TROPHIC STATUS AND PHYTOPLANKTON COMMUNITY STRUCTURE IN WADI EL-RAYIAN LAKES, WESTERN DESERT, EGYPT

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Abstract

This study was carried seasonally at Wadi El-Rayian Lakes during 2006. Total phytoplankton densities in the upper Wadi El-Rayian Lake were 4.8 fold higher than the lower lake.. Their major peak was recorded in winter and the minor in summer. Cyanophyceae and Chlorophyceae were dominated in the first lake, while Bacillariophyceae and Dinophyceae in the second lake. Cyanobacteria as *Microcystis flos-aquae*, *Microcystis aeruginosa* and *Lyngbya limnetica* blooms in the first lake during winter. The algal species in the first lake are mainly freshwater forms while some of those found in the second lake are brackish and marine forms such as *Chaetocerous similes* Cleve, *Prorocentrum micans* Ehr., *Prorocentrum apora* Schiller and. *Hermesium adriaticum* Zacch which also new record. Diversity index values indicate instability of Wadi El-Rayian depression, its values less than 1 and not exceeding 3. Similarity index exhibited a close relationship between the middle and the southernmost stations of both lakes. According to Carlson's trophic index, the first reservoir is classified as mesotrophic to eutrophic, while the second lake ranged from oligotrophic to eutrophic. Ammonium concentrations were much higher than the oxidized nitrogen in the two lakes under investigations. The trophic status, increased over time through continuous watershed management neighboring this depression.

Key words: Brackish water, phytoplankton blooms, diversity, similarity trophic index.

Introduction

Wadi El-Rayian Lakes are great reservoir for the agricultural drainage water of El-Fayioum province. Taha and Farghaly (1994) found that phytoplankton communities in the upper lake were much greater than those recorded in the lower lake. Farghaly and Taha (1994) reported that phytoplankton production reached its maximum value in winter while its minimum value occurred during spring. Abdel Mawla (1994) showed an obvious drop in growth and metabolic activity of three chlorophytes (*Ankistrodesmus falcatus*, *Ankistrodesmus convalatus* and *Scenedesmus quadricauda* isolated from Wadi El-Rayian lakes with increasing salinity to 10, 12 and 15ppt. The high nutrient levels discharging with agriculture drainage water has a positive effect on the trophic status of the upper Wadi El-Rayian Lake (Taha and Abd El-Monem, 1999). As well, Konsowa and Abd Ellah (2002) reported that the massive

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blooms of the blue greens *Microcysitis aeruginosa* and *Microcysitis flos-aquae* should be controlled through reducing watershed nutrient loading particularly at the beginning of winter seasons. Abd El-Karim (2004) studied the periphytic algal communities in Wadi El-Rayian Lakes and observed that the increase of salinity was the factor controlling diatoms and cyanophytes.

This research aimed to study the impact of fish farms wastes on phytoplankton communities inhabiting Wadi El-Rayian Lakes.

Structure of the studied area:

Wadi El-Rayian depression (28^0 15\ and 29^0 29\) consists of two Man-made Lakes at different elevations in the Western Desert of Egypt (135 km southwest of Cairo). The upper lake (1st lake) receives the first lot of agricultural drainage water (200 million m^3/year) from El-Fayoum province since 1973, and overflow to the lower reservoir (2nd lake) from 1987 to solve the problem of increasing the drainage water level in Lake Qarun. The two major lakes are connected by a canal (4.5 km), covered by dense vegetation of macrophytes. the upper Lake covers an area about 47.59 km^2 and volume of about 0.57 km^3, while the lower lake covers an area of about 51.81 km^2 and volume of 0.619 km^3 (Abd Ellah, (1999). The maximum depths are more than 29 and 33m in the mid area and decreases shorewords in the first and second lakes, respectively. The mean elevation of the depression is 43 m below sea level and its lowest point is 64 m below sea level (EL Bayomi 2006).

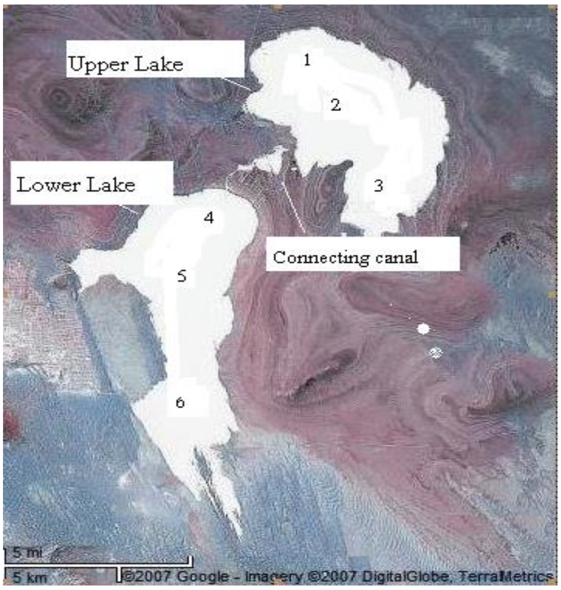

Figure 1: Map of Wadi El-Rayian Lakes Showing the selected stations

Methods

Four quarterly cruises to Wadi El-Rayian Lakes were carried out in winter, spring, summer and autumn 2006. Composite water samples were collected by Ruttner Bottle from the different locations of both Lakes. Stations 1, 2, 3 and 4, 5, 6 represent the north, middle and south areas of the first lake and second lake respectively (Fig. 1).
Nutrient concentrations (NH_4, NO_3, PO_4, TOP and SiO_3) were determined according to APHA (1992). Chlorinity was determined by titration the water samples against silver nitrate according to Mohr's method as described by Vogel (1953). Salinity was calculated by multiplying chlorinity value by 2.47 and adding 2.47 (Meshal, 1973).
Phytoplankton samples were preserved in situ with 4%-neutralized formaline. Sedimentation method was used to concentrate the phytoplankton cells. Drop method technique was applied for counting the phytoplankton community (APHA, 1992). The main references used for identification of phytoplankton organisms were Kimor and Pollingher (1965), Stansbery (1971), Weber (1971), Vinyard (1975), and Dillard (1989).

Total chlorophyll *a*: A known volume (50 ml) of well-shacked water samples was filtered in situ using syringe filtration unit (Sartorious) through 25-mm diameter and 0.7 µm pore size glass micro fiber filters (GF/F). The filters were kept at –20ºC. Chlorophyll *a* was extracted by socking the filters in 5 ml acetone 90% for 24 hour at –4ºC (Jacobsen and Rai, 1990). The extractions were measured using Kontron 930 double beam spectrophotometer (3-ml cell, 1-cm path length, and 8 nm-slit width) and the pigment concentration was calculated according to SCOR/UNESCO (1991).

Statistical analysis of data

Correlation analysis:

Correlation (person), analysis was performed using minitab software program.

Similarity index

Bray-Curtis measure was calculated to assess the degree of similarity between algal classes of the selected station using Primer 5 program.

Diversity index

This index was calculated using phytoplankton abundance expressed as absolute cell density (cell L^{-1}) It was calculated according to equation represented by Raymont (1980).

$$D = \frac{S - 1}{\ln N}$$

Where S = number of species in the population.
N = number of individuals in the population

Trophic state index (TSI)

Trophy index system devised by Carlson (1977). TSI_{chl} was calculated from chlorophyll *a* concentrations as follows:

$$TSI = 10[6 - \frac{2.04 - LnChla}{Ln2}]$$

Results and Discussion

Data concerning chemical properties (Table, 1 and 2) revealed that, NH_4-N concentrations increased over the oxidized nitrogen (NO_3-N) by about 9.5 times. The data disagree with Taha and Abd El-Monem (1999), Konsowa and Abd Ellah (2002) and Abd El-Karim (2004) who found that NH_4-N alternate the dominance with NO_3-N concentrations. Also, the current data indicated that nutrient concentrations were much higher than that recorded by the previous investigators. On the other side salinity levels in the 1st lake varied within a narrow range, but its content at the 2nd one increased about 1.3 times than that determined by Abd El-Karim (2004). The dramatic changes in water quality mainly realized to discharging a great amount of wastes from the neighboring fish farms into the channel between the two lakes.

Table (1): Seasonal average values of chemical properties of Wadi El-Rayian Lakes in 2006
(after A. Abd-Elstar, personal communication)

Seasons	NH_4 (mg/l)	NO_3 (mg/l)	PO_4 (mg/l)	TOP (mg/l)	SiO_3 (mg/l)
winter	0.500	0.057	0.08	0.35	8.21
spring	0.591	0.054	0.17	0.37	6.24
summer	0.905	0.083	0.09	0.61	4.30
autumn	0.521	0.061	0.10	0.22	1.40

Table (2): Regional average values of chemical properties of the studied stations in Wadi El-Rayian Lakes in 2006 (after A. Abd-Elstar, personal communication)

Parameters	Stations					
	1	2	3	4	5	6
Salinity ‰	1.50	1.52	1.53	4.98	7.77	7.81
NH_4 (µg/L)	0.84	0.43	0.45	0.24	0.27	0.30
NO_3 (µg/L)	0.089	0.062	0.036	0.034	0.022	0.025
PO_4 (µg/L)	0.11	0.10	0.09	0.07	0.062	0.055
TOP (µg/L)	0.93	1.08	0.70	0.51	0.48	0.33
SiO_3 (mg/L)	2.56	3.1	2.36	5.25	7.4	8.39

Total phytoplankton densities in the upper Wadi El-Rayian Lake were much higher than the lower lake (4.8 folds) (Table, 3). This may be due to the high nutrient concentrations loaded with drainage water via El-Wadi Drain. However, phytoplankton declined in the 2nd lake due to depletion of the major nutrient salts (N & P) (Table 2) by autotrophic organisms either phytoplankton or dense vegetation of macrophytes in the connecting canal (4.5Km).

Spatial phytoplankton distribution in the 1st lake revealed their abundance in the middle and south stations due to the turbidity that reduces transparency in the discharging area of El-Wadi Drain into the 1st lake (Taha and Farghaly, 1994, Taha and Abd El-Monem, 1999). Therefore its regional average density in the upper lake increased southwards from 429 X 10^4 unit/L to 637 X 10^4 unit/L. However, phytoplankton density in the lower one decreased southwards from 127 X 10^4 unit/L to 47 X 10^4 unit/L, due to decrease nutrients (N and P) and increase in salinity levels southwards which decreased freshwater algae and induced some marine algal species. Based on temporal variations, the two major peaks of phytoplankton density (1120 and 503 X 10^4 unit/L) were observed in winter and autumn respectively, while the minor peak (167 X 10^4 unit/L) was recorded in summer.

This finding is mainly due to outburst of blue green algae in mid area of the 1st lake during winter and declined in summer.

Table (3): Total phytoplankton density No. x 10^4 units/L in Wadi El-Rayian Lakes during 2006

Seasons	Upper Lake			Lower Lake			
	1	2	3	4	5	6	avg.
winter	92	3722	1538	192	650	524	1120
spring	32	982	566	130	124	18	309
summer	262	296	172	130	50	94	167
autumn	992	596	1172	120	108	28	503
avg.	429	625	637	127	94	47	326

Phytoplankton communities are represented by six classes namely, Cyanophyceae, Chlorophyceae, Bacillariophyceae, Dinophyceae Cryptophyceae and Euglenophyceae as shown in Table, 4. Ninety one phytoplankton species were identified. Cyanophyceae were the most dominant (68% of the total density) and represented with 16 species, followed by Chlorophyceae (19%) with 36 species, Bacillariophyceae (12%) with 26 species, while the other classes were rarely occurred.

It is somewhat surprising that, blue green algae bloomed in the first lake to be visible to the naked eye during winter (Table 5). The colonial forms *Microcystis aeruginosa*, *Microcystis flos-aquae* triggered markedly in autumn and extended to spring. This event was accompanied by a rapid decline in the green algae and diatoms during summer. The blooms generally occur after breakdown of the thermal stratification (maximum depth equal 29m) in summer (Taha and Abd El-Monem, 1999) and turnover of the water column and the injection of phytoplankton cysts from the sediment into the lake’s surface waters. Abdel-Karim (2004), recorded these blue greens among the periphytic algae in Wadi El-Rayian Lakes. Also, Konsowa and Abd Ellah (2002) indicated that *Microcysitis* blooming arise when the Lake is being highly eutrophic, particularly in January. On the other side, zooplankton grazing was declined to the lower extent in winter (El-Shabrawy, 1993 and 1996). Also, O’Brien (1974) stated that zooplankton have often been implicated as the agents responsible for crashes in many spring and summer phytoplankton blooms

Table (4): Seasonal variations in class composition of phytoplankton (organisms x 10^4 l^{-1}) and its percentage of abundance to the total numerical density in Wadi El-Rayian Lakes in 2006

Stations	Upper Lake						Lower Lake						avg.	
	1		2		3		4		5		6			
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Chlorophyceae														
winter	34	37.0	750	20.2	98	6.4	72	38	44	7	32	6.1	172	15.3
spring	8	25.0	56	5.7	36	6.4	4	3	4	3	8	44.4	19	6.3
summer	140	53.4	118	39.9	112	65.1	88	68	8	16	28	29.8	82	49.2
autumn	8	0.8	12	2.0	84	7.2	42	35	16	15	0	0.0	27	5.4
Avg.	48	29	234	17	83	21	52	36	18	10	17	20	75	19
Cyanophyceae														
Winter	26	28.3	2956	79.4	1430	93.0	62	32	48	7	70	13.4	765	68.4
spring	14	43.8	878	89.4	474	83.7	126	97	120	97	2	11.1	269	87.1
summer	118	45.0	148	50.0	22	12.8	10	8	4	8	0	0.0	50	30.1
autumn	900	90.7	548	91.9	1004	85.7	60	50	32	30	8	28.6	425	84.6
Avg.	265	52	1133	78	733	69	65	47	51	35	20	13	378	68
Bacillariophyceae														
Winter	32	34.8	10	0.3	6	0.4	56	29	558	86	420	80.2	180	16.1
spring	10	31.3	48	4.9	56	9.9	0	0	0	0	8	44.4	20	6.6
summer	4	1.5	30	10.1	38	22.1	32	25	38	76	66	70.2	35	20.7
autumn	4	0.4	4	0.7	36	3.1	14	12	56	52	4	14.3	20	3.9
Avg.	13	17	23	4	34	9	26	16	163	53	125	52	64	12
Dinophyceae														
Winter	0	0.0	0	0.0	0	0.0	0	0	0	0	0	0.0	0	0.0
spring	0	0.0	0	0.0	0	0.0	0	0	0	0	0	0.0	0	0.0
summer	0	0.0	0	0.0	0	0.0	0	0	0	0	0	0.0	0	0.0
autumn	0	0.0	0	0.0	0	0.0	4	3	4	4	16	57.1	3	0.6
Avg	0	0	0	0	0	0	1	1	1	1	4	14	1	0
Cryptophyceae														
Winter	0	0.0	6	0.2	4	0.3	2	1.04	0	0	2	0.4	1	1.4
spring	0	0.0	0	0.0	0	0.0	0	0	0	0	0	0.0	0	0.0
summer	0	0.0	0	0.0	0	0.0	0	0	0	0	0	0.0	0	0.0
autumn	80	8.1	32	5.4	48	4.1	0	0	0	0	0	0.0	16	35.3
Avg.	20	2	10	1	13	1	1	0	0	0	1	0	4	9

Therefore, *Microcystis aeruginosa*, *Microcystis flos-aquae* and *Lyngbya limnetica* are actually autochthonous species and may be inhabiting this depression for a long another phase, where they tolerate a wide range of salinity and fluctuations in Wadi El-Rayian water chemistry. This predict is confirmed by Konsowa and Taha (2002) who recorded these blue greens in the freshwater and estuary of Rosetta Branch.

Blue green algal blooms were experienced by many investigators; Konsowa, (1991 and 1996) recorded *Aphanizomenon issatschenkoi* and *Lyngbya limnetica* blooms in the first and second lakes in autumn and summer respectively. Konsowa and Abd Ellah (2002) observed *Microcystis aeruginosa* and *Microcystis flos-aquae* in the first lake in winter and *Lyngbya limnetica* in the second lake in summer.

Chlorophyceae occupied the second dominant position and constituted 19% of the total phytoplankton crop (Table, 6). This finding disagree with Taha & Abd El-Monem, (1999) and Konsowa & Abd Ellah (2002) who found that

Table 5: Species composition of blue green algae recorded in the first and second lakes of Wadi El-Rayian during 2006
1- First Lake 2- Second Lake

Blue green algal species	1	2	Blue green algal species	1	2
Microcystis aeruginosa Kutz	+	+	*Aphanizomenon issatschenkoi* Lavrenko	+	-
Microcystis flos-aquae Witter	+	-	*Aphanozemenon flos-aquae* (Linne) Ralfs	+	-
Microcystis marginata	+	+	*Phormidium laminosa (Agardh.) Gomont.*	+	-
Lyngbya limnetica Lemmer	+	+	*Phormidium spp.*	+	-
Lyngbya chlocospira Skuja	+	-	*Chrococcus turgidus (Kutz)Nageli*	+	+
Merismopedia glauca	+	+	*Chroococcus Giganteus* W.West	+	+
Merismopedia punctata Meyen	+	-	*Anabaena affinis*	+	-
Merismopedia tenuissima Lemmer.	+	+	*Anabaena solitaria* Klebahn	+	+

Chlorophyceae constituted 27.9% and 38%, respectively. This decline in percentage abundance attributed mainly to eutrophication from fish farms neighboring Wadi El-Rayian Lakes that induced domination of blue-green algae (Trifonova, 1989). *Binuclaria tenuis* and *Planktonema lauterbornii*, *Oocystis* spp. and *Cosmarium* spp. were abundant in the first lake and sporadically occurred in the 2nd lake. *Stigeoclonium* and *Closteriopsis* spp. are new records for this location since they are not previously recorded in published records of Taha and Abd El-Monem (1999) and Konsowa & Abd Ellah (2002). *Stigeoclonium tenue*. (Chaetophorales, differentiated into irregularly branches) was recorded in summer in the two lakes, while *Closteriopsis longissima* and *Closteriopsis longissima var.tropica* (Oocystaceae, filamentous, un-branched, ends produced into acute) were observed in station 1 during winter.

Table 6: Species composition of green algae in the first and second lakes of Wadi El-Rayian
1- First Lake 2- Second Lake

Green algae	1	2	Green algae	1	2
Ankistrodesmus convalatus Corda	+	+	*Closteriopsis longissima var. tropica* West & West.	+	-
Ankistrodesmus falcatus (Corda)Ralfs	+	-	*Pediastrum duplex var. reticulatum* smith	+	+
Staurastrum paradoxum Meyen	+	-	*Pediastrum tetras*	+	+
Quadrigula chodatii Smith	+	-	*Coelastrum microporum* Naegeli	+	-
Oocystis borgei Snow	+	+	*Planktonema lauterbornii* Schmidle	+	-
Oocystis crassa Wittrock	+	+	*Cosmarium laeve* West	+	+
Oocystis gigas Archer	+	+	*Cosmarium depressum*	+	-
Oocystis parva G.S.West	+	+	*Cosmarium punctulatum*	+	-
Oocystis solitaria Wittrock	+	+	*Cosmarium meneghinii* Debrebisson	+	-
Scenedesmus quadricauda (Turpin)Breb.	+	+	*Characium acuminatum* Braun	+	+
Scenedesmus quadricauda var. longispina (Chodat)Smith	+	-	Lagerheimia ciliata (Lager.) Chodat	+	-
Scenedesmus bijuga (Turp.)Lager.	+	-	Lagerheimia longiseta (Lemm.) printz	+	-
Scenedesmus bicaudatus	+	+	*Binuclaria tenuis*	+	-
Scenedesmus acuminatus	+	-	*Stigeoclonium tenue* (Agardh)Kuetz.	+	+
Scenedesmus opoliensis	+	-	*Closterium strigosum* Breb.	+	+
Scenedesmus portuberans Fritch	+	+	*Tetraedron minimum* (Braun)Hansgirg	+	+
Golenkinia radiata Fresenius	+	+	*Crucigenia quadrata* West	-	+
Closteriopsis longissima Lemm.	+	-	*Staurastrum sp.*	+	-

Bacillariophyceae were scarcely occurred in the 1st lake but its density reached 558 x 10^4 cells/L in the 2nd lake (Table 7). *Synedra rumpens* and *Chaetocerous similes* were new records and their abundance are related to the increase in water salinity (about 7.8‰) (euryhaline forms) in the lower lake. Also, *Chaetocerous* spp. are marine diatoms flourished in Lake Qarun (Konsowa, 2005) and Bardawil Lagoon (Taha, 1990). Cryptophyceae were observed mainly in the 1st lake in autumn, but they rarely occurred in the 2nd lake (Table 8). *Cryptomonas acuta* and *Cryptomonas ovata* were the leader species

Dinophyceae were usually observed in the lower lake in summer and autumn. *Prorocentrum micans* was restricted in the middle area of the 2nd lake during summer while, *Prorocentrum apora* was more occurred during autumn. *Hermesium adriaticum* was confined in summer season, but in the two lakes. These dinoflagellates were not previously recoded in this depression and they are marine species. *P.micans* and *P.apora* were detected in Lake Qarun (El-Fayoum Depression) in winter and summer, respectively by Abdel-Monem, (2001) while *Harmonium adriaticum* was observed in the hypersaline Bardawil Lagoon (Abd El-Karim and Hassan (2006 and Konsowa, 2007). Euglenophyceae was represented only by *Euglena viridis* during summer in the entrance of the second lake.

Table 7: Species composition of diatoms in the first and second lakes of Wadi El-Rayian
1- First Lake 2- Second Lake

Diatoms species	1	2	Diatoms species	1	2
Cyclotella glomerata Bachmann	+	+	*Synedra rumpens Kutz*	-	+
Cyclotella operculata Kutz.	+	+	*Melosira granulata* (Ehr.)Ralfs	+	+
Cyclotella ocellata Pant	+	+	*Melosiera granulata var.anguistissma* Muller	+	-
Cyclotella meneghiniana Kutz.	+	+	*Navicula anglica* Ralfs	+	+
Mastogloia dieselbe Agardh	-	+	*Navicula subtilissima* Cleve	+	-
Nitzchia closterium W.Smith	+	+	*Navicula rotaeana* (Rabh.) Grun.	+	-
Nitzschia amphibiana (Ehr.)Ralfs	+	+	*Navicula placentula*	+	-
Nitzschia frustulum (Kutz.)Grun.	+	+	*Amphora ovalis* Kutz.	-	+
Nitzschia filiformis (W.Smith)Hustedt	+	+	*Chaetocerous affinis* Lauder	+	-
Nitzschia palea (Kutz.)W.Smith	+	+	*Chaetocerous muelleri* Lemm.	+	+
Nitzschia sigma (Ehr.)W.Smith	+	+	*Chaetocerous similis Cleve*	-	+
Nitzschia hungarica	+	-	*Cymbella affinis*	+	+
Nitzschia vitrea	+	-	*Cocconeis placentula*	+	+
Synedra ulna (Nitz.)Ehr.	+	+	*Cymbella amphicephala* Naegeli	+	-
Synedra affinis	+	+			

Table (8): Species composition of dinoflagellates, Cryptophyceae and Euglenophyceae recorded in Wadi El-Rayian Lakes during 2006

Dinophyceae	1	2	Cryptophyceae	1	2
Prorocentrum micans Ehr.	-	+	*Cryptomonas acuta* Ehr.	-	+
Prorocentrum apora Schiller	-	+	*Cryptomonas ovata* Ehr.	+	-
Peridinium achromaticum Lavender	+	-	*Cryptomonas restrata* Troitzkaja	+	-
Peridinium bipes Schilling	+	-	*Mallomonas heterospina Lund*	+	-
Hermesium adriaticum Zacch	-	+	*Rhodomonas lacustris Pascher*	+	-
Euglenophyceae	1	2	*Mallomonas multimnca*	+	-
Euglena viridis .Ehr	-	+			

Total chlorophyll *a* concentrations in the first lake (2.1µg/L - 39.9µg/L) were much higher than in the second depression (1.2µg/L - 14.5µg/L (Table 9). Its concentrations were significantly correlated with blue green (r= 0.88, p= 0.00) and green algae (0.58, p= 0.003) which represent the important living and active form of algae in the 1st lake. Chlorophyll *a* of nanoplankton (<20µm) comprised 77.1 % of total phytoplankton biomass. This finding disagree with Taha and Abd El-Monem (1999) who found that nanoplankton constituted 51% of the phytoplankton biomass. This reflect the dangerous effect of eutrophication which may result in major water-quality problems (Huppert, *et. al*., 2002).

Table (9): Chlorophyll *a* concentrations (µg/L) of the studied stations at Wadi El-Rayian Lakes in 2006

Seasons	Tot. chlorophyll *a* (µg/L).						Avg.
	Upper lake			Lower lake			
	1	2	3	4	5	6	
Winter	4.2	39.9	26.5	11.8	14.5	13.2	18.3
spring	2.1	27.7	20.8	5.2	3.2	1.2	10.0
summer	5.3	7.5	10.8	3.3	2.9	7.5	6.2
Autumn	30.4	13.8	24.5	6.3	3.0	2.7	13.4
avg.	12.6	16.3	18.7	4.9	3.0	3.8	9.9
nanoplankton							
Winter	3.3	29.3	21.0	9.3	11.5	10.4	14.1
spring	1.7	21.9	16.5	4.1	2.5	0.9	7.9
summer	4.2	5.9	8.5	2.6	2.3	5.9	4.9
Autumn	20.6	10.9	19.3	5.0	2.4	2.1	10.0
avg.	8.8	12.9	14.8	3.9	2.4	3.0	7.6
netplankton							
Winter	0.9	10.6	5.5	2.5	3.0	2.8	4.2
spring	0.4	5.8	4.3	1.1	0.7	0.3	2.1
summer	1.1	1.6	2.3	0.7	0.6	1.6	1.3
Autumn	9.8	2.9	5.1	1.3	0.6	0.6	3.4
avg.	3.8	3.4	3.9	1.0	0.6	0.8	2.3

Diversity index values were high in the upper lake compared to the lower one, chiefly the southernmost station (No.6) (Table 10). Its values within the green algae (0.01- 2.5) increased than blue green algae (0.01 - 0.94) and diatoms (0.01 and 2.02). This results revealed the instability of the 2nd lake compared to the first one. Diversity index values less than 1 indicate instability or heavy pollution, while values exceeding 3 indicate stability or clean water (Swartz, 1978). Also, the dominance of blue green algae by few species in this depression leads to reduction in diversity (Moritou-Apostopoulou, 1981).

Similarity index as shown in the dendrogram (Fig. 3) revealed the high relationship between stations 2 and 3 (79.61%) of the upper lake. The discharging area of El-Wadi drain into the 1st lake (St. 1) is forever loaded with high nutrient concentrations (N and P) and may be explain the high similarity index between stations 2 and 3.

Table (10): Diversity index in Wadi El-Rayian Lakes during 2006

	1	2	3	4	5	6	Avg
Green algae							
winter	1.20	1.05	1.54	2.40	0.79	0.01	1.17
spring	0.48	1.49	1.67	0.20	0.20	0.10	0.69
summer	2.50	2.50	1.90	1.70	0.20	0.30	1.52
autumn	0.56	0.20	0.80	0.69	0.30	0.10	0.44
Avg.	1.19	1.31	1.48	1.25	0.37	0.13	0.95
Blue green algae							
winter	0.94	0.75	0.81	0.72	0.51	0.23	0.66
spring	0.40	0.29	0.32	0.21	0.21	0.10	0.26
summer	0.21	0.59	0.33	0.10	0.10	0.01	0.22
autumn	0.16	0.60	0.16	0.10	0.37	0.10	0.25
Avg.	0.26	0.49	0.27	0.14	0.23	0.07	0.24
Diatoms							
winter	2.02	0.43	0.55	0.48	0.47	0.49	0.74
spring	0.37	1.03	1.00	0.10	0.10	0.48	0.51
summer	1.50	0.29	0.96	1.40	0.27	0.48	0.82
autumn	0.01	0.01	1.38	0.10	0.56	0.01	0.35
Avg.	0.63	0.44	1.11	0.53	0.31	0.32	0.56

However, salinity concentration increased southwards in the 2nd lake that also explain the high conformity between stations 4 and 5 (76.32 %). On the other side, the lowest diversity values between the first and second lakes confirmed the great variation between the biotic and abiotic characteristics between the two lakes.

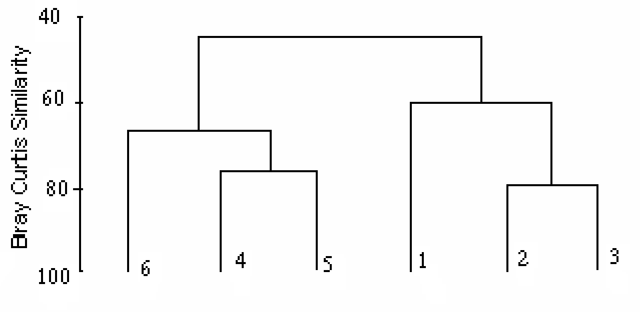

Figure 2: Bray Curtis Similarity indices between different sites in Wadi El-Rayian Lakes 2006

Trophic state index (TSI) depending on the total weight of living algae (biomass) revealed high TSI in the upper lake (41 – 84) compared to the lower one (33 – 69).

According to Carlson's trophic index, the first reservoir is classified as mesotrophic or eutrophic water, while the second lake oligotrophic or eutrophic.

Table (11): Trophic state index (TSI_{Chl})

	1	2	3	4	5	6
Winter	51	84	78	66	69	68
Spring	41	79	74	54	47	33
summer	55	60	65	48	46	60
autumn	80	68	77	57	46	45
avg.	57	73	73	56	52	51

The current trophic status, increased over time through human activities neighboring this depression. So, this study recommend to prevent discharging the wastes of fish farms or at least treatment of any effluents before their flowing into the lakes.

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العلاقة بين زيادة المخصبات والعوالق النباتية فى بحيرات وادى الريان، الصحراء الغربية-مصر

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بدأت هذه الدراسة الموسمية على بحيرات وادي الريان سنة 2006 وذلك بهدف معرفة تأثير إنشاء العديد من المزارع السمكية وزيادة المخصبات الأساسية من النيتروجين والفسفور على مجموعات العوالق النباتية.
أوضحت هذه الدراسة زيادة تركيز المخصبات الأساسية من النيتروجين والفسفور وخاصة الأمونيا والتي زادت 9.5 أضعاف القيم المسجلة في الدراسات السابقة. وأيضا زادت ملوحة البحيرة الثانية بعد إنشاء العديد من المزارع السمكية حول منخفض وادي الريان.
أشارت النتائج أيضا زيادة الكثافة العددية للعوالق النباتية في المسطح الأول عن المسطح الثاني. وكانت أعلى قيمها في الشتاء وأقلها في الصيف. ولقد سادت الطحالب الخضراء المزرقة (الميكروسيست فلوس أكوا والاريجينوزا وكذلك الينبيا ليمنتكا) والطحالب الخضراء في المسطح الأول بينما الدياتومات والسوطيات في المسطح الثاني. وأظهرت النتائج أيضا أن طحالب المياه العذبة هي الأكثر انتشارا في المسطح الأول بينما سجلت بعض أنواع المياه المالحة لأول مرة في المسطح الثاني.
التنوع البيولوجى ضعيف في بحيرات وادي الريان وخاصة في المنخفض الثاني. وهناك تشابه كبير في الخصائص الكيميائية والحيوية بين الوسط والجنوب في كل من البحيرتين الأولى والثانية. يصنف المنخفض الأول من بحيرات وادي الريان مابين متوسط ومرتفع الخصوبة بينما المسطح الثاني مابين ضعيف ومرتفع الخصوبة.
منخفض وادي الريان تزيد خصوبته تدريجيا نتيجة صرف المزارع السمكية المحيطة بالمنخفض مما أدى إلى ازدهار الطحالب الخضراء المزرقة خلال فصل الخريف والشتاء والربيع ونقص الأنواع الأخرى من الطحالب الدقيقة.
توصى هذه الدراسة بصرف المزارع السمكية في قنوات خاصة بعيدا عن منخفض وادي الريان والاستفادة منها في زيادة خصوبة الأراضي المستصلحة لشباب الخريجين والمنتشرة حول هذا المنخفض في الصحراء الغربية.