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ALGAL FLORA OF AIN HELWAN
I. ALGAE OF THE WORM SPRING

Sanaa M. M. Shanab

Botany department, Faculty of science, Cairo University

Abstract

Seasonal water samples were collected during the period of April 2004 to January 2005 and physico-chemical analyses were performed for each sample. Isolation and identification of the different algal species were carried out. Concerning the physical water characteristics, temperature of the water samples, during the period of study, ranged 26 - 30 ºC, pH values ranged 6.9 – 7.78 and light intensities, received by the surface of shallow water of the spring, ranged 26.4-115 Klux. On the other hand the values of chemical water characteristics (anions, cations, micronutrients) were seasonally fluctuated and no detection of cobalt and cadmium were recorded. The total identified algal flora in the water samples of the four seasons recorded 209 species and 116 genera belonging to 8 algal divisions; Cyanobacteria, Chlorophyta, Bacillariophyta, Chrysophyta, Xanthophyta, Euglenophyta, Dinophyta and Charophyta. Cyanobacteria were the maximally represented division (91 species and 29 genera) during the period of study, followed by Chlorophyta (59 species and 45 genera), Bacillariophyta (52 species and 35 genera), Chrysophyta and Euglenophyta were represented each by (2 species and 2 genera).While, the least representative algal divisions were Charophyta, Dinophyta and Xanthophyta (1 species and 1 genera). The largest algal biomass was recorded in winter sample (138 species and 92 genera) followed in descending order by autumn (87 species and 56 genera), summer (71 species and 45 genera) and spring samples (48 species and 25 genera). It seemed that the diversity of algal flora in water samples was mainly controlled by and significantly correlated with some physico-chemical characteristics of water samples.

Key Words: Algal flora, Ain Helwan, Physico-chemical analyses, Worm Spring.

Introduction

Many researches have been reported in different parts of the world concerning thermal springs as in Czechoslovakia, Greece, Italy, India, Japan, Pakistan, Spain, Saudia Arabia, South Africa, USA and USSR (Kullberg, 1971; Ali *et al*, 1983; Nikitina, 1983; Foged, 1984; Schoeman and Archibald, 1988; Arif, 1989; Seoane, 1990; Jha and Kumar, 1990). Egypt has a fair number of thermal springs distributed in Cairo, Suez, Sinai and Western desert. A lot of geochemical, hydrogeological studies (El Ramly, 1969; Issar *et al*, 1971; Swanberg *et al*., 1976 and 1984; El Kiki *et al.*, 1978; Abdou, 1994) and phycological researches (Shaaban and El Habibi, 1978; Shaaban, 1985; Abou-El kheir and Ismail, 1986; Abou-El kheir and Mekky, 1986; Hamed 1995) were done dealing with separate and or combind comparative studies on the different springs and recording their algal communities.

The algal flora of Ain Helwan was partly studied by Abou-El Kheir and Mekky, 1986 (identified 34 taxa belonging to Bacillariophyta (25 species), Cyanobacteria (5 species) and Chlorophyta (4 species), Hamed, 1995 (compared the algal flora of 10 Egyptian thermal springs), and El-Gamal and Salah El-Din,

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1999 identified a new species from Ain Helwan spring (*Compsopogon helwanii*). These studies concluded that each spring in Egypt has its own chemical characteristics and algal flora.

From the historical point of view, Ain Helwan spring is a permanent spring which started flowing in 1939 during the construction of the Cairo-Helwan railway and still flowing till now. This spring and many old and new sulphur springs (≈ 8) lie in an area east of the Nile River and 25 km South of Cairo between El-Maasara in the North and El-Tabbin in the south.

Water temperature range (26-30 °C) did not show large changes with time which indicates that these springs receives most of their water from great depth (originate from the Nubian sandstone aquifer and water moves upward through a thick fractured limestone strata along fault planes affecting the area, feeding these springs with their water). Chemical analysis of spring's water, from previous studies, (Abdou, 1994, Hamed 1995), showed that it contained large amounts of dissolved salts (considered as brackish water as it contained 0.4 % NaCl), small amounts of metals (Cu, Zn and Al), and radioactivity within the permissible dose. Based on the physico-chemical properties, Helwan Springs have long been used for natural mud therapy and its water is useful in treatment of chronic articular disease and certain skin disorders (Abdou, 1994).

The studies conducted on the water quality and floral composition of Ain Helwan hot spring over many years have resulted in questioning weather there are changes in algal species composition due to change in water quality of the spring. Accordinglly this work was designed to investigate the seasonal changes in population of different thermophilic algal species inhabiting the water of the spring.

Material and Methods

The worm spring of Ain Helwan (Figure 1), can be divided into three sites, the original site (1) surrounded by hexagonal cement building of 5 meters height and 3.5 meters in diameter, (its temp. was 30 ºC) Figure (2a), then the water of the spring pass through an underground passage (≈ 100 meters long) then it pass upward on the ground surface through an exposed granite part (temp. 28 ºC, it termed site 2), which is about 1 meter large and high and of more than 100 meters long. The first 15 meters of the passage was more covered with fixed slimy colored algal growths (grey filaments, dark blue-green and brown patches and spots), as seen in Figure (2b and c). The granite part, leads to the second exposed shallow, narrow and muddy passage of the spring (called site 3). It is of 0.5 meter large and about 0.3-0.5 meter deep in some parts of its passage and more than 100 meters long. Its temperature was 26 ºC and it was inhabited by dense algal growths (tufts and aggregation of long green filaments were obviously seen on water surface together with epipelic blue green and/or brown growths) Figure (2d). The worm spring is terminated by a shallow lake-like part (160 m^2) where many children were swimming since four years ago. But nowadays, this lake was inhabited by dense hydrophytic plants, (Figure 2e and f) such as

Phragmites sp. (+++), *Juncus subulatus* Forssk (+), *Typha domingensis* Pers. (+++), *Cyperus laevigatus* L. (++) and *Cynodon* sp. (++).

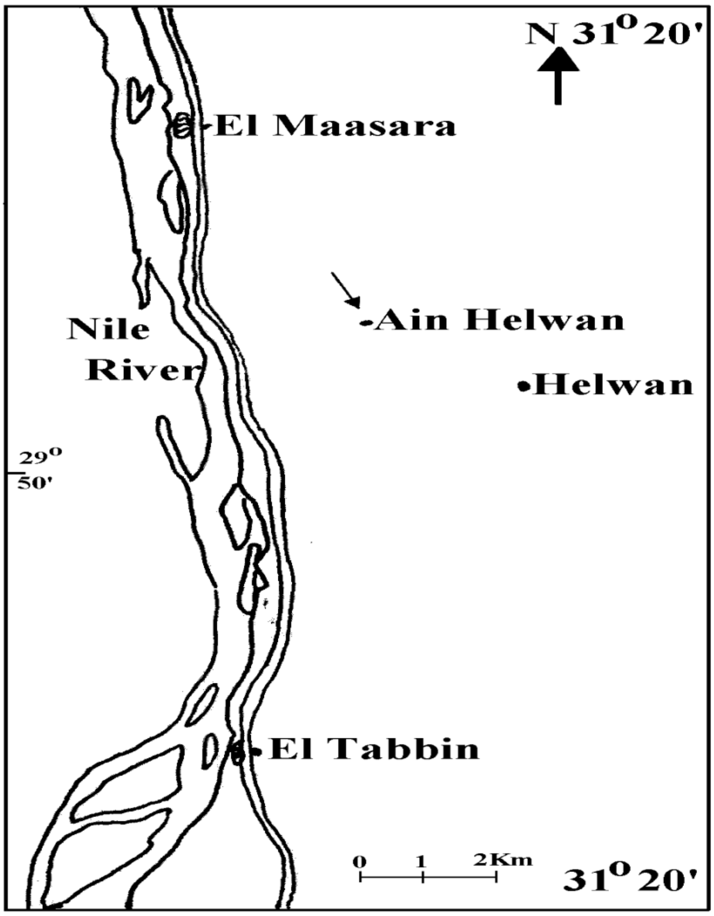
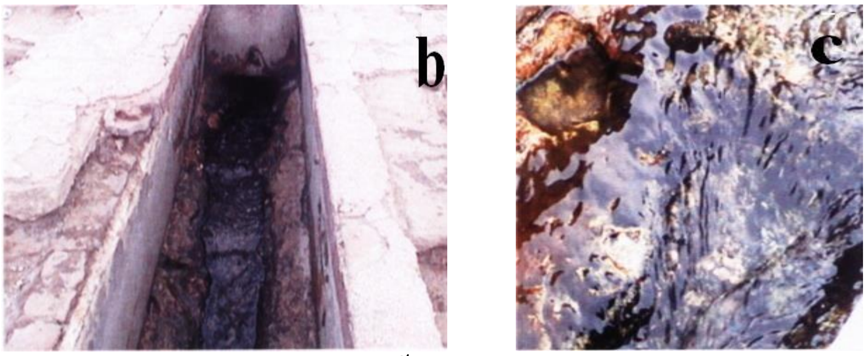


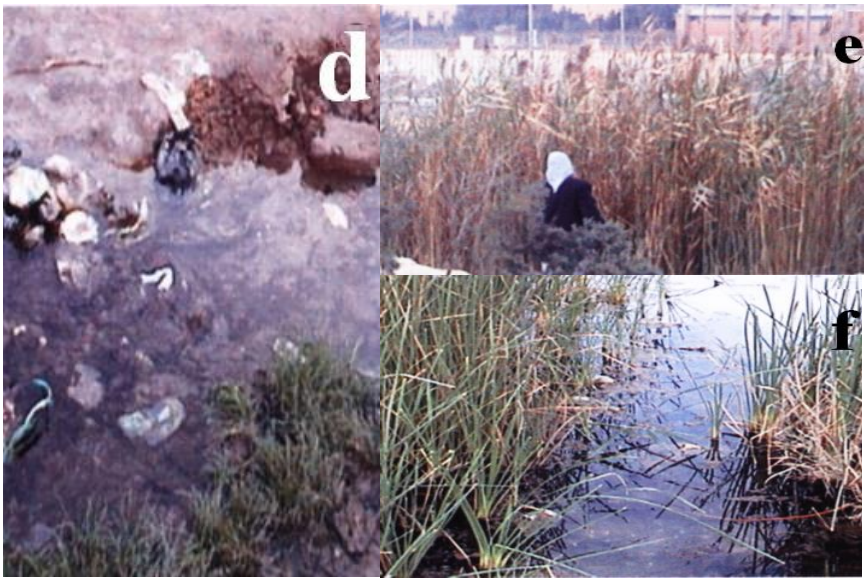
Figure (1): Location of Ain Helwan Spring From (Abdou, 1994)

To study the different characteristics of the warm spring of Ain Helwan and its algal flora, samples were collected from the three sites of the spring and physico-chemical analysis were performed as well as microscopic examination of algal taxa and their identification. No algal presence in water sample from site (1), while the exposed site (2) have always fixed slimy unchangeable algal flora on the walls and bottom of the passage. Samples from these algae were collected by scratching with a knife and Table (2) showed the identified algal flora of site (2) of the spring. The exposed muddy site (3) have free living and epipelic algal flora, which was found by continuous sample examination, to undergo different seasonal changes. So, seasonal water samples were collected from site (3) of the spring to study the seasonal variations in the algal flora as affected by both physical and chemical water characteristics.

a- The original site with cement building surrounding the spring



b and c- The 1st exposed granit site



d- The 2nd exposed muddy site
e and f- The terminal lake-like inhabited with different hydrophytes

Figure (2): The Warm Spring of Ain Helwan

1. Collection of water samples from the three sites of the spring

Water samples were collected from the three sites of Ain Helwan according to the method of Bourrelly (1970); its physico-chemical characteristics and algal identification were performed.

2. Collection of Seasonal water samples (from site 3).

Water samples from site (3) of the spring were seasonally collected, in 1L glass-bottles at approximately the same morning time of each season [spring sample was collected at 14 April 2004, summer sample at 14 July 2004, autumn sample at 14 October 2004, winter sample at 14 January 2005 and were given the signs L1, L2, L3 and L4, respectively]. Each water sample was divided into three parts:

The 1st part was preserved in 4% formalin and used for the identification of the algal species.

The 2nd part was kept in the incubator at 20 ± 1^{o} C under continuous illumination of 30 µE / m^2 / s (using cool white fluorescent lamps).

The 3rd part was used for the determination of the physico-chemical analyses.

3. Physical parameters

The following physical analyses were carried out:

a- pH; *in situ* by pH meter (ORION) model 230 A portable pH / ISE Meter Instruction Manual.

b- Light intensities were measured *in situ* using LT Lutron Lx-101 digital Lux Meter Operation Manual Digital Lux Meter.

c- Temperatures were measured *in situ* using thermometer.

4. Chemical analyses

Different methods of chemical analyses were performed for water samples. Soluble anions, cations, chemical oxygen demand (COD), biological oxygen demand (BOD), macro- and micro-nutrients and heavy metals (Cu, Ni, Zn, Co, Cd and Pb) were also determined according to Doeck and Tracy (1956), Boyed (1984), and APHA (1985).

5. Algal identification and Photography

Identification of the algal species was carried out according to Desickachary (1959), Bourrelly (1968, 1970 and 1972), Prescott (1978 and 1982), Foged (1980) and Cox (1996). The algal species were sketched and photographically recorded using Nikon Labo-Photo (AFX-II) microscope combined with camera (Nikon Fx-35, Japan). Most photos were magnified by (x 400) except otherwise cited in the plates.

Results and Discussion

The Physico-chemical characteristics of water samples of the worm spring (Table 1) revealed that the covered (control) original site (1) and the two exposed sites (2, 3) have almost similar values of total soluble salts (TSS), pH, soluble anions, BOD and cations (except a slight increase in Mg^{2+} and decrease in Na^{+} of water sample in site 3) while variations in temperatures and COD values were recorded.

COD increased markedly in sites (2 and 3) and this increase was much more pronounced in site (2). The temperature of the three sites varied and fluctuated between 30, 28 and 26 °C in sites (1, 2 and 3), respectively. Phosphorus decreased in site (3) and increased in site (2) as compared with its value in site (1). Iron value was slightly decreased in site (3) while it was completely absent in site (2). It is worthy to mention that the data of cupper content revealed its absence in sites 1 and 2, while it is unexpectedly present in site (3).

Table (1): Physico-chemical analyses of water samples from sites (1, 2 and 3) of Ain Helwan worm spring.

Chemical Analysis	Water Samples		
	Site(1)	Site (2)	Site (3)
Total soluble salts ppm	4.90	4.85	4.90
EC as mM / mL	3136	3104	3136
pH	6.84	7.00	7.42
Water temperature (°C)	30	28	26
Soluble Anions (mg/L)			
Carbonate CO_3^{--}	—	—	—
Bicarbonate HCO_3^-	4.50	4.40	4.50
Chloride Cl^-	43.26	44.03	43.45
Sulfates SO_4^{--}	3.36	3.65	2.94
Soluble Cations (mg/L)			
Ca^{++}	10.50	10.39	9.95
Mg^{++}	9.40	9.44	10.77
Na^+	30.87	31.92	29.82
K^+	13.65	12.87	13.65
COD (mg / L)	29.00	49.00	38.00
BOD (mg / L)	9.00	9.00	9.00
Macro- and Microelements (mg/L)			
N^{+++} (%)	0.06	0.05	0.05
P^{+++}	36.50	41.40	31.30
Fe^{++}	52.30	—	41.85
Mn^{++}	0.95	0.25	0.75
Zn^{++}	—	—	—
Cu^{++}	—	—	0.102

(Samples were collected in winter where the air temperature was 15 °C).

Microscopic examination of the water sample from the three sites of the spring of Ain Helwan showed no algal presence in the covered original site (1), which might be mainly due to the unavailability of natural light penetration, a cause of the hexagonal cement building which surround the origin of the spring (inspite of the suitability of other physical and chemical characteristics of this water for algal growth). A scratched sample from the exposed granite site 2 showed an aggregation of gray filaments fixed on the walls and identified as

Lyngbya birgie together with other Cyanobacteria, Chlorophyta and Bacillariophyta species, which were mainly present on the bottom of the passage and recorded in Table (2). These algal species might be thermophilic and pollution tolerant species as site 2 receive always pollutants (as detergents and others) from the visitors who use the water of this place and the polluted water pass to site (3) altering some of its chemical characteristics (phosphorus, iron, cupper and COD contents) and consequently its algal flora.

Table (2): Algal Flora of the exposed granite place (2) of the warm Spring of Ain Helwan (all over the year).

№	Cyanobacteria	Bacillariophyta	Chlorophyta
1	*Chroococcus minor* (Kütz)Naegell	*Amphora clevei* Grun.	*Cerasterias staurastroides* West & West
2	*Isocystis messanensis* Borzi	*Cymbella cistula* (Hempr.) Kirvh.	*Enteromorpha compressa* (Linnaeus) Nees
3	*Lyngbya birgie* G.M.Smith	*Denticula tenuis* Kuetz.	*Mougeotia scalaris* Hassal
4	*L .erugineo-coerulea* (Kütz.) Gommont	*Fragilaria capucina* Desmazieres	*Pseudopleurococcus printzii* Vischer
5	*L. tenue* Gommont	*Gyrosigma acuminatum* (Kuetz.) Rabenhorst	-
6	*L. perelegans* Lemmermann	*Navicula angusta* Grunow	-
7	*Microcoleus Lacustris* (Rab.) Forlow	*Nitzschia linearis* (C.A. Agardh) W. Smith	-
8	*Myxosarcina spectabilis* Geitter	*N.frustulum* (Kütz.) Grunow	-
9	*O .acuminate* Gommont	*N. obtuse* W. Smith	-
10	*O .limnetica* Lemmermann	*Stauroneis parvula* var. proninula Grunow	-
11	*O. tenuis* var. tergestina Rabenhorst	*Surirella oblonga* Her.	-
12	*O. rubescens* De Cand	-	-
13	*Synechocystis aquatilis* Sauvageau	-	-
Total species	13	11	4
Total genera	7	9	4

Cyanobacteria was represented by (7 genera and 13 species), Chlorophyta by (4 genera and 4 species) and Bacillariophyta by (9 genera and 11 species). Algal flora of this exposed granite site (2) of the sprin was found to be extremely stable allover the year and could be controlled mainly by the worm temperature of the water. These were in confirmity with the findings of Lund (1965) and Sompong *et al*. (2005).

The second exposed muddy passage (site 3) of the spring have different algal flora which are affected by seasonal physico-chemical changes of the water. On the contrary to sites (1 and 2), site (3) showed seasonally different algal flora. So this study was directed and concentrated on the seasonal algal growths in water of passage (3) as affected by the seasonal physico-chemical characteristics of water.

The limited variations in seasonal temperatures (26-30 ºC) recorded in this study (Table 3), and confirmed by the previous investigations of Abdou (1994) and Hamed (1995), indicated that, this spring (considered worm according to Meinzer,1923) receives its water from great depths. Any increase or decrease in algal populations seemed to be correlated with fluctuations in water temperatures. This was in accordance with the results obtained by Lund (1965), Thompson and Guo (1992) and Kobbia *et al*. (1995).

Table (3): Seasonal physico-chemical analyses of water samples (site 3) of Ain Helwan during 2004 –2005.

Parameters		Water Samples			
		L1 (Spring)	**L2 (Summer)**	**L3 (Autumn)**	**L4 (Winter)**
Physical Analyses	**Temperature (ºC)**	28.5	30	27.5	26
	pH	7.28	7.68	7.78	6.92
	Light intensity (klux)	60	115	46.3	26.4
Chemical Analyses	**Anions (mg / mL)**				
	PO_4-P	0.00003	0.093	0.145	0.072
	NH_4-N	0.047	0.009	0.0005	0.045
	NO_3-N	0.023	0.0005	0.002	0.006
	SiO_3^{-2}	0.098	0.111	0.082	0.048
	Cl^-	0.035	0.060	0.050	0.040
	CO_3^{--}	2.4	1.8	5.1	6.0
	HCO_3^-	9.0	11.4	8.4	6.0
	Heavy metals (µg / mL)				
	Zn	0.02	0.02	0.04	0.04
	Pb	0.02	0.09	0.132	0.010
	Cu	0.03	0.120	0.101	0.16
	Ni	0.146	0.00	0.00	0.392
	Co	0.00	0.00	0.00	0.00
	Cd	0.00	0.00	0.00	0.00

The recorded pH values of the water in this study were mostly shifted to the alkaline side (6.92 – 7.78). This tendency could be mainly due to the higher activity of photosynthetic processes of the dense algal populations which were controlled by the seasonal water characteristics. Such assumption seemed to be in confirmity with the findings of Kobbia *et al*. (1993).

The fluctuated seasonal light intensities (26.4- 115 Klux), received by the water surface of the shallow Spring during different light/dark cycles and the recorded algal flora indicated that light and temperature of the Spring water could be the most controlling physical factors affecting algal productivity. These results were in harmony with the results obtained by Carvalho and Malcata (2003); Sompong *et al*. (2005) and Abrontes *et al*. (2006) who emphasized the predominant role of water temperature and light in phytoplankton succession.

According to the chemical characteristics, water of Ain Helwan Spring is classified as brackish water habitat contained 0.4 % NaCl as reported by Hamed (1995) and this was confirmed by the higher abundance of mesohalobien algal species [*Enteromorpha compressa* (Green), *Oscillatoria tenuis* (Cyanobacteria) and *Nitzschia palea* (Diatom)]. The filamentous green alga, *E. compressa* was found persisted in all seasonal water samples, and it was normally found in marine habitats, confirmed the brackish nature of the spring water which stimulated the growth of certain α–mesohalobien species (Hamed, 1995).

The total identified algae/year were 209 species and 116 genera belonging to 8 algal divisions; Cyanobacteria, Chlorophyta, Bacillariophyta, Chrysophyta, Euglenophyta, Xanthophyta, Charophyta and Dinophyta.

Winter samples recorded the maximum algal flora followed in descending order by autumn, summer and spring ones as recorded in Table 4 and 5 (L4 > L3 > L2 > L1). These results were in confirmity with the findings of Reeders *et al.* (1998); Ali (2000); Gaballah *et al.* (2000) and Domingues *et al.* (2005) who reported the importance of light and micronutrient factors influencing phytoplankton distribution.

Cyanobacteria dominated by 91 species and 29 genera, which represented 43.54% and 25 % of the total recorded algae, respectively and as illustrated in Plates (I and II) and Tables (4 and 5). The prokaryotic Cyanobacterial cells were characterized by its tolerance and adaptability to grow under wide range of seasonal physico-chemical water variabilities. This was obviously noticed in Cyanobacterial dominance allover the year (Table 5). These results were in accordance with the results obtained by Kobbia *et al*. (1993).

Chlorophyta Plate (III and IV) with 59 species and 45 genera represented 28.23 % and 38.79 % subdominated Cyanobacteria not only in total algal mass production/year but also in seasonal samples (except for winter sample where diatoms subdominated the Cyanobacteria). Higher temperature and light intensities in summer and spring seasons were inhibitory to members of Chlorophyta, Bacillariophyta and those of other divisions.

Bacillariophyta followed Chlorophyta was represented by 52 species and 35 genera of 24.88 % and 30.17 % as shown in Plate (V) and Tables (4 and 5). Diatoms flourished in winter and subdominated Cyanobacteria in this season.

This was confirmed by the marked decrease in silicate content in winter. Pennate forms always predominated the centric forms; this oligotrophic tendency of pennate forms was also obtained by Kobbia *et al*. (1990 and 1995). Abundance of mesohalobien diatoms (*Synedra* and *Nitzschia*) were recorded together with some oligohalobien ones (*Amphora* and *Navicula*).

Division Euglenophyta, Chrysophyta, Dinophyta, Charophyta and Xanthophyta were very poorly presented in the spring seasonal water samples during the period of study. They were found during autumn and winter samples which were considered the most favourable seasons for algal growths not only for the three main algal divisions (Cyanobacteria, Chlorophyta and Bacillariophyta) constituting the water algal community but also to members of other divisions.

Table (4): Seasonal algal composition of the water samples of Ain Helwan Spring during 2004-2005.

Algal Species	**Seasonal Water Samples**			
	L1 (Spring)	**L2 (Summer)**	**L3 (Autumn)**	**L4 (Winter)**
Cyanobacteria				
Albrightia tortusa Copeland	—	—	—	+
Anabaena viguieri Denis and Fremey	—	—	—	+
Anabaena spiroides Klebahn	+	—	—	+
Anabaena spiroides var. crassa Lemmermann	+	—	—	+
Anabaena helicoidea Bernard	+	—	—	+
Anabaena iyengari Bharad	+	—	—	—
Anabaena affinis Lemmermann	+	—	—	—
Anabaena wisconsienense Prescott	+	—	—	—
Aphanothece castagnei (Bréb.) Rabenhorst **#**	+	+	+	+
Aphanothece elabens (Bréb.) Elenkin	—	—	+	+
Aphanothece caldariorum Richter **#**	+	+	+	+
Aphanothece elachista (West and West) Starmach	—	+	+	+
Aphanothece nidulans Richter	—	—	—	+
Aphanocapsa delicatissima West and West	—	+	—	—
Borzia trilocularis Cohn	—	+	—	—
Chroococcus minor (Kütz.) Naegeli	—	+	—	+
Chroococcus turgidus (Kütz.) Naegeli	+	—	—	—
Cyanareus hamiformis Pascher	—	—	+	—
Cyanoptyche gloeocystis Pascher fo. minor Starmach	—	+	—	+
Dactylococcopsis acicularis Lemmermann **#**	+	+	+	+
Dactylococcopsis fascicularis Lemmermann **#**	+	+	+	+
Gomphosphaeria aponina Kuetzing	—	—	—	+
Lithococcus schizodicwarmomum Copeland	—	+	+	+
Lyngbya valderianum Gomont	+	+	—	+
Lyngbya tenue Gomont	+	+	—	+
Lyngbya turidum Gomont	—	+	—	+
Lyngbya lucidum Kütz.	—	+	+	+
Lyngbya contorta Lemmermann	—	—	—	+
Lyngbya lagerheimii (Moebius) Gomont	—	—	+	+
Lyngbya perelegans Lemmermann **#**	+	+	+	+
Lyngbya aerugineo-caerulea (Kuetzing) Gomont	—	—	+	+
Lyngbya bipunctata Lemmermann **#**	+	+	+	+
Lyngbya spirulinoides Gomont	+	+	—	—
Lyngbya tylorii Drouet and Strickland	—	—	+	+
Lyngbya birgei G.M. Smith	+	+	+	—
Lyngbya latissima Prescott	—	—	+	—
Lyngbya limnetica Lemmermann	—	—	+	—
Lyngbya putealis Montagne	+	+	—	—
Lyngbya autumnale (Agardh) Gomont	+	—	—	—
Mastigocoleopsis obtuse (Carter) Geitler	—	—	—	+
Microcystis aeruginosa Kütz.	+	+	—	—
Microcystis elachista (West and West) Starmach **#**	+	+	+	+

Microcystis viridis (A. Braun) Lemmermann	—	—	+	—
Microcoleus vaginatus (Vaucher) Gomont	—	+	+	+
Microcoleus acutissimus Gardner	—	+	—	—
Myxosarcina dubia Ercegovic	—	—	+	+
Myxosarcina spectabilis Geitler and Ruttner	—	—	—	+
Nodularia spumigena Mertens	—	—	—	+
Nodularia implexa (Bornet and Flah) Nordstedt and Wittrock	+	—	—	—
Nodularia harveyana Thuret	+	—	—	—
Nostoc piscinale Kütz.	—	+	—	—
Nostoc paludosum Kütz.	+	—	—	+
Nostoc linckia (Roth) Bornet and Flash	+	—	—	+
Nostoc carneum C.A. Agardh	—	—	—	+
Nostoc parmelioides Kütz.	+	—	—	—
Oscillatoria platensis (Nordstedt) Geitler	—	—	—	+
Oscillatoria tenuis C.A. Agardh	—	—	+	+
Oscillatoria limnetica Lemmerman	+	—	—	—
Oscillatoria rubescens De Cand.	—	—	+	—
Oscillatoria limosa (Roth) C.A. Agardh.	—	—	+	—
Oscillatoria sancta (Kütz.) Gomont	—	—	+	—
Oscillatoria chalybea Mertens	—	—	+	—
Oscillatoria tenuis var. tergestina (Kütz.) Rabenhorst	—	—	+	—
Oscillatoria hamelii Frémey	—	—	+	—
Oscillatoria okeni Agardh	—	+	—	—
Oscillatoria acuminata Gomont	—	+	—	+
Oscillatoria margaritifera Kütz.	—	+	—	—
Oscillatoria lacustris (Klebahn) Geitler	—	+	+	—
Phormidium retzii (C.A. Agardh) Gomont	—	—	+	—
Phormidium ambiguum Gomont	—	+	+	+
Phormidium mucicola Naumann and Huber Pestalozzi	—	—	+	—
Plectonema nostocorum Bornet #	+	+	+	+
Plectonema purpureum Gomont	—	+	—	+
Plectonema malayense Biswas	+	—	+	—
Plectonema notatum Schmidle #	+	+	+	+
Plectonema wollei Farlow	—	+	—	—
Pseudanabaena catenata Lauterb.	+	—	—	—
Rhodostichus expansus Geitler and Pascher	+	+	—	—
Schizothrix lacustris A. Braun	—	—	—	+
Schizothrix muelleri Naegeli	—	—	—	+
Spirulina laxa G.M.Smith	—	+	—	—
Spirulina major Kütz.	—	—	—	+
Spirulina subsalsa Oersted	—	+	+	+
Synechococcus vantieghemi Pringsheim	—	+	+	+
Synechococcus nidulans (Pringsheim) Komarek	—	—	—	+
Synechococcus cedrorum Sauvageau	—	+	—	—
Synechocystis aquatilis Sauvageau #	+	+	+	+
Stigonema turfaceum (Berkeley) Cooke	—	—	—	+
Stigonema mamillosum (Lyngb) C.A. Agardh	—	—	—	+
Stigonema minutum (Agardh) Hass.	+	—	—	+
Stigonema mesentericum Geitler	+	—	—	—
Tubiella elenkini Hollerbach.	+	—	—	+
Chlorophyta				
Actinastrum hantzschii Lagerheim	—	+	—	—
Ankistrodesmus fractus (West and West) Brunn	+	—	—	—
Ankistrodesmus braunii (Naegeli) Brunn	—	—	+	—
Apatococcus lobatus (Chodat) Boye Petersen	—	+	+	—

Bracteacoccus minor (Chodat) Petrova	—	—	—	+
Cerasterias irregularis G.M. Smith	—	—	+	+
Chaetophora elegans (Roth.) C.A. Agardh	—	—	+	+
Chlorococcum humicola (Naegeli) Rabenhorst	—	—	+	+
Chlorococcum wimmeri Rabenhorst emend Starr	—	—	+	+
Chlorella vulgaris Beyerinck	—	+	+	+
Chloronomala palmelloides Mitra	—	—	—	+
Chlorosarcina consociata (Klebs) G. M. Smith	—	—	—	+
Closterium lunuta (Müller) Nitzsch	—	+	—	—
Coelastrum cambricum Archer	—	+	—	+
Coelastrum microsporum Naegeli	—	—	—	+
Crucigenia tetrapedia (Kirchner) West and West	+	+	+	—
Cyanoptyche gloeocystis Pascher fo. minor Starmach	—	+	+	—
Dactylococcus infusionum Naegeli	—	—	+	+
Desmococcus vulgaris Brand	—	—	+	
Enteromorpha compressa (Linnaeus) Nees **#**	+	+	+	+
Eremosphaera viridis De Bary	—	—	—	+
Genicularia spirotaenia De Bary	—	—	—	+
Hormidiella parvula Iyengar and Kanthamma	—	—	—	+
Hyaliella polytomoides Pascher	—	—	—	+
Kentrosphaera gloeophila (Bohlin) Brunnthaler	—	—	—	+
Kirchneriella elongata G.M. Smith **#**	+	+	+	+
Kirchneriella contorta (Schmidle) Bohlin	—	—	+	+
Kirchneriella lunaris (Kirchner) Moebius	+	+	+	—
Microthamnion strictessimum Rabenhorst	—	—	—	+
Mougeotia floridana Trans	—	—	+	+
Mougeotia genuflexa (Dillw.) C.A. Agardh	—	—	+	—
Mougeotia scalaris Hassall	—	+	—	—
Muriella terrestris Petersen fo.major	—	—	+	+
Murelliopsis pyrenigera Reisigl	—	—	+	—
Myremecia aquatica G.M. Smith	—	—	—	+
Neochloris aquatica Starr	—	—	+	+
Palmodictyon varium (Naegeli) Lemmermann	—	+	—	—
Pandorina morum (Müller) Bory	—	—	—	+
Planktosphaerella terrestris Reisigl	—	—	—	+
Polytoma obtusum Pascher	—	—	+	—
Pseudopleurococcus printzii Vischer	—	—	+	+
Rhizoclonium hookeri Kütz.	—	—	—	+
Rhopalocystis oleifera Schuss	—	—	—	+
Schizomeris leibleinii Kütz.	—	—	+	+
Schroederiella papillata Korch	—	—	—	+
Spirotaenia condensate Breb.	—	—	—	+
Spirogyra porticalis (Muell.) Cleve	+	+	+	—
Spirogyra rhizobrachialis Jao.	—	—	+	—
Spirogyra majuscula Kütz.	—	+	—	—
Spirogyra varians (Hassall) Kütz.	—	+	—	—
Tetraedron muticum (A. Braun) Hansgirg	—	—	—	+
Tetraedron minimum (A. Braun) Hansgirg	—	—	—	+
Tetraedron obesum (West and West) Wille	—	—	—	+
Trochiscia obtusa (Reinsch) Hansgirg	—	—	+	+
Tussetia elaiogenetes Moewus	—	—	+	—
Ulothrix subtilissima Rabenhorst	—	—	+	+
Ulothrix tenuissima Kütz.	—	+	—	—
Ulothrix aequalis Kütz.	—	+	—	—
Uronema elongatum Hodgetts	—	—	—	+
Bacillariophyta				
Actinocyclus sp. Ehrenberg **#**	+	+	+	+

Achnanthes lanceolata (Bréb.) Grunow	—	—	—	+
Amphora ovalis Kütz.	+	+	—	+
Amphora clevei Grunow **#**	+	+	+	+
Amphora libyca Ehrenberg	—	—	—	+
Asterionella Formosa Hassall	—	—	—	+
Bacillaria paradoxa Gmelin	—	—	—	+
Biddulphia laevis Ehrenberg	—	—	+	+
Brebissonia boeckii (Ehrenberg) Grunow	+	+	—	+
Campylodiscus noricus var. hibernicus (Ehrberg) Grunow	—	—	+	—
Cocconeis placentula (Her.) var. euglypta (Her.) Cleve	—	—	—	+
Coscinodiscus lacustris Grunow **#**	+	+	+	+
Cymbella cistula (Ehrenberg) Kirchner	—	+	+	—
Denticula elegans Kütz.	—	+	+	+
Denticula tenuis Kütz.	—	—	+	—
Denticula Kuetzingii Grunow	—	—	—	+
Diatoma mesodon (Ehrenberg) Kütz.	—	—	—	+
Diatomella sp. Greville	—	—	+	—
Fallacia hudsonis (Grunow and Cleve) A.J. Strickle and D.G. Mann	—	—	—	+
Fragillaria capucina Desmazières	—	—	+	+
Fragillariforma virescens (Ralfs) Williams and Round	—	—	—	+
Gomphoneis herculeana (Ehrenberg) Cleve	—	—	—	+
Gomphonema lanceolatum var. insignis (Greg.) Cleve	—	—	—	+
Gyrosigma acuminatum (Kuetzing) Rabenhorst	—	+	+	+
Hantzchia amphioxys (Ehrenberg) Grunow	—	—	—	+
Mastogloia dansei Thwaites and W. Smith	—	—	+	+
Melosira italica (Ehrenberg) Kuetzing	—	—	+	—
Melosira granulata (Ehrenberg) Ralfs	—	+	—	+
Meridion circulare (Greville) Agardh	—	—	—	+
Navicula certa Hust.	—	+	—	—
Navicula digitoradiata fo. minor Foged.	+	+	—	+
Navicula halophila (Grun.) Cleve	—	—	—	+
Navicula viridula (Kuetzing) var. rostellata (Kuetzing) Cleve	—	—	—	+
Navicula tuscula (Ehrenberg) Grunow fo. rostrata Hustedt	—	—	—	+
Navicula slesvicensis Grunow	—	—	—	+
Neidium magellanicum Cleve	—	—	—	+
Nitzschia interrupta (Reichelt) Hust.	—	+	—	—
Nitzschia bilobata W. Smith	—	—	+	—
Nitzschia recta Hantzsch and Rabenhorst	—	—	—	+
Nitzschia ovalis Arnott	—	—	—	+
Nitzschia valdestriata Aleem and Hustedt	—	—	—	+
Nitzschia amphibia Grunow	—	—	—	+
Nitzschia palea (Kütz.) W. Smith	—	—	—	+
Opephora martyl Herib.	—	—	+	—
Rhoicosphenia curvata (Kütz.) Grunow	—	—	+	—
Rhopalodia gibba var. ventricosa (Ehrenberg) O. Mütter	—	+	—	+
Stauroneis parvula var. prominula Grunow	—	+	—	—
Surirella angusta Kütz.	—	—	—	+
Surirella oblonga Ehrenberg	—	—	+	+
Synedra rumpens Kütz.	—	—	—	+

Tabellaria fenestrata var. asterionelloides Grunow	—	—	—	+
Tabellaria flocculosa (Roth) Kütz.	—	—	—	+
Charophyta				
Tolypella intricata (trentep.) N. leonhardi	—	—	—	+
Chrysophyta				
Chrysamoeba radians Klebs	—	+	+	+
Chrysidiastrum catenatum Lanterborn.	—	—	+	+
Xanthophyta				
Tribonema bombycinum var. tenue Hazen	—	—	+	—
Dinophyta				
Amphidinium klebsii Kof.	—	—	+	+
Euglenophyta				
Euglena polymorpha Dangeard	—	—	—	+
Phacus orbicularis var. caudatus Skvortzow	—	—	—	+

+ = presence of algal species; — = absence of algal species. # = persisting species in the four seasonal samples.

Table (5): Seasonally isolated algal genera and species belonging to different divisions from water samples (site 3) during 2004-2005.

Algal Taxa	Water Samples					
	L1 Spring	L2 Summer	L3 Autumn	L4 Winter	Total algae per year	% per total algae
Cyanobacteria						
Species	36	39	38	53	91	**43.54**
Genera	15	18	14	24	29	**25**
Chlorophyta						
Species	6	17	28	38	59	**28.23**
Genera	5	13	23	33	45	**38.79**
Bacillariophyta						
Species	6	14	17	41	52	**24.88**
Genera	5	12	16	29	35	**30.17**
Chrysophyta						
Species	—	1	2	2	2	**0.96**
Genera	—	1	2	2	2	**1.72**
Euglenophyta						
Species	—	—	—	2	2	**0.96**
Genera	—	—	—	2	2	**1.72**
Xanthophyta						
Species	—	—	1	—	1	**0.86**
Genera	—	—	1	—	1	**0.48**
Charophyta						
Species	—	—	—	1	1	**086**
Genera	—	—	—	1	1	**0.48**
Dinophyta						
Species	—	—	1	1	1	**0.96**
Genera	—	—	1	1	1	**1.72**
Seasonal Isolated Algal Species	**48**	**71**	**87**	**138**	**209**	—
Seasonal Isolated Algal Genera	**25**	**45**	**56**	**92**	**116**	—

Chrysophyta was the only division of the previously mentioned five ones recorded in summer sample (1 genus and 1 species); this means that certain members of golden-brown algae could tolerate adverse physico-chemical characteristics of spring water in this season (*Chrysamaeba radians*).

From Table (4) certain species were found to be persisted in all seasonal samples and marked (#). Ten Cyanobacteria, two Chlorophyta and three Bacillariophyta species were recorded allover the year, which generally confirmed the high tolerance of Cyanobacteria species as well as certain species belonging to the other two divisions. However, it was not possible to correlate community structure with any specific environmental factor (Davey and Rothery, 1993) since each taxon varied independently to the others.

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الفلورا الطحلبية لعين حلوان
1- طحالب مياه العين الدافئه

ثناء محمود متولى شنب

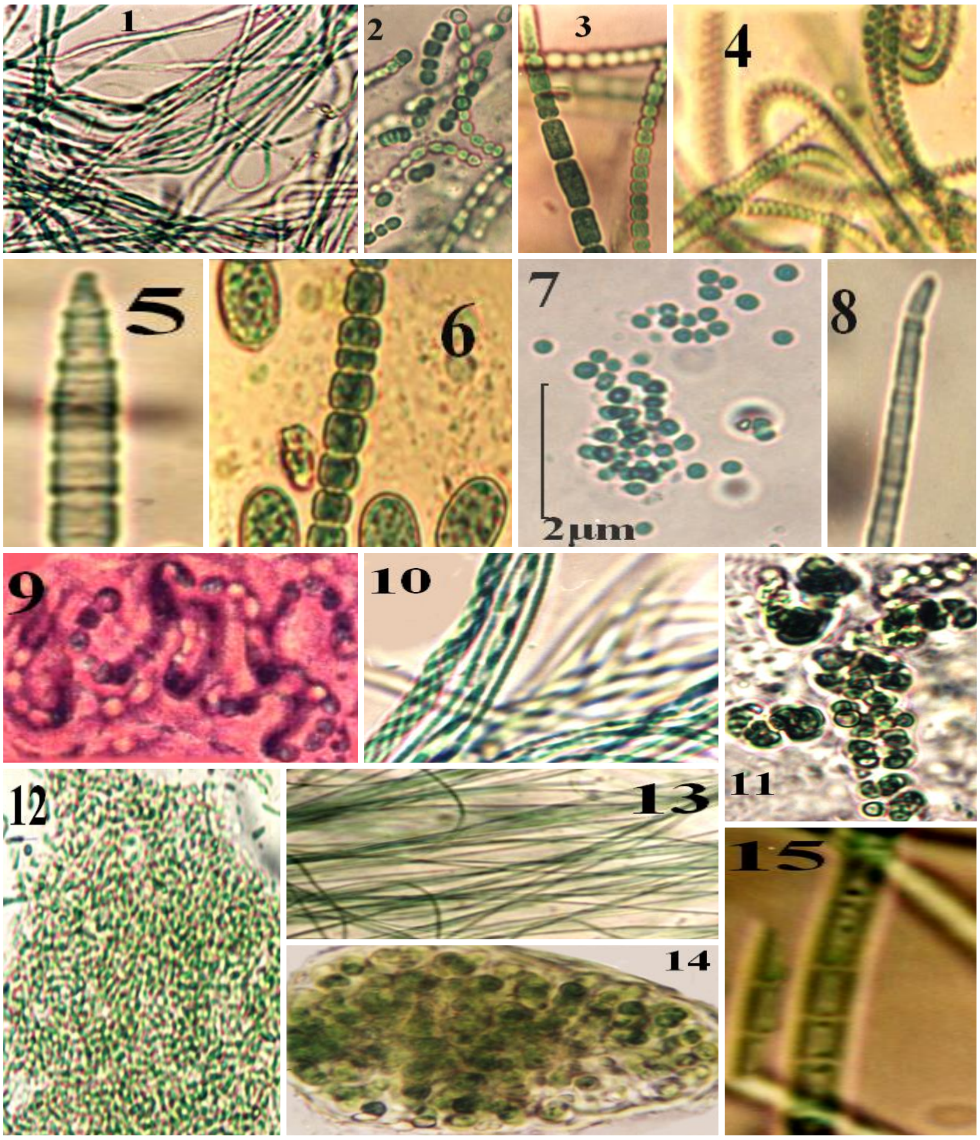
قسم النبات - كلية العلوم - جامعة القاهرة

تم جمع العينات الموسمية لمياه عين حلوان خلال مدة الدراسه من أبريل 2004 حتى يناير 2005 تم إجراء التحاليل الفيزيقوكيميائية لكل عينه. كما تم عزل و التعرف على الانواع الطحلبيه المختلفه.

بالنسبه للخواص الفيزيائيه لعينات الماء تراوحت درجات الحراره خلال مدة الدراسة بين 26-30 °م، الأس الهيدروجينى تراوح بين 6.9 - 7.78 و كانت شدة الاضاءه الساقطه على سطح الماء الضحل تتراوح بين 26.4 – 115 كيلولوكس. و من ناحيه أخرى فأن التحاليل الكيميائيه لعينات المياه (الإيونات و العناصر الغذائيه الصغرى) أظهرت تباينا و تذبذبا فى الفصول المختلفه بالضافه الى عدم وجود اى اثر للكوبلت و الكادميوم بها. العدد الكلى للفلورا الطحلبيه التى تم التعرف عليها فى عينات المياه كانت تحتوى على 209 نوع (116 جنس) منتميه الى 8 مجاميع طحلبيه هى السيانوبكتريا, الطحالب الخضراء, الدياتومات, الطحالب البنية-الذهبية, الطحالب الخضراء- المصفرة, اليوجلينيه, الدواره و الكاريه. تمثل العدد الاكبر من الفلورا الطحلبيه (خلال مده الدراسه) فى السيانوبكتريا (91 نوع , 29 جنس) تليها الطحالب الخضراء (59 نوع , 45 جنس) ثم الدياتومات (52 نوع , 25 جنس) فالطحالب البنية-الذهبية و اليوجلينيه التى مثل كل منهما (2 نوع , 2 جنس). أما العدد الادنى من الفلورا الطحلبيه فكان للطحالب الكارية والخضراء-المصفرة والدوارة التى تم التعرف على جنس واحد و نوعا واحدا من كل منهم فقط. أحتوت عينه المياه فى فصل الشتاء على أعلى نمو من الطحالب فى المجاميع المختلفه تليها تنازليا عينه الخريف فالصيف ثم الربيع. و لقد ظهر من نتائج هذه الدراسة وجود علاقة هامة بين التنوع فى الفلورا الطحلبية الفصلية وبعض الخواص الفيزيقوكيميائية لعينات مياة العين.

Plate I

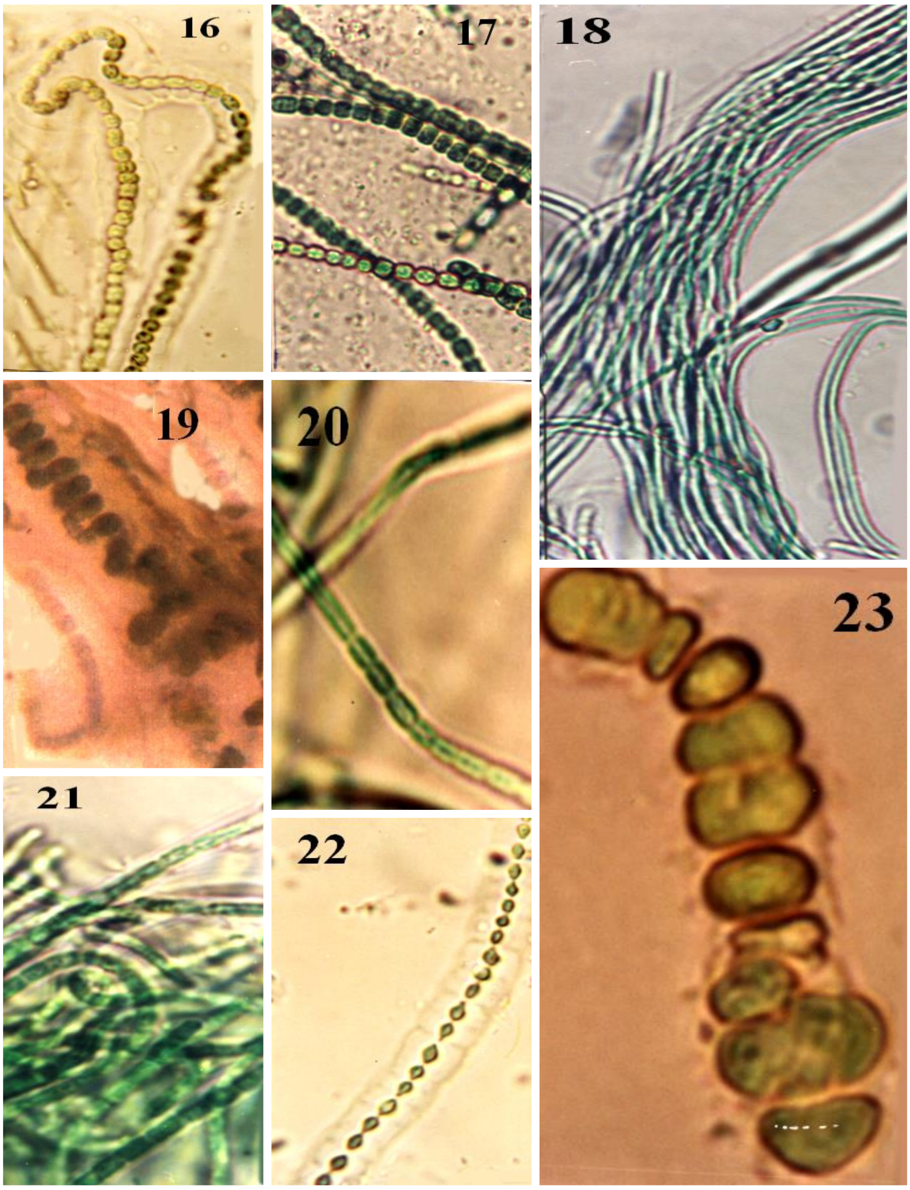
Certain Cyanobacteria species inhabiting water of Ain Helwan (Site 3) at different seasons during 2004-2005.



1. ***Plectonema nostocorum*** **Bornet.**
2. ***Nostoc Linckia*** **(Roth) Bornet et Flah.**
3. ***Pseudanabaena catenata*** **Lauterb.**
4. ***Spirulina subsalsa*** **(Oersted) Agardh.**
5. ***Oscillatoria okeni*** **Agardh.**
6. ***Anabaena Iyengari*** **Bharad.**
7. ***Microcystis aeruginosa*** **(Kütz.) Kütz.**
8. ***Oscillatoria acuminata*** **Gomont.**
9. ***Nostoc paludosum*** **Kütz.**
10. ***Schizothrix lacustris*** **A.Braun.**
11. ***Stigonema minutum*** **(Ag.) Hass.**
12. ***Aphanothece caldariorum*** **Richter.**
13. ***Lyngbya tenue*** **Gomont.**
14. ***Stigonema mamillosum*** **(Lyngb.) C.A. Agardh.**
15. ***Lyngbya bipunctata*** **Lemm.**

Plate II

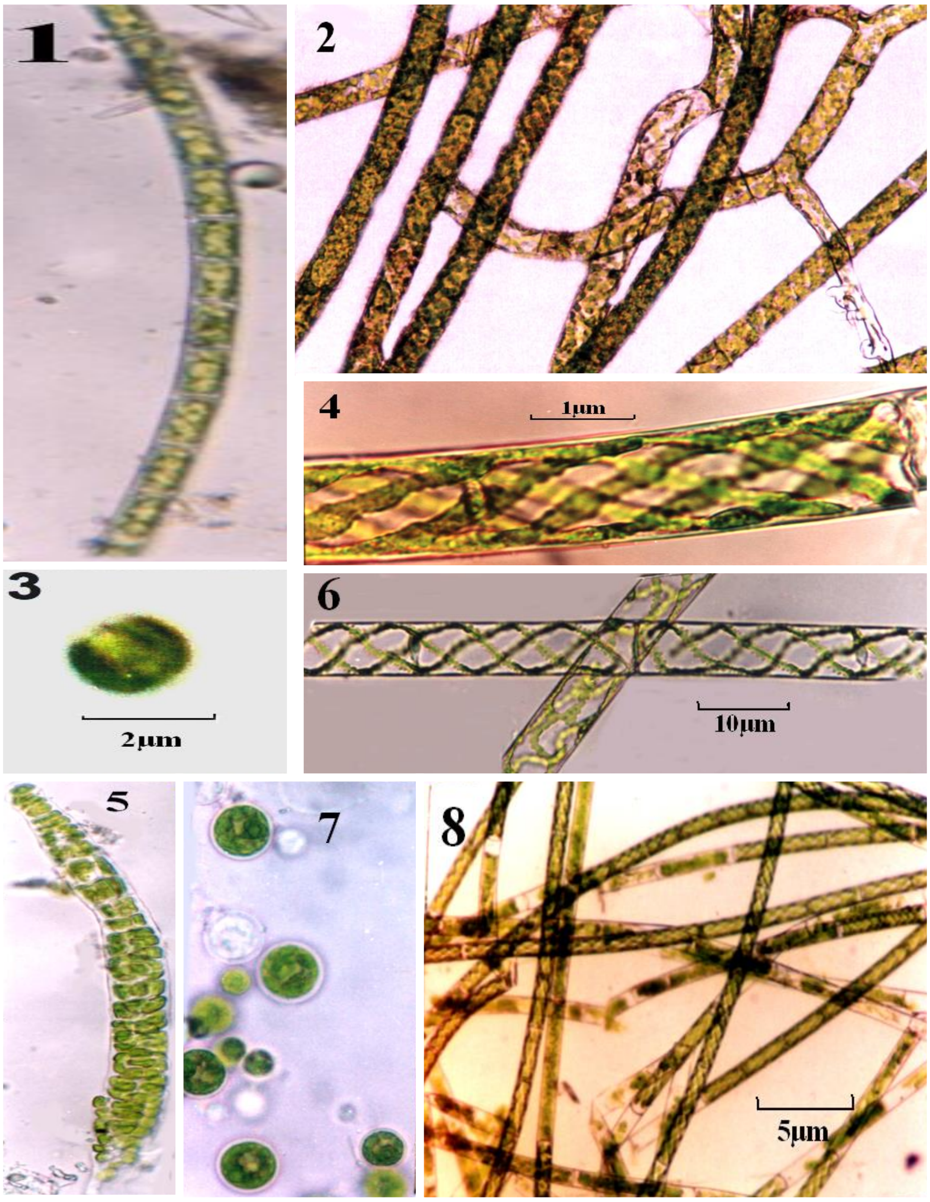
Certain Cyanobacteria species inhabiting water of Ain Helwan (Site 3) at different seasons during 2004-2005.



16. *Albrightia tortusa* Copeland (x 1000). 17. *Nodularia implexa* Bornet et Flah.
18. *Microcoleus vaginatus* (Vaucher) Gomont. 19. *Anabaena helicoidea* Bernard.
20. *Lyngbya turidum* Gomont. (x 1000). 21. *Lyngbya valderianum* Gomont. (x 1000).
22. *Mastigocoleopsis obtusa* (Carter) Geitler. 23. *Nodularia harveyana* Thuret (x 1000).

Plate III

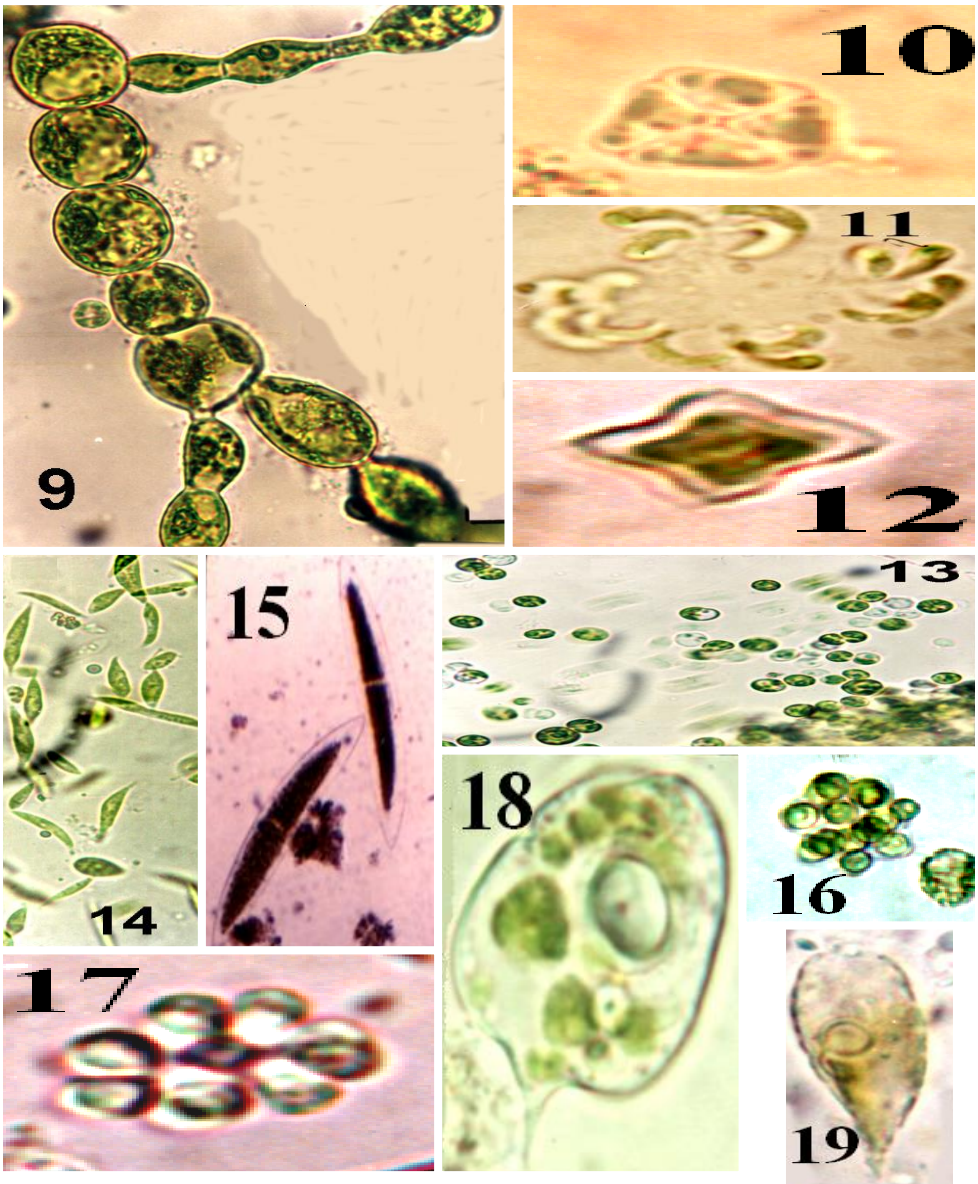
Certain Chlorophyta species inhabiting water of Ain Helwan (Site 3) at different seasons during 2004-2005.



1. ***Mougeotia scalaris*** **Hassal.** **2.** ***Spirogyra rhizobrachialis*** **Jao. (x 200).**
3. ***Chlorella vulgaris*** **Beijer.** **4.** ***Spirogyra porticalis*** **(Muell.) Cleve (x 1000).**
5. ***Schizomeris leibleinii*** **Kütz.** **6.** ***Spirogyra pratensis*** **Transeau (x 200).**
7. ***Chlorococcum humicola*** **(Naeg.) Rabenhorst.**
8. ***Spirogyra acquinoctialis*** **G.S.West (x 100)**

Plate IV

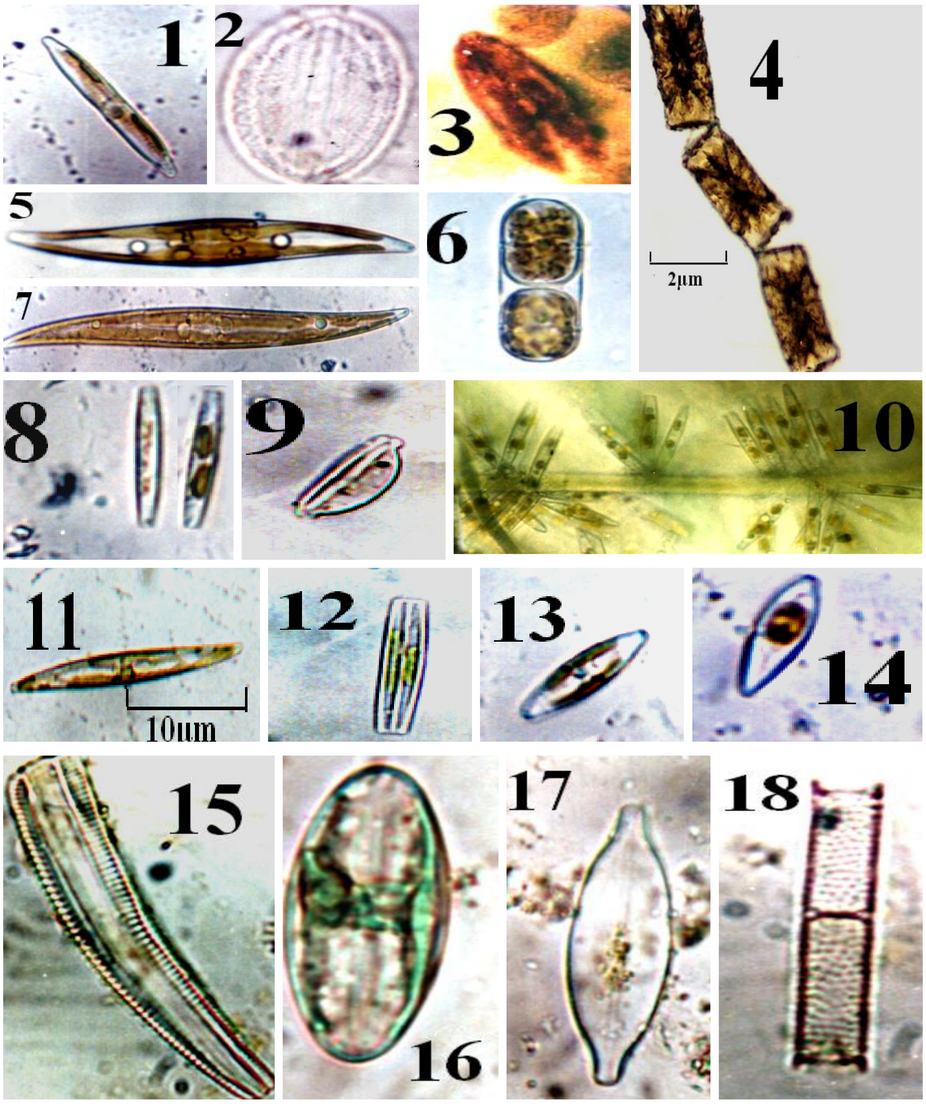
Certain Chlorophyta and Euglenophyta species inhabiting water of Ain Helwan (Site 3) at different seasons during 2004-2005.



9. *Pseudopleurococcus printzii* Vischer **10. *Crucigenia tetrapedia* (Kirch.) West and West**
11. *Kirchneriella elongata* G. M. Smith **12. *Tetraedron minimum* (A. Braun) Hansgirg**
13. *Muriella terrestris* Petersen fo. major
14. *Ankistrodesmus braunii* (Naeg.) Brunn. and *A. fractus* (West and West)Brunn.
15. *Closterium lunula* (Müller) Nitz. **16. *Coelastrum microsporum* Naegeli.**
17. *Pandorina morum* (Müller) Bory. **18. *Phacus arbicularis* var. Caudatus Skvortzow.**
19. *Euglena polymorpha* Dangeard. (all photo x 1000).

Plate V

Certain Bacillariophyta species inhabiting water of Ain Helwan (Site 3) at different seasons during 2004-2005.



1. ***Nitzschia recta*** **Hantzsch ex Rabenhorst.** **3.** ***Neidium magellanicum*** **Cleve.**
2. ***Cocconeis placentula*** **Ehr. var. euglypta (Ehr.) Cleve.** **4.** ***Biddulphia Laevis*** **Ehrenberg.**
5. ***Gyrosigma acuminatum*** **(Kütz.) Rabenhorst.** **6.** ***Melosira dickiei*** **(Thwaites) Kuetzing.**
7. ***Gyrosigma spencerii*** **(W.Smith) Cleve.** **8.** ***Nitzshia palea*** **(Kütz.) W.Smith.**
9. ***Cymbella cistula*** **(Hempr.) Grunow.** **10.** ***Nitzschia ovalis*** **Arnott.**
11. ***Navicula digitoradiata*** **(Gregory) Ralfs.** **12.** ***Fragillaria capucina*** **Desmazières.**
13. ***Fallacia hudsonis*** **(Grunow and Cleve) A. J. Stickle and D.G. Mann.**
14. ***Gomphonema olivaceum*** **(Hornemann)Brébisson (Photo8-14 are x 160).**
15. ***Rhoicosphenia curvata*** **(Kütz.) Grun.** **16.** ***Amphora ovalis*** **Kütz.**
17. ***Anomoeoneis spherophora*** **(Kütz.) Pfitzer.** **18.** ***Melosira granulate*** **(Ehr.)Ralfs.**