatoria brivis (Kutz.) Gom.				+	+		+		
Oscillatoria deflexa W.et. G.S. West		+			+			+	
Oscillatoria deflexoides Elenk. et .Kossinsk		+			+			+	
Oscillatoria margaritifera (Kutz) Gom.				+	+				
Oscillatoria terebriformis (Ag.) Elenk.emend		+		+		+			
Spirulina major Kutz.				+			+		
Spirulina subtillisima Kutz.				+	+		+	+	
Lyngybya aestuarii (Mert.) Liebm.				+					+
Lyngybya lagerhimii (Hollerb.) Elenk						+		+	+
Microcoleus delicatulus W. et. G. S. West			+						
Bacillariophytes									
Achnanthes hungarica Grun							+	+	+
Achnanthes lanceulata (Br'eb.) Grun	+						+	+	+
Amphiprora alata Kutz.				+	+	+			
Amphora coffeaeformis (Ag.) Kutz.	+			+	+				
Amphora ovalis var. pediculus (Kutz.) V.H.ex.Det.							+	+	+
Cocconies placentula Eher.							+	+	
Coloneis budensis (Grun) Krammer	+						+		
Conscinodiscus lacustris Eher. Grun	+	+	+						
Cyclotella meneghiniana Kutz.				+	+		+	+	
Cyclotella ocellata Pant	+	+		+			+		
Diploneis ovalis Hilse Cl.	+			+					
Fragilaria brevistriata Grun							+	+	
Gomphonema clevei Fricke.	+								
Gomphonema parvulum (Kutz.) Grun	+			+	+		+	+	
Melosira granulate (Her.) Ralfs.	+						+		
Melosira moniliformis var. subglobosa Grun							+		+
Navicula acicularis	+	+		+	+				
Navicula cryptocephala Grun							+	+	
Navicula mutica Kutz.							+	+	
Navicula radiosa Kutz.	+						+	+	
Navicula tuscula Ehr.							+	+	
Nitzschia amphibian Grun	+						+	+	
Nitzschia caspidata var. ambigua Grun				+	+				
Nitzschia puncitata (W. Sm.) Grun	+			+	+				
Pinnularia borealis Eher	+								
Pinnularia viridis (Nitzsch.) Eher	+								
Rhoicosphania curvita (Kutz.) Grun	+	+		+					

Rhopalodia gibba (Her.) O. Muller	+			+					
Surirella angustata Grun									
Symbella ventricosa Kutz.	+	+		+			+		
Synedra ulna (Nitzsch.) Eher.	+			+			+		
Synedra ulna var. danica (Kutz.) Grun	+			+					
Synedra ulna var. impressa Hust.	+			+	+				
Chlorophytes									
Cladophora glomerata (L.) Kutz.							+	+	
Cladophora marina (Kutz.) Brand	+	+							
Enteromorpha torta Mert.	+								
Chaetophora elegans (Huds) Hazen							+	+	
Colsterium microsporum Naeg.							+		
Pediastrum duplex Meyen							+		
Pediastrum quarteroid Ralfs							+	+	
Pediastrum tetras (Her) Ralfs							+		
Scenedesmus bejugatus (Turp.) Kutz.							+		
Scenedesmus bejugatus f. bicellularis		+					+	+	
Scenedesmus dimorphus (Turp.) Kutz.								+	
Scenedesmus caudatus f. quadricauda (Turpin) Breb.				+			+	+	
Scenedesmus quadriquda Chodat G.M. Smith							+		
Chlorella vulgaris Beijer.					+			+	
Chlamydomonas atactogama Korsch					+	+		+	
Microspora amoena (Kutz) Lagerh.					+				
Totals	25	11	5	26	21	7	35	28	8

From the soil samples, 29 algal taxa were isolated and identified, composed of 16 cyanophytes, 8 chlorophytes, 4 bacillariophytes and one euglenophytes (recorded only in the reclaimed soil) (Table 5). The highest number of species came from the road sample (15).

Table 5: Soil algal flora isolated from soil samples cultured in either liquid or solid media.

Soil algal taxa	road		drainage banks		reclaimed soil	
	liquid	solid	liquid	solid	liquid	solid
Cyanophytes						
Synechococcus cedrorum Sauv.					+	
Merismopedia tenuissima Lemm.	+		+			
Aphanothece conferta					+	
Aphanothece salina Elenk. et Danil.					+	
Gloeocapsa minuta Kutz.) Hollerb. Ampl.	+	+				
Gloeocapsa turgida (kutz.) Hollerb.emend.	+	+				
Amorphonostoc paludosum (Kutz.) Elenk	+	+				
Anabaena bergi f. minor (Kissel.) Kossinsk					+	+
Anabaena variabilies f. rotundospora Hollerb	+	+			+	+
Oscillatoria deflexa W et G. S. West.					+	
Lyngbya aestuarii (Mert.) Liebm.	+	+	+	+		
Lyngbya lagerhimii f. edaphica (Hollerb.) Elenk		+				
Phormidium mucicola Hub. Pestalozzi et Naum.					+	
Phormidium frigidum F. E. Fritsch					+	
Schizothrix tinctoria (Ag.) Gom.			+	+		
Microcoleus delicatulus W. et. G. S. West.		+			+	
Bacillariophytes						
Amphora coffeoeformis (Ag.) Kutz.	+	+	+			
Navicula cryptocephala Kutz.	+	+				
Nitzschia palae (Kutz.) W. Sm.	+		+			
Nitzschia acicularis W.Sm. Grun.	+		+			
Chlorophytes						
Chaetophora elegans (Huds) Hazen			+			
Chlamydomonas gelatinosum Korsch.					+	

Chlamydomonas pertyi Gorosch.					+	
Chlorella vulgaris Beijer.	+	+				
Microspora amoena (Kutz) Lagerh	+					
Scenedesmus bejugatus (Turp.) Kutz.	+		+	+		
Scenedesmus dimorphus (Turp.) Kutz.			+	+		
Sorastrum spinolusum					+	
Euglenophytes						
Euglena viridis Ehr.					+	
Totals	13	11	9	5	13	3

Discussion

Although the waters were alkaline, this study indicated that Bacillariophytes dominated, particularly in Lake Qarun; this may due to the high available silicates in this lake. The distribution of diatoms is known to be related to the nutrient status in combination with pH (Shields & Durrell 1964). Qarun lake recorded low numbers of chlorophytes and cyanophytes, perhaps due to the high electrical conductivity and Na^+. The greatest numbers of chlorophytes were isolated from the drainage water, perhaps correlated with the relatively high Mg^{++} cation levels (Singh *et al*. 1990). Edaphic pH values were slightly alkaline to alkaline, correlated with the dominance of cyanophytes: Nair *et al*. (1993) and Lukesova & Hoffmann (1996) suggested that neutral and alkaline soil are more favourable to the development of blue-green algae. The soil algal flora had the highest species richness in the road sample, characterized by high silt and clay fractions (Yongding & Shanghao 1989).

The identified algal flora (particulary cyanophytes and chlorophytes) increased under culturing and propagation conditions. Several genera and species characterized each of the aquatic and edaphic samples. For the aquatic samples, *Aphanothece clathrata, Microcoleus delicatulus* (cyanophytes), *Conscinodiscus lacustris Pinnularia borealis, Gomphonema clevi* (bacillariophytes) and *Enteromorpha torta* (chlorophytes) characterized the Lake Qarun sample; *Gloeocapsa minuta*, *Oscillatoria margaritifera* (cyanophytes); *Amphiprora alata, Nitzschia caspidata var. ambigua* (bacillariophytes) and *Microspora amoena* (chlorophytes) were present only in the first lake of Wadi El-Rayan; *Merismopedia tenuissima* (cyanophytes*)* *Melosira moniliformis, Fragilaria brevistriata, Amphora ovalis, Navicula mutica, Navicula tuscula, Nitzschia amphibia* (bacillariophytes*), Cladophora glomerata, Chaetophora elegans, Colsterium microsporum, Pediasrum doplex, Pediasrum quarteroid, Pediastrum tetrous, Scenedesmus bejugatus* and *Scenedesmus dimorhus* (chlorophytes) were only recorded in the drainage water of the Wadi El-Rayan protected area.

For the soil samples, *Gloeocapsa minuta, Gloeocapsa turgida, Amorphonostoc paludosum, Lyngbya lagerhimii f. edaphica* (cyanophytes), *Navicula cryptocephala* (bacillariophytes), and *Microspora amoena* (chlorophytes) were recorded only from the road sample; the drainage-bank soil was characterized by *Schizothrix tinctoria* (cyanophytes); *Chaetophora elegans, Scenedesmus dimorphus; Scenedesmus caudatus quadricauda* and *Sorastrum spinolusum* (chlorophytes); and *Synechococcus cedrorum, Aphanothece conferta, Aphanothece salina, Anabeana bergi f. minor, Oscillatoria deflexa, Phormidium frigidum Phormidium mucicola* (cyanophytes), *Chlamydomonas gelatinosum* and *Chlamydomonas pertyi* (chlorophytes) were identified only in the reclaimed soil.

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الملخص العربى

الفلورا الطحلبية الطبيعية والمُنَمَّاة والمعزولة من محافظة الفيوم

هدى أنور منصور

قسم النبات- كلية العلوم – جامعة عين شمس – القاهرة – مصر

تكونت الفلورا الكلية للطحالب المعرفة من عينات الماء والتربة لمحافظة الفيوم من 98 وحدة طحلبية. حيث انتسبت الفلورا الطحلبية فى عينات الماء الى 69 وحدة طحلبية تابعة إلى ثلاثة أقسام طحلبية : الطحالب العَصَوِيّة (33 وحدة تقسيمية) والطحالب الزرقاء المُخْضَرَّة (20 وحدة تقسيمية) والطحالب الخضراء (16 وحدات تقسيمية). أما طحالب التربة للمناطق المدروسة فقد أعطت 29 وحدة طحلبية تابعة الى أربعة أقسام طحلبية : الطحالب الزرقاء المُخْضَرَّة (16 وحدة تقسيمية) والطحالب الخضراء (8 وحدات تقسيمية) والطحالب العَصَوِيّة (4 وحدات تقسيمية) والطحالب اليوجلينية (وحدة تقسيمية واحدة).

وصاحَبَ ذلك زيادة ملحوظة فى التنوع الطحلبى للفلورا المائية خاصة فى تنوع الطحالب الزرقاء المُخْضَرَّة والطحالب الخضراء المعزول ة من المناطق المدروسة بعد زراعتها وتنميتها على الوسط الغذائى الصناعى المستخدم . حيث زاد التنوع فى الطحالب الزرقاء المُخْضَرَّة لعينا ت الماء بحوالى 18 وحدة تقسيمية (7 وحدات تقسيمية فى بحيرة قارون، 6 وحدة تقسيمية فى البحيرة الأولى لوادى الريان و 5 وحدات تقسيمية فى منطقة شلالات محمية وادي الريان) وفى الطحالب الخضراء بحوالى 7 وحدات تقسيمية (3 وحدات تقسيمية لكلٍّ من البحيرة الأولى لوادى الريان ومنطقة شلالات محمية وادى الريان، وزادت بمقدار وحدة تقسيمية واحدة فى منطقة بحيرة قارون) وأوضحت الدراسة أن الطحالب العَصَوِيّة قد أعطت أعلى تنوع طحلبى لها فى عينة الماء لبحيرة قارون حيث المحتوى العالى نسبياً فى السيليكات المتوفر بهذه المنطقة. أما الطحالب الخضراء فقد أعطت أكبر تنوع طحلبى لها فى عينات الماء والتربة للمناطق المدروسة ذات المحتوى المرتفع نسبياً من كاتيون الماغنسيوم . كما أعطت الطحالب الزرقاء المُخْضَرَّة تنوعها الطحلبى العالى فى عينات التربة ذات الأس الأيدروجينى القلوى