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List of phytoplankton species of the northeastern part of Lake Manzala, Egypt

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ABSTRACT

The present study was conducted in Lake Manzala at Ashtoum El-Gamil Protected Area that locates in the northeastern part of the lake. Subsurface water samples for phytoplankton investigation were collected monthly from four sites during October 2013-September 2014. A list of 109 species was identified and classified into a specific level. The recorded species belonged to 59 genera and was classified into seven Phyla. Bacillariophyta was the most diversified group with the highest number of the recorded species (51 species, 26 genera), constituting 47% of the phytoplankton community. The three Phyla; Chlorophyta, Dinoflagellata, and Cyanobacteria contained a relatively close number of species (17, 16 and 13 species, respectively) and occupied the second order, collectively belong to 27 genera, constituting 43% of the phytoplankton community. The other three Phyla; Euglenozoa, Charophyta, and Ochrophyta (Dictyochophyceae) were represented by a low number of species (5, 5, and 2 species, respectively forming 10%), and each belongs to two genera. The composition of the phytoplankton community in Lake Manzala was greatly influenced by the relatively high inflows of both freshwater and nutrients into the lake, producing a phytoplankton community dominated by Chlorophyta, and Cyanophyta which had fresh and brackish water affinity. In addition, receiving seasonal backflows of seawater from the Mediterranean Sea and Suez Canal enhanced the Bacillariophyta and Dinoflagelata species.

INTRODUCTION

Lake Manzala is the largest and most productive brackish coastal lakes fringing the Nile Delta of Egypt. It is located in the north-eastern extremity of the Nile Delta at latitudes 31°07′N and 31°30′N, and longitudes 31°48′E and 32°17′E **(Elmorsi *et al*., 2017)**. Its northern border is a narrow sandy beach, which separates the lake from the Mediterranean Sea. It is bounded by Suez Canal at the east, Damietta branch of the Nile to the west, Dakahliya province in the southwest and Sharkiya Governorate in the southeast **(El-Sherif and Gharib, 2001)**. Although the lake is still considered as the largest of the Egyptian Delta lakes, its area has been gradually decreased since the early decades of the last century. In 1900's its area was estimated at about 1,709 km^2 **(Fouad, 1926)**. The gross area of the lake was progressively reduced as estimated by satellite images during 1973 - 2013 from 1,100 km^2 in 1973 to 385 km^2 in 2013 **(Hereher, 2014; El-Asmar and Hereher, 2015)**. This shrinking in the lake area was attributed to the continuous processes of agricultural land, reclamation activities and to the construction of the coastal highway. The lake is shallow with a depth range of 0.6-1.5m, and 35 km length from northwest to southeast and 30 km width **(Abdel- Moati, 1985; Fayed, 2004; Rashad and Abdel-Azeem, 2010)**.

At the north border, Lake Manzala is connected to the Mediterranean Sea by five openings; they are from the east to west: old Ashtoum El-Gamil, new Ashtoum Al-Gamil, Al-Baghdadi, El-Deiba and Al-Burg . Near the northeast part, the lake is connected with the Suez Canal through a small canal (Al-Qabouti Canal). These six outlets supply the lake with marine water. The western and southern borders have many inlets that introduce great amount of wastewater discharges into the lake. The most important drainage are Bahr El-Baqar, Bahr Hadous, Ramsis, Al-Sirw, Abu Garida and Faraskur drains. The northwestern part of the lake is connected to Damietta estuary via the two canals El-Ratama and El-Souffara. These canals were constructed mainly to freshen the north-western part of the lake by Nile water during the flood season **(El-Bokhty, 1996; Aamer, 1999)**.

Ashtoum El-Gamil Protected Area was declared as a nature protectorate according to the Prime ministerial decree No. 459 for 1988. It locates in the eastern north corner of Lake Manzala, including old and new Ashtoum El-Gamil inlets (31°15'N, 32°l0'E). The main purpose for creating this protected area was the protection of many resident and migratory species of birds, marine and fresh water fish, natural plants and historical sites scattered throughout the lagoon. It represents a modest example of a highly threatened and rapidly disappearing habitat in Egypt and the Mediterranean basin **(Ibrahim, 1989; Meininger and Atta, 1992)**.

Phytoplankton constitutes the primary producers that able to absorb and assimilate nutrients in aquatic environments and comprise the base of the food chain **(Smolyakov *et al*., 2010)**. Thus, the diversity and abundance of phytoplankton in aquatic ecosystems reflect the ecological condition and, therefore, can used as a bioindicators of aquatic pollution and ecosystem health **(Abd El-Monem and Kanswa, 2001; Madkour *et al*., 2007a)**. Lake Manzala are heavily impacted by human activities and suffers from exposure to high inputs of industrial, domestic, and agricultural pollutants that can degrade water quality causing eutrophication and alter phytoplankton community **(Delgado, 1990; Ismail and Hettiarachchi, 2017)**. A number of studies have been conducted on the phytoplankton species composition and abundance of Lake Manzala **(Khalil, 1990; Gab-Allah, 1990; El-Naggar *et al*., 1997; El-Sherif and Gharib, 2001;**

Fathi *et al*., 2001, Salah El Din, 2005; Madkour, 2007a; Abd El-Karim, 2008; Ramdani *et al*., 2009; Deyab *et al*., 2019). However, the continuous change in the lake morphology and adding sources of industrial wastes has direct impact on its water quality and biodiversity, making the continuous monitoring of water quality is mandatory. The aim of the present research is to compile a taxonomically sound checklist of phytoplankton and to study the spatio-temporal variation in the species composition of phytoplankton in the north eastern part of Lake Manzala.

MATERIALS AND METHODS

Study area

The present study was conducted at Ashtoum El-Gamil Protected Area in Lake Manzala locates between Bahr El-Bashtier in the south and Ashtoum El-Gamil in the north. This area covers the part of the lake which is affected by sewage, agricultural and industrial wastes. Four sites were chosen to cover the different types of pollutants that affect the water quality and the phytoplankton growth in Lake Manzala. Site I locates at Bahr Al Kur in El-Gamil area and receives sewage and industrial wastes. Site II lies in front of New Boughaz El-Gamil (seawater exchange). Site III locates at Bahr El-Bashtier (industrial, agriculture and sewage wastes). Site IV lies at Al-Raswa in El-Qabouti Canal (sewage and industrial wastes) (Fig. 1). The coordinates of selected sites are represented in Table (1).

Fig. 1. Location of the studied sites in Lake Manzala.

Table 1. Coordinates of studied sites in the northeastern Lake Manzala.

Site	Location	Longitude	Latitude
I	Bahr Al Kur at Al Gamil area	31°13′44 ″N	32°13′21″E
II	Boughaz El-Gamil	31°16′04″N	32°12′34″E
III	Bahr El-Bashtier	31°15′07″N	32°10′19″E
IV	Al Raswa	31°14′08″N	32°16′49″E

Phytoplankton sampling and identification

Subsurface water samples (2 liters) for phytoplankton investigation were collected monthly from October 2013 to September 2014. For preservation, each sample was divided into two parts (1 liter each), one of them was preserved with Lugol's solution and the other with 4% neutral formalin. Each sample was then allowed to settle for two days and then the supernatant was siphoned off slowly and the volume was adjusted to 100 ml and kept in dark bottles until analysis. Phytoplankton species were investigated using inverted microscope (OPTIKA), and algal taxa were identified according to the standard references, including **Hendey (1964)**, **Riley (1967)**, **Prescott (1978)**, **Bourrelly (1980)** and **Botes (2003)**.

Statistical analysis

Differences between sites and months were tested by one way analysis of variance (ANOVA) using software program SPSS V. 17 with significant level at 0.05.

RESULTS

Phytoplankton species composition

In the present study, phytoplankton was collected for a year during October 2013-September 2014 at four sites from Ashtoum El-Gamil Protectorate in Lake Manzala. A total of 109 species belong to 59 genera was recorded and classified into seven Phyla. Bacillariophyta was the most diversified group with the highest number of the recorded species (51 species) belongs to 26 genera, constituting 47% of the phytoplankton community (Fig. 2). The three Phyla; Chlorophyta, Dinoflagellata and Cyanobacteria contained relatively close number of species (17, 16 and 13 species, respectively) and occupied the second order, collectively belong to 27 genera constituting 43% of the phytoplankton community. The other three Phyla; Euglenozoa, Charophyta and Ochrophyta (Dictyochophyceae) were represented by a very low number of species (5, 5 and 2 species, respectively forming 10%), and each belong to two genera (Fig. 2). The dominant genera, in terms of the number of species, were *Navicula*, *Nitzschia*, *Prorocentrum* (6 species each) and *Scenedesmus* (5 species).

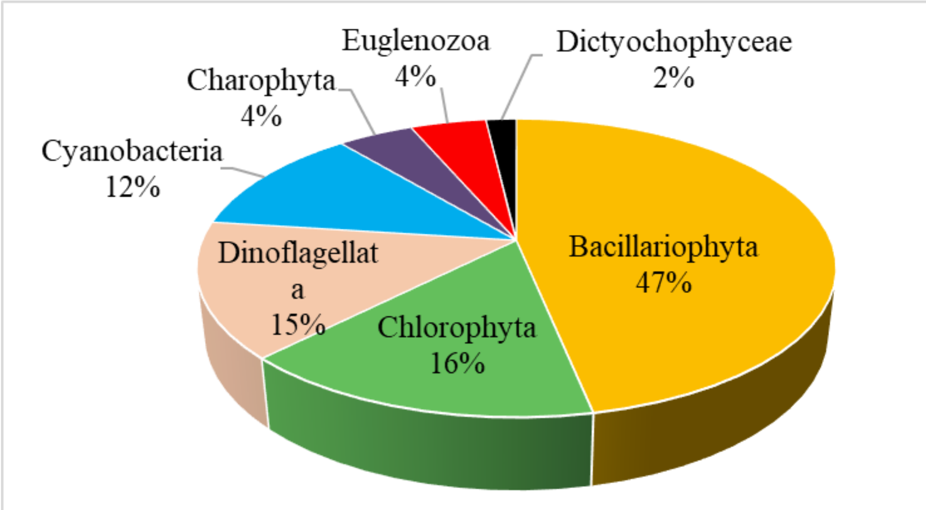

Fig. 2. The percentage of species number of each recorded phytoplankton group in Lake Manzala during October 2013-September 2014.

Spatio-temporal variation of phytoplankton species number

The total number of phytoplankton species recorded at each site in Lake Manzala varied monthly during study period (Fig. 3). Site I showed the highest number of species most of the year (range: 32-62 species in October and June, respectively), with significant monthly variation (ANOVA, $p<0.05$). Sites IV and III alternate the situation in terms of species number where site IV harboured more species during the period July-November, and site III harboured more species during the period January to June, with the same range of species number (34-55 species) and non significant monthly variation (ANOVA, $p>0.05$) for both sites. On the other hand, site II demonstrated the lowest number of species throughout the whole period of study (range: 27-51 species), with significant monthly variation (ANOVA, $p<0.05$).

The monthly average frequency of the all phytoplankton species in the whole study area showed high values during spring and summer seasons (March-August) with the maximum value (55 species) in June, while low values were observed during autumn and winter seasons (September-February) with the minimum value (37 species) in October (Fig. 4). During the entire study period, Bacillariophyta displayed the highest frequency (range: 15-28 species in October and June, respectively), followed by Chlorophyta which scored the second order in frequency, ranging between 7 species in January and February and 12 species in June. Cyanobacteria and Dinoflagellata came in the third and fourth orders, respectively and their frequency did not exceed 7 species throughout the whole study period. The remaining groups of phytoplankton showed lower frequency, collectively ranged between 2-5 species (Fig. 4).

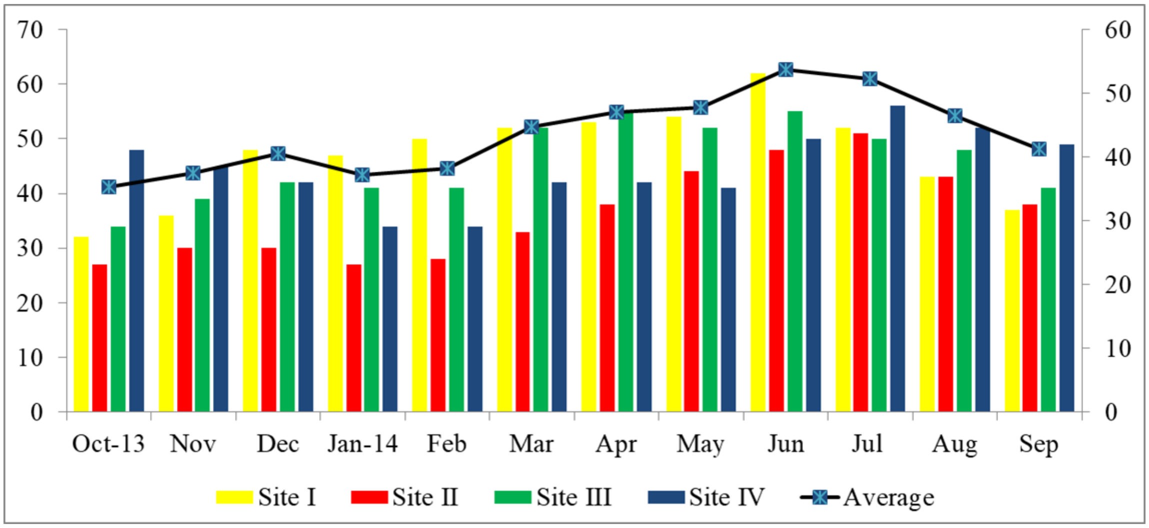

Fig. 3. Monthly variation of total phytoplankton species number at each site in Lake Manzala during October 2013 to September 2014.

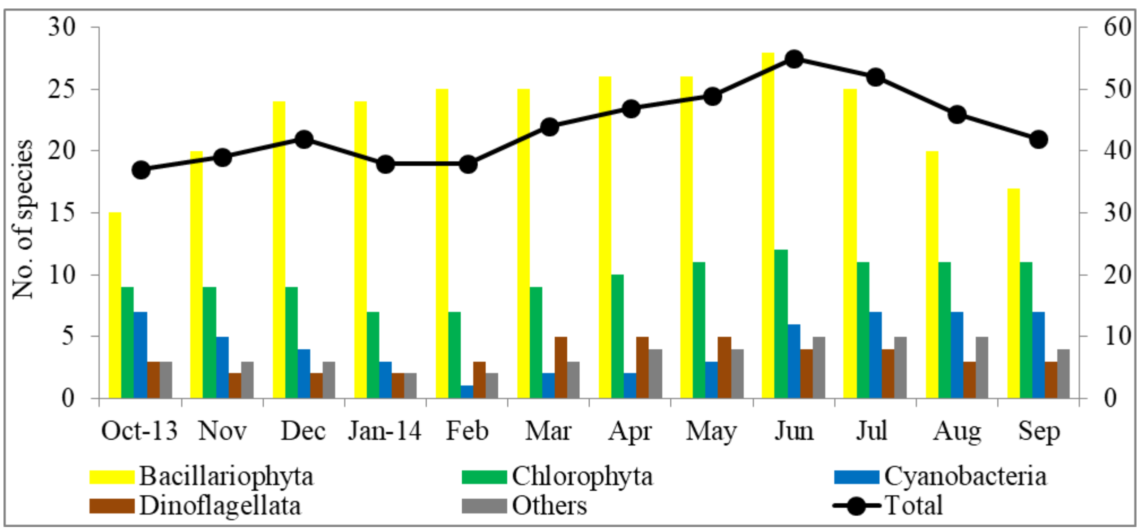

Fig. 4. Monthly average of the species number of phytoplankton groups in Lake Manzala during October 2013 to September 2014.

The annual average of species number of phytoplankton groups at each site during the whole study period illustrated little variation with non-significant difference (ANOVA, $p>0.05$). Bacillariophyta showed the highest frequency (range: 19-27 species at sites II and III, respectively), followed by Chlorophyta (range: 7-12 species at sites II and III, respectively) (Fig. 5). Cyanobacteria and Dinoflagellata ranged between 2-5 species while other groups did not exceed 2 species.

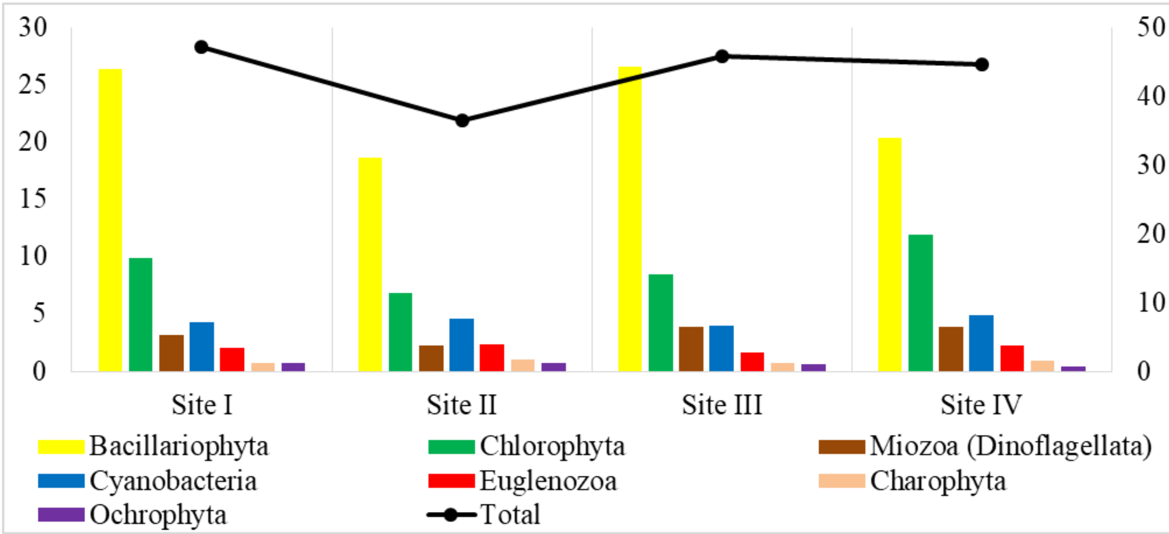

Fig. 5. The number of species of phytoplankton groups at each site in Lake Manzala during October 2013 to September 2014.

The list of the recorded phytoplankton species in Lake Manzala during October 2013 to September 2014 with their systematic position are given. The accepted names and valid taxonomy of the phytoplankton species are based on the taxonomic database online sites such as AlgaeBase.com (AB) and World Register of Marine Species (WoRMS).

Empire: Prokaryota Allsopp
Kingdom: Eubacteria Cavalier-Smith
Phylum: Cyanobacteria Stanier ex Cavalier-Smith
Class: Cyanophyceae Schaffner
Subclass: Nostocophycidae Hoffmann, Komárek & Kastovsky
Order: Nostocales Borzì
Family: Nostocaceae Eichler
Genus: *Anabaena* Bory ex Bornet & Flahault
A. azollae Strasburger
Genus: *Nostoc* Vaucher ex Bornet & Flahault
N. commune Vaucher ex Bornet & Flahault
Subclass: Oscillatoriophycidae L.Hoffmann, J.Komárek & J.Kastovsky
Order: Chroococcales Schaffner
Family: Microcystaceae Elenkin
Genus: *Gloeocapsa* Kützing
G. magma (Brébisson) Kützing
Genus: *Microcystis* Lemmermann
M. aeruginosa (Kützing) Kützing
Family: Chroococcaceae Rabenhorst
Genus: *Chroococcus* Nägeli
C. disperses (Keissler) Lemmermann

C. minor (Kützing) Nägeli
Order: Oscillatoriales Schaffner
Family: Oscillatoriaceae Engler
Genus: *Oscillatoria* Vaucher ex Gomont
O. rubescens De Candolle ex *Gomont*
O. tenuis C.Agardh ex Gomont
Order: Spirulinales J.Komárek, J.Kastovsky, J.Mares & J.R.Johansen
Family: Spirulinaceae (Gomont) L.Hoffmann, J.Komárek & J.Ka
Genus: *Spirulina* Turpin ex Gomont
S. platensis (Gomont) Geitler
S. subsalsa Oersted ex Gomont
Subclass: Synechococcophycidae L.Hoffmann, J.Komárek & J.Kastovsky
Order: Synechococcales L.Hoffmann, J.Komárek & J.Kastovsky
Family: Merismopediaceae Elenkin
Genus: *Merismopedia* Meyen
M. elegans Braun ex Kützing
M. punctata Meyen
M. tenuissima Lemmermann
Empire: Eukaryota Chatton
Kingdom: Chromista Cavalier-Smith
Phylum: Bacillariophyta Karsten
Class: Bacillariophyceae Haeckel
Subclass: Bacillariophycidae D.G.Mann
Order: Thalassiophysales D.G.Mann
Family: Catenulaceae Mereschkowsky
Genus: *Amphora* Ehrenberg ex Kützing
A. ovalis (Kützing) Kützing
Order: Cocconeidales E.J.Cox
Family: Cocconeidaceae Kützing
Genus: *Cocconeis* Ehrenberg
C. pediculus Ehrenberg
C. placentula Ehrenberg
C. scutellum Ehrenberg
Order: Cymbellales D.G.Mann
Family: Cymbellaceae Kützing
Genus: *Cymbella* C.Agardh
C. delicatula Kützing
Order: Naviculales Bessey
Family: Naviculaceae Kützing
Genus: *Gyrosigma* Hassall
G. acuminatum (Kützing) Rabenhorst
Genus: *Navicula* Bory
N. angusta Grunow
N. cancellata Donkin
N. cuspidate (Kutzing) Kutzing
N. gastrum (Ehrenberg) Kützing

N. lanceolata Ehrenberg
N. palpebralis Brébisson ex W.Smith
Genus: *Trachyneis* P.T.Cleve
T. aspera (Ehrenberg) Cleve
Family: Stauroneidaceae D.G.Mann
Genus: *Fistulifera* Lange-Bertalot
F. pelliculosa (Kützing) Lange-Bertalot
Family: Pleurosigmataceae Mereschowsky
Genus: *Pleurosigma* W.Smith
P. capense Petit
Family: Pinnulariaceae D.G.Mann
Genus: *Pinnularia* Ehrenberg
P. major (Kützing) Rabenhorst
P. variarea Metzeltin & Krammer
P. viridis (Nitzsch) Ehrenberg
Order: Lyrellales D.G.Mann
Family: Lyrellaceae D.G.Mann
Genus: *Petroneis* A.J.Stickle & D.G.Mann
P. monilifera (Cleve) Stickle & D.G.Mann
Order: Mastogloiales D.G.Mann
Family: Mastogloiaceae Mereschkowsky
Genus: *Decussiphycus* Guiry & Gandhi
D. placenta (Ehrenberg) Guiry & Gandhi
Order: Bacillariales Hendey
Family: Bacillariaceae Ehrenberg
Genus: *Cylindrotheca* Rabenhorst
C. closterium (Ehrenberg) Reimann & J.C.Lewin
Genus: *Nitzschia* Hassall
N. angularis W.Smith
N. australis (Peragallo) A.Mann
N. longissima (Brébisson) Ralfs
N. palea (Kützing) W.Smith
N. regula Hustedt
N. sigma (Kützing) W.Smith
Genus: *Pseudonitzschia* H.Peragallo
P. australis Frenguelli
P. delicatissima (Cleve) Heiden
Subclass: Fragilariophycidae Round
Order: Tabellariales Round
Family: Tabellariaceae Kützing
Genus: *Asterionella* Hassall
A. formosa Hassall
Genus: *Diatoma* Bory
D. elongate (Lyngbye) C.Agardh
D. mesodon (Ehrenberg) Kützing
D. vulgaris Bory

Genus: *Meridion* C.Agardh
M. circulare (Greville) C.Agardh
Order: Fragilariales P.C.Silva
Family: Fragilariaceae Kützing
Genus: *Fragilaria* Lyngbye
F. crotonensis Kitton
Genus: *Synedra* Ehrenberg
S. ostenfeldii (Willi Krieger) Cleve-Euler ex Stalberg
S. ulna (Nitzsch) Ehrenberg
Order: Thalassionematales Round
Family: Thalassionemataceae Round
Genus: *Thalassionema* Grunow ex Mereschkowsky
T. nitzschioides (Grunow) Mereschkowsky
Subclass: Eunotiophycidae D.G.Mann
Order: Eunotiales P.C.Silva
Family: Eunotiaceae Kützing
Genus: *Eunotia* Ehrenberg
E. arcus Ehrenberg
E. rhomboidea Hustedt
Class: Mediophyceae Medlin & Kaczmarska
Subclass: Thalassiosirophycidae Round & R.M.Crawford
Order: Stephanodiscales Nikolaev & Harwood
Family: Stephanodiscaceae I.V.Makarova
Genus: *Cyclotella* (Kützing) Brébisson
C. comta Kützing
C. meneghiniana Kützing
C. striata (Kützing) Grunow
Order: Thalassiosirales Glezer & Makarova
Family: Skeletonemataceae Lebour
Genus: *Skeletonema* Greville
S. costatum (Greville) Cleve
Class: Coscinodiscophyceae Round & R.M.Crawford
Order: Rhizosoleniales P.C.Silva
Family: Rhizosoleniaceae De Toni
Genus: *Rhizosolenia* Brightwell
R. setigera Brightwell
Subclass: Coscinodiscophycidae Round & R.M.Crawford
Order: Coscinodiscales Round & R.M.Crawford
Family: Coscinodiscaceae Kützing
Genus: *Coscinodiscus* Ehrenberg
C. centralis Ehrenberg
C. curvatulus Grunow
C. granii L.F.Gough
C. radiatus Ehrenberg
Subclass: Melosirophycidae E.J.Cox
Order: Melosirales R.M.Crawford

Family: Melosiraceae Kützing
Genus: *Melosira* C.Agardh
M. nummuloides C.Agardh
M. varians C.Agardh
Phylum: Miozoa Cavalier-Smith
Class: Dinophyceae F.E.Fritsch
Order: Amphidiniales Moestrup & Calado
Family: Amphidiniaceae Moestrup & Calado
Genus: *Amphidinium* Claperède & Lachmann
A. mootonorum Shauna Murray & D.J.Patterson
A. scissum Koifoid & Swezy
Order: Gymnodiniales Apstein
Family: Gymnodiniaceae Lankester
Genus: *Gymnodinium* F.Stein
G. catenatum H.W.Graham
Genus: *Akashiwo* G.Hansen & Moestrup
A. sanguinea (K.Hirasaka) Gert Hansen & Moestrup
Family: Gyrodiniaceae Moestrup & Calado
Genus: *Gyrodinium* Kofoid & Swezy
G. instriatum Freudenthal & J.J.Lee
Family: Kareniaceae Bergholtz, Daugbjerg, Moestrup & Fernández-Tejedor
Genus: *Karenia* Gert Hansen & Moestrup
K. brevis (C.C.Davis) Gert Hansen & Moestrup
Family: Ptychodiscaceae (Schütt) Lemmermann
Genus: *Ptychodiscus* Stein
P. noctiluca Stein
Order: Peridiniales Haeckel
Family: Peridiniaceae Ehrenberg
Genus: *Peridinium* Ehrenberg
P. cinctum (O.F.Müller) Ehrenberg
Family: Podolampadaceae Lindemann
Genus: *Podolampas* F.Stein
P. palmipes Stein
P. spinifera Okamura
Order: Prorocentrales Lemmermann
Family: Prorocentraceae F.Stein
Genus: *Prorocentrum* Ehrenberg
P. cordatum (Ostenfeld) J.D.Dodge
P. gracile F.Schütt
P. hoffmannianum M.A.Faust
P. lima (Ehrenberg) F.Stein
P. mexicanum Osorio-Tafall
P. micans Ehrenberg
Phylum: Ochrophyta Cavalier-Smith
Class: Dictyochophyceae P.C.Silva
Order: Dictyochales Haeckel

Family: Dictyochaceae Lemmermann
Genus: *Dictyocha* Ehrenberg
D. fibula Ehrenberg
Class: Eustigmatophyceae D.J.Hibberd & Leedale
Order: Goniochloridales
Family: Goniochloridaceae
Genus: *Tetraëdriella* Pascher
T. limbata Pascher
Kingdom: Plantae Haeckel
Phylum: Chlorophyta Reichenbach
Class: Trebouxiophyceae Friedl
Order: Chlorellales Bold & M.J.Wynne
Family: Chlorellaceae Brunnthaler
Genus: *Actinastrum* Lagerheim
A. hantzschii Lagerheim
Genus: *Chlorella* Beyerinck [Beijerinck]
C . vulgaris Beyerinck [Beijerinck]
Order: Trebouxiophyceae ordo incertae sedis
Family: Trebouxiophyceae incertae sedis
Genus: *Crucigenia* Morren
C. quadrata Morren
C. tetrapedia (Kirchner) Kuntze
Class: Chlorophyceae Wille
Order: Chlamydomonadales F.E.Fritsch
Family: Chlamydomonadaceae F.Stein
Genus: *Chlamydomonas* Ehrenberg
C. reinhardtii P.A.Dangeard
Family: Chlorococcaceae Blackman & Tansley
Genus: *Chlorococcum* Meneghini
C. humicola (Nägeli) Rabenhorst
C. hypnosporum Starr
Family: Volvocaceae Ehrenberg
Genus: *Eudorina* Ehrenberg
E. elegans Ehrenberg
Genus: *Pandorina* Bory
P. morum (O.F.Müller) Bory
Family: Tetrasporaceae Wittrock
Genus: *Tetraspora* Link ex Desvaux
T. cylindrica (Wahlenberg) C.Agardh
Order: Sphaeropleales Luerssen
Family: Hydrodictyaceae Dumortier
Genus: *Pediastrum* Meyen
P. boryanum (Turpin) Meneghini
P. tetras (Ehrenberg) Ralfs
Family: Scenedesmaceae Oltmanns
Genus: *Scenedesmus* Meyen

S. acuminatus (Lagerheim) Chodat
S. acutus Meyen
S. dimorphus (Turpin) Kützing
S. obliquus (Turpin) Kützing
S. quadricauda (Turpin) Brébisson in Brébisson & Godey

Phylum: Charophyta Migula
Class: Zygnematophyceae Round ex Guiry
Subclass: Zygnematophycidae Melkonian, Gontcharov & Marin
Order: Desmidiales C.E.Bessey
Family: Closteriaceae Bessey
Genus: *Closterium* Nitzsch ex Ralfs
C. acutum Brébisson
C. juncidum Ralfs
Family: Desmidiaceae Ralfs
Genus: *Cosmarium* Corda ex Ralfs
C. botrytis Meneghini ex Ralfs
C. nymannianum Grunow
C. phaseolus Brébisson ex Ralfs

Kingdom: Protozoa R.Owen
Phylum: Euglenozoa Cavalier-Smith
Class: Euglenophyceae Schoenichen
Subclass: Euglenophycidae Busse & Preisfeld
Order: Euglenida F.Stein
Family: Euglenidae Dujardin
Genus: *Euglena* Ehrenberg
E. viridis (O.F.Müller) Ehrenberg
Family: Phacidae J.I.Kim, Triemer & W. Shin
Genus: *Phacus* Dujardin
P. acuminatus Stokes
P. brevicaudata (G.A.Klebs) Lemmermann
P. longicauda (Ehrenberg) Dujardin
P. pleuronectes (O.F.Müller) Nitzsch ex Dujardin

DISCUSSION

From the previous studies conducted on the phytoplankton of the lake, we displayed the results of the studies that gave a list of the recorded species. **Khalil (1990)** investigated the plankton and primary productivity at 10 sites in Lake Manzala during June 1985-June 1986. He identified the phytoplankton at the generic level and recorded 24 genus, of them 10 belong to diatoms, 12 Chlorophyta and 2 Cyanophyta. **El-Naggar *et al*. (1997)** studied the effect of treated sewage on the quality of water and phytoplankton populations of Lake Manzala. They identified 157 species of phytoplankton, of them; 59 Chlorophyta, 37 Bacillariophyta, 30 Cyanophyta, 28 Euglenophyta, one Pyrrhophyta and two Cryptophyta. They stated that the phytoplankton standing crop was mainly due to the contribution of Bacillariophyta whereas the species composition is dependent mainly on Chlorophyta.

El-Sherif and Gharib (2001) studied species composition and diversity cycle of the phytoplankton community in Lake Manzala during the period from May 1992 to April 1993 at 11 sites. They recorded 141 phytoplankton species comprising 64 diatoms, 42 green algae, 24 blue-green algae, 5 dinofagellates and 6 Euglenophyceae. They reported that diatoms were the most important algae during the winter and spring. Chlorophyta were mainly observed during autumn, while Cyanophyta preferred summer. **Fathi *et al*. (2001)** collected phytoplankton seasonally from 10 sites in the lake during 1998 and identified 33 species. Of them; 12 Chlorophyceae, 10 Bacillariophyceae, 7 Cyanophyceae, 2 Euglenophyceae, one Cryptophyta and one Dinophyceae. **Salah El Din (2005)** identified 57 phytoplankton species from Lake Manzala based on seasonal samples during 2003-2004 from 10 sites covered the whole lake. She found that Chlorophyta and Bacillariophyta were represented by 18 species each (31.58% of the total phytoplankton each), 14 species belong to Cyanophyta (24.56%), 6 species to Dinophyta (10.53%) and only 1 species to Euglenophyta (1.75%). In her study on the potential effect of Lake Manzala on the Suez Canal phytoplankton, Madkour (2007a) collected seasonal samples from two sites in the Lake Manzala, one at the northeastern part of the lake and the other site in El-Qabouty Canal. She authenticated 192 species belong to 8 groups; Bacillariophyta (90), Dinophyta (54), Chlorophyta (20), Cyanophyta (17), Euglenophyta (5), Charophyta (3), Cryptophyta (2), and Dictyophyceae (1).

The number of the recorded phytoplankton in the present study was compared with those recorded by previous studies and represented in Table (2). It can be observed from Table (2) that the phytoplankton community in Lake Manzala belonged to many taxonomic groups of phytoplankton (5-8), except in the study by **Khalil (1990)**, belonged to three groups. Bacillariophyta and Chlorophyta represented the most important groups in terms of the number of species, giving collectively the percentage range of >60%-75% in all studies, except that by **Khalil (1990)** where they represented about 90% of the community. The two groups alternated between the first and second orders except in the study by **Madkour (2007a)**, when the Bacillariophyta kept its first order but Dinophlagelata came in the second order and Chlorophyta scored the third order. On the other hand, the percentage of Cyanophyta ranged between 2-30%, occupying the third order in all the previous studies except in the study by **Madkour (2007a)** and in the present study, they arranged in the fourth order. This contradiction is not due to change in the lake trophic status but is mainly contributed to the nature of sampling sites. Whereas, one of sites in the present study and in the study by **Madkour (2007a)** positioned in the canal connects the lake with the Suez Canal (El-Qabouty Canal). It seems that the influence of Lake Manzala water diminishes through El-Qabouty canal and the effect of water exchange with the Suez Canal is pronounced. Other groups showed terminal importance in terms of number of species and represented by few species.

The composition of phytoplankton community in Lake Manzala is greatly influenced by the relatively high inflows of both freshwater and nutrients into Lake Manzala, producing a phytoplankton community dominated by Chlorophyta, and Cyanophyta which had fresh and brackish water affinity. In addition, receiving seasonal back flows of seawater from Mediterranean Sea and Suez Canal at sites I and IV, respectively enhanced the Bacillariophyta and Dinoflagelata to be more diversified, especially during the summer period **(Madkour, 2005; Madkour *et al.*, 2007b)**. The dominance of Bacillariophyta in terms of the number of species cauld be attributed to their tolerance to a wide range of salinity **(Madkour, 2007b)**.

Table 2: Phytoplankton species composition recorded in the Lake Manzala by the previous studies and the present study.

	Khalil, 1990	**El-Naggar et al., 1997**	**El-Sherif and Gharib, 2001**	**Fathi et al., 2001**	**Salah El Din, 2005**	**Madkour, 2007a**	**Present study**
Bacillariophyta	10 (42%)	37 (23.3%)	64 (45%)	10 (30.4%)	18 (31.6%)	90 (46.9%)	51 (46.8%)
Chlorophyta	12 (50%)	59 (37.3%)	42 (30%)	12 (36.4%)	18 (31.6%)	20 (10.4%)	17 (15.6%)
Dinoflagellata		1 (0.6%)	5 (3.5%)	1 (3%)	6 (10.5%)	54 (28.1%)	16 (14.7%)
Cyanobacteria	2 (8%)	30 (19%)	24 (17%)	7 (21.2%)	14 (24.6%)	17 (8.9%)	13 (11.9%)
Euglenozoa		28 (18.6%)	6 (4.5%)	2 (6%)	1 (1.7%)	5 (2.7%)	5 (4.6%)
Charophyta		2 (1.3%)				3 (1.5%)	5 (4.6%)
Cryptophyta				1 (3%)		2 (1%)	
Dictyochophyceae						1 (0.5%)	2 (1.8%)
Total	24	157	141	33	57	192	109

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