DOI: http://dx.doi.org/10.22092/ijb.2012.13150

PHYTOPLANKTON FLORA OF MIANKALEH WETLAND

M. Masoudi, R. Ramezannejad Ghadi & H. Riahi

Received 23.07.2011. Accepted for publication 21.02.2011.

Masoudi, M., Ramezannejad Ghadi, R. & Riahi, H. 2012 06 30: Phytoplankton Flora of Miankaleh Wetland. -*Iran. J. Bot. 18 (1): 141-148*. Tehran.

Miankaleh international wetland and peninsula are one of the main UNESCO biosphere reserve in Iran and Middle East. Phytoplankton diversity of the Miankaleh wetland was investigated from October 2009 to September 2010. Apart from the work done by Ramezannejad Ghadi, this study is the second floristic study of algae in the Miankaleh wetland in north of Iran. Five main algal groups were recorded namely: *Bacillariophyta*, *Cyanobacteria*, *Chlorophyta*, *Euglenophyta* and *Xantophyta*. A total of 94 species and varieties belonging to 47 genera were identified. Among them green algae formed the most abundant group making up 43 species and varieties from 18 genera. This was followed by Diatoms, with 31 species from 15 genera, Cyanobacteria, with 18 species from 12 genera. *Euglenophyta* and *Xantophyta* with 1 species make up an insignificant part of taxa. All of these taxa are new records for Miankaleh wetland and Mazandaran province.

Morteza Masoudi (correspondence <m.masoodie@yahoo.com> *and Hosein Riahi* <h.riahi@cc.sbu.ac.ir>*, Faculty of Biological Science, University of Shahid Beheshti, G.C. Evin, Tehran. - Rza Ramezannejad Ghadi* < *rrghadi@yahoo.com>, Department of Biology, Faculty of Science, Golestan University, Gorgan, Iran.*

Key words. Algae, Floristic, Iran, Miankaleh, Phytoplankton.

فلور فیتوپلانکتونی تالاب میانکاله

مرتضی مسعودی، فارغ التحصیل کارشناسی ارشد دانشکده علوم زیستی دانشگاه شهید بهشتی.

رضا رمضان‌نژاد قادی، عضو هیئت علمی گروه زیست‌شناسی دانشگاه گلستان.

حسین ریاحی، استاد دانشکده علوم زیستی دانشگاه شهید بهشتی.

تالاب و شبه‌جزیره میانکاله یکی از ذخایر اصلی زیست‌کره یونسکو در ایران و خاورمیانه است. تنوع فیتوپلانکتونی تالاب میانکاله از مهرماه ۸۸ الی شهریور ۸۹ بررسی شده است. بخشی از کار توسط رمضان‌نژاد قادی انجام گرفته و این دومین مطالعه فلورستیک جلبک در تالاب میانکاله ایران است. پنج گروه اصلی جلبکی به نام‌های باسیلاریوفیتا، سیانوباکتری‌ها، کلروفیتا، اوگلنوفیتا و گزانتوفیتا گزارش شده است. ۹۵ گونه و واریته متعلق به ٤٧ جنس شناسائی شده است. در این میان جلبک سبز با ٤٣ گونه و واریته از ۱۸ جنس گروه غالب را تشکیل می دهد. به دنبال آن دیاتومه ها با ۳۱ گونه از ۱۵ جنس، سیانوباکتری ها با ۱۸ گونه از ۱۲ جنس بودند. اوگلنوفیتا وگزانتوفیتا با ۱ گونه بخش ناچیزی از تاکسون‌ها را تشکیل داده اند. همه این تاکسون‌ها برای تالاب میانکاله و استان مازندران گزارش جدید بودند.

INTRODUCTION

Algae are regarded as valuable component of lakes, since they make an important role in biological diversity and productivity of lakes. (Moss 1969, Akten & Agkulu 2001). Their importance in terms of productivity and as a food source in higher trophic levels is well known (Burkholder & Wetzel 1990). To benefit from the algae in freshwater ecosystems, it is necessary to study the floristic composition of them. Freshwater aquatic ecosystems are little investigated in Iran and there is little information about algal flora of them. Löffler (1961) reported different algal groups from several geographical areas of Iran. In recent years, in additional investigations on marine areas, algological studies related to freshwater ecosystems have been carried out. Algae of Anzali lagoon was studied by Dogadina et. al. (2002) and Ramezanpoor (2004). There are some reports on algal flora of wetlands on southeast of Caspian Sea (Ramezannejad Ghadi 2007, 2008, 2009). Seasonal distribution of Epiphytic algae in the Anzali lagoon was reported by Nejadsattari et. al. (2005). Epilithic Diatoms of Jajrood River was reported

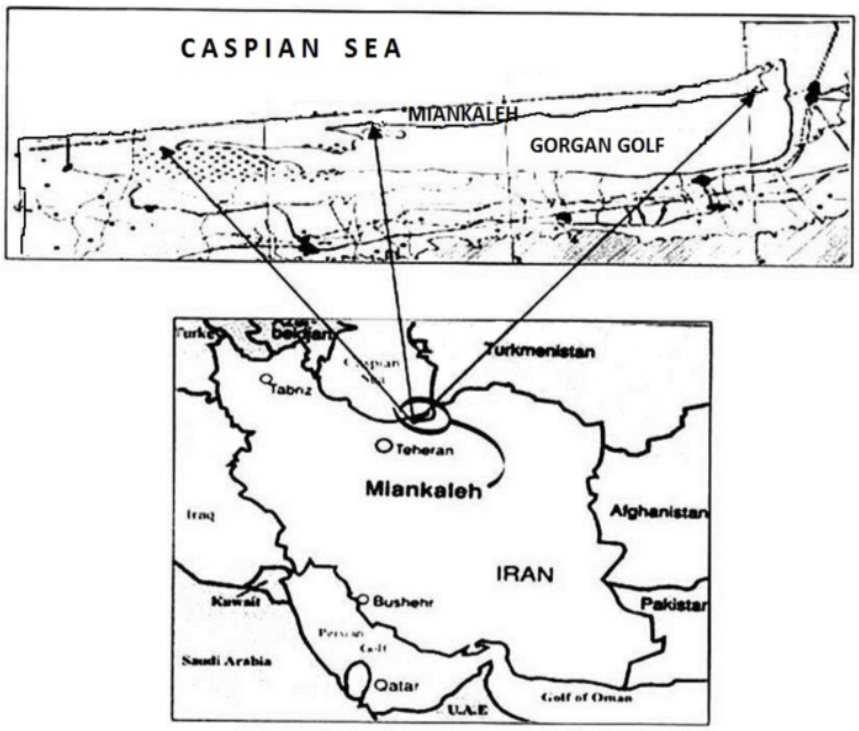

Fig. 1. Map of the Miankaleh Peninsula and Gorgan Golf (Shokri, et. al. 2004)

by Jamallou et al. (2005). Also, algal flora of lotic water of Zayandehrood River was investigated by Afsharzadeh et. al. (2003). Algal flora in first Iranian land-marine the Boujagh National Park was studied by Noroozi et al. (2009). Zarei Darki reported 891 species from Rivers of Iran (2009 a). Also, marine species in the algal flora of the Anzali Swamp was investigated by Zarei Darki (2009 b). Regarding the main rule of Miankaleh wetland as a UNESCO biosphere reserved coastal ecosystem in southwest of Caspian Sea, apart from the work done by Ramezannejad Ghadi (2007), there are no published articles on algal diversity of this wetland. Therefore, the aim of the present study was to investigate the phytoplankton flora in Miankaleh international wetland.

MATERIAL AND METHODS

Study site

The Miankaleh international wetland with 23800 ha. area located at 36° 48′ to 36° 55′ N and 53° 25′ to 54° 02′ E, in the southeast of Caspian Sea in north of Iran (Fig. 1). It is almost totally cut from the open sea by the 60 km long Miankaleh peninsula, a low sandy peninsula. This ecosystem plays a substantial hydrological and ecological role in the functioning of the coastal system of the southeast Caspian region. The flora of the region includes over 200 species, with the origin of Euro- Siberian and Irano- Touranian regions (Shokri et al., 2004). The entire area of Miankaleh peninsula and wetland was designed as a protected region in May 1970 and was designated as a UNESCO biosphere reserve in June 1976 (Ramsar convention Bureau, 2002). This wetland has first position of ranking of reserved ecosystem in north of Iran for management program. Miankaleh wetland has a muddy bottom and is oligotrophic ecosystem with maximum depth of 4.5 meters. Its average of rainfall and temperature are 580 mm and 21.8°c, respectively. (Sharifnia et al., 2007; Ramezannejad Ghadi 2006).

Collection and analysis of phytoplankton samples

In order to investigate phytoplankton flora of Miankaleh wetland 20 stations were chosen. Phytoplankton samples were collected by 1 liter bottles and plankton net from October 2009 to September 2010 at each site. Water Samples were collected in a 1 liter polyethylene bottle with wide mouth from depth 15-30

cm and 50-100 cm from the water edge (Sourina, 1978; Watzel and Linkens, 1991). In addition, water samples were gathered in different depths (1.5, 2, 2.5 m) to decrease the sampling error (Goodwin and Goodard, 1974). Plankton net in size of 30, 50 and 100 micron had used to collect algae in two different methods, either by hand and boat. For phytoplankton qualitative and quantitative analysis, the samples were fixed in 4% formaldehyde and concentrated by sedimentation (Stein, 1973). All algae except *Bacillariophyta* were examined on temporary slides. Number of filamentous species enumerated by assessment of the total filament length per ml as the sum of the extension of each filament within a counting grid placed in the ocular of the microscope (Chorus and Bartram, 1999). Number of unicellular species estimated by Neubauer Haemocytometer (Lobban,1988). Diatoms were cleaned using the method Oxidation by hydrogen peroxide and potassium dichromate was carried out (Patrick & Reimer, 1975; Stevenson, R. J. and L. L. Bahls. 1999). Identification of algae was done using an Olympus (BH-2) microscope at magnifications x400 and x1000.

Taxonomic identification was made according to Dillard (1990; 1991a; 1991b; 1993a; 1993b), Patrick and Reimer (1966; 1975), Prescott (1970), Desikachary (1987a; 1987b; 1988), Wehr & Sheath (2002) and Tiffany & Britton (1971).

RESULTS

In this study, 47 genera and 94 species and varieties of phytoplankton were recorded from Miankaleh wetland (table 1). As expected, *Chlorophyta* and *Bacillariophyta* were predominant and Comprising 46% and 33% of all recorded taxa respectively. *Cyanophyta* (19%) make up subdominant taxa. *Xantophyta* (1%) and *Euglenophyta* (1%) make up an insignificant part of taxa (Fig. 2).

Our results revealed that phytoplankton diversity in dry seasons was higher than wet season and density of phytoplankton population decrease from spring toward winter (Fig. 3).

Scenedesmus opoliensis P. G. Richter, *Pediastrum tetras* var. *tetraodon* (Corda.) Hansgirg, *Fragilaria* crotenensis Kiitton, *Navicula cuspidata* Kützing, *Calothrix ghosei* Bharadwaja and *Tetraedron minimum* (A.Braun) Hansgirg were the most important phytoplanktons, which occurred in this region (Fig. 5).

DISCUSSION

The phytoplankton flora of Miankaleh international wetland shows some similarity to the algal flora of Anzali swamp in southwest of Caspian Sea (Dogadina et al. 2002; Nejatkhah et al. 2003) and Gomishan, Alagol, Ulmagol and Ajigol wetlands in southeast of Caspian Sea (Ramezannejad Ghadi 2006, 2008, 2009). Some algae, which have been found in this project, have a wide distribution in Iran (Dogadina, 2002; Afsharzadeh, 2003, Zarei-Darki, 2009a). According to distribution data of algabase website, some of them are widespread or cosmopolitan species too (Guiry, M. D. and Guiry, G. M. 2011). *Bacillariophyta* was the predominant group in the phytoplankton communities of the Miankaleh wetland. Similar conditions of *Bacillariophyta* predominance have been observed in other studies in Iran (Dogadina, 2002; Afsharzadeh, 2003, Zarei-Darki, 2009a) and other parts of the world (Moore, 1974). Moore pointed out that in more temperate areas diatoms are usually the most common element of epipelic communities (Moore, 1974).

Many algal species are useful indicators of trophic conditions in lake and rivers (Patrick & Reimer 1966; Palmer 1980; Shubert 1984). Taxa have been found in Miankaleh international wetland mainly reflects the trophic state of this ecosystem. Some identified genera such as *Eunotia* Ehrenberg, *Pinnularia* Ehrenberg, *Achnanthes* Bory and species such as *Pediastrum boryanum* (Turpin) Meneghini, *Cosmarium laeve* Rabenhorst, *Oscillatoria limosa* Ag. ex Gomont, *Cymbella affinis* Kützing and *Navicula cryptocephala* Kützing are characteristic species of oligotrophic lakes (Rawson, 1956). Based on the analysis of the phytoplankton flora composition, Miankaleh wetland has an oligotrophic character. However, previous studies according to physical and chemical analysis of the wetland water confirmed this subject (Ramezannejad Ghadi, 2007). Light intensity, temperature, nutrients and day length were effective factors in this process (Boney, 1975). Green algae and Diatoms were dominant algal groups in spring and winter, respectively (Fig. 4). Some Phytoplanktonic algae were also observed in the epiphytic and epipelic communities in Miankaleh wetland according to previous study by Ramezannejad Ghadi (2007). Similar conditions have been observed in other ecosystems in which algal communities have been studied (Altuner, 1988; Kolayll & Baysal, 1988; Altuner & Gurbuz, 1991)

ACKNOWLEDGEMENTS

We thank Prof. Brian Whitton from Durham University (London), Dr. Yuwadee Peerapornpisal from Chiang Mai University (Thailand) and Dr. Suseela R. Mekhala from National Botanical Research Institute of India for their technical assistance, identification or confirmation the name of of some taxa.

Table 1. A List of phytoplankton species

Division Bacillariophyta
Achnanthes obliqua Turpin
Cocconeis placentula Ehrenberg
Cymatopleura librile (Ehrenberg) Pantocsek
Cymbella affinis Kützing
Cymbella cistula (Hemprich & Ehrenberg) O. Kirchner
Cymbella lanceolata Kirchner
Cymbopleura angustata (W. Smith) Krammer
Diatoma anceps (Ehrenberg) Grunow
Diatoma vulgare Bory de Saint-Vincent
Encyonema silesiacum (Bleisch) D. G. Mann
Fragilaria crotonensis Kitton
Gomphonema aciforme Kociolek, Spaulding, Sabbe & Vyverman
Gomphonema acuminatum f. malayensis Hustedt
Gomphonema acuminatum var. *coronatum* (Ehrenberg) Ehrenberg
Gomphonema acuminatum var. *intermedium* Grunow
Gomphonema olivaceum (Hornemann) Brébisson
Gomphonema parvulum (Kützing) H. F. Van Heurck
Gomphonema truncatum Ehrenberg
Navicula cryptocephala Kützing
Navicula cuspidata Kützing
Navicula halophila (Grunow ex Van Heurck) Cleve
Navicula insignita Hustedt
Navicula salinarum Grunow
Nitzschia angularis W. Smith
Nitzschia linearis var. *subtilis* (Grunow) Hustedt
Nitzschia palea (Kützing) W. Smith
Nitzschia philippinarum Hustedt
Pinnularia viridis Kützing
Rhoicosohenia abbreviate (C. Agardh) Lange-Bertalot
Rhopalodia gibba var. *ventricosa* (Ehrenberg) Grunow
Tryblionella hungarica (Grunow) Frenguelli
Division Chlorophyta
Acutodesmus acuminatus (Lagerheim) Tsarenko
Acutodesmus obliquus (Türpin) Hegewald and Hanagata
Ankistrodesmos densus Korshikov
Ankistrodesmus falcatus (Corda) Ralfs
Ankistrodesmus spiralis (W. B. Turner) Lemmermann
Characium ornithocephalum var. *pringsheim*ii (A. Braun) Komárek
Characium sieboldii A. Braun
Characium substrictum C. C. Jao
Chlorella vulgaris Beijerinck.
Cosmarium biretum Brébisson ex Ralfs
Cosmarium calcareum Wittrock
Cosmarium laeve Rabenhorst
Cosmarium sexangulare P. Lundell
Desmodesmus tropicus (W. B. Crow) E. Hegewald
Eremosphaera viridis De Bary
Franceia droescheri (Lemmermann) G. M. Smith
Microspora quadrata Hazen
Microspora stagnorum (Kützing) Lagerheim
Monoraphidium contortum (Thuret) Komarkova-Legnerova
Monoraphidium minutum (Nageli) Komarkova-Legnerova
Oedogonium crispum (Hassall) Wittrock
Pediastrum boryanum (Turpin) Meneghini
Pediastrum duplex Meyen
Pediastrum simplex (Meyen) Lemmermann
Pediastrum tetras var. *Tetraodon* (Corda.) Hansgirg
Rhizoclonium africanum Kützing
Scenedesmus abundans (Kirch.) Chodat
Scenedesmus bijuga (Turpin) Lagerheim
Scenedesmus caudato-aculeolatus Chodat
Scenedesmus denticulatus Lagerheim
Scenedesmus lefevrei var. *muzzanensis* Huber-Pestalozzi
Scenedesmus magnus Meyen
Scenedesmus obtusus Meyen
Scenedesmus opoliensis P. G. Richter
Scenedesmus quadricuda var. *quadrispina* (Chodat) G. M. Smith
Scenedesmus raciborskii Woloszynska
Selenastrum gracile Reinsch
Spirogyra condensata (Vaucher) Kützing
Spirogyra gracilis var. *parva* (Hass.) Kützing
Tetraedron minimum (A. Braun) Hansgirg
*Tetraedron muticum (*A. Braun) Hansgirg
Tetraedron trigonum var. *gracile* (Reinsch) De Toni
Westella botryoides (W. West) De wileman
Division Cyanobacterai
Anabaena catenula var. *affinis* (Lemmermann) Geitler
Anabaena planctonica Brunnthaler
Anabaena vaginicola F. E. Fritsch & Rich
Anabaenopsis tanganyikae (G. S. West) Woloszynska & Miller
Arthrospira jenneri Stizenberger ex Gomont
Calothrix ghosei Bharadwaja
Chroococcus minor (Kützing) Nageli
Cylindrospermum indicum C. B. Rao
Jaaginema angustissimum (West & G. S. West) Anagnostidis & Komárek
Merismopedia elegans A. Braun ex Kützing
Merismopedia Smithii de Toni.
Microcystis aeruginosa (Kützing) Kützing
Microcystis flos-aquae (Wittrock) Kirchner
Microcystis robusta (Clark) Nygaard
Nostoc calcicola Brebisson ex Bornet & Flahault
Nostoc spongiaeforme C. Agardh ex Bornet & Flahault
Oscillatoria limosa var. *chalybea* Kützing ex Gomont
Spirulina subsala Orstedt ex Gomont
Division Xantophyta
Characiopsis naegelii (A. Braun) Lemmermann
Division Euglenophyta
Colacium calvum Stein

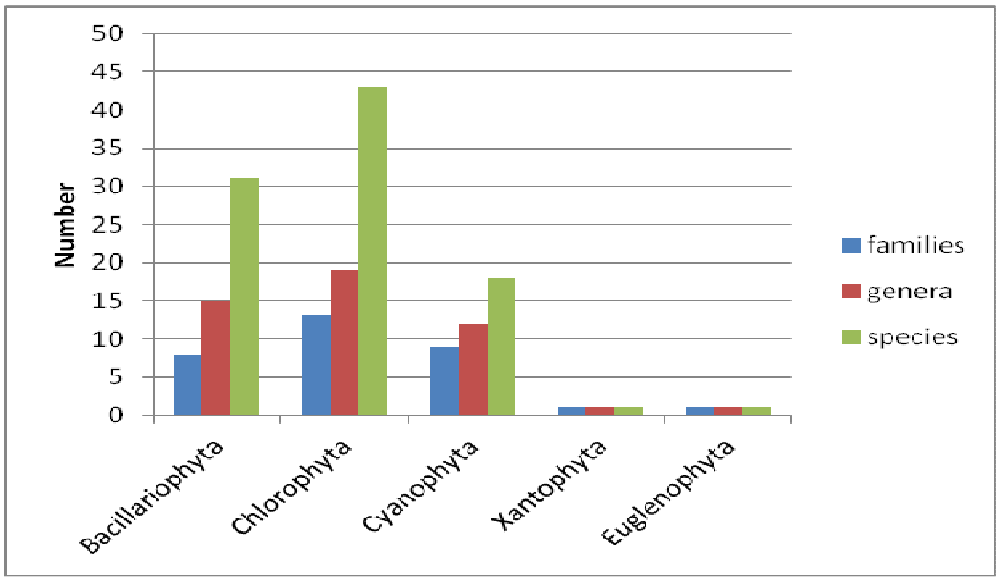

Fig. 2. The spectrum of leading, families, genera and species in Miankaleh Wetland algal flora of Iran.

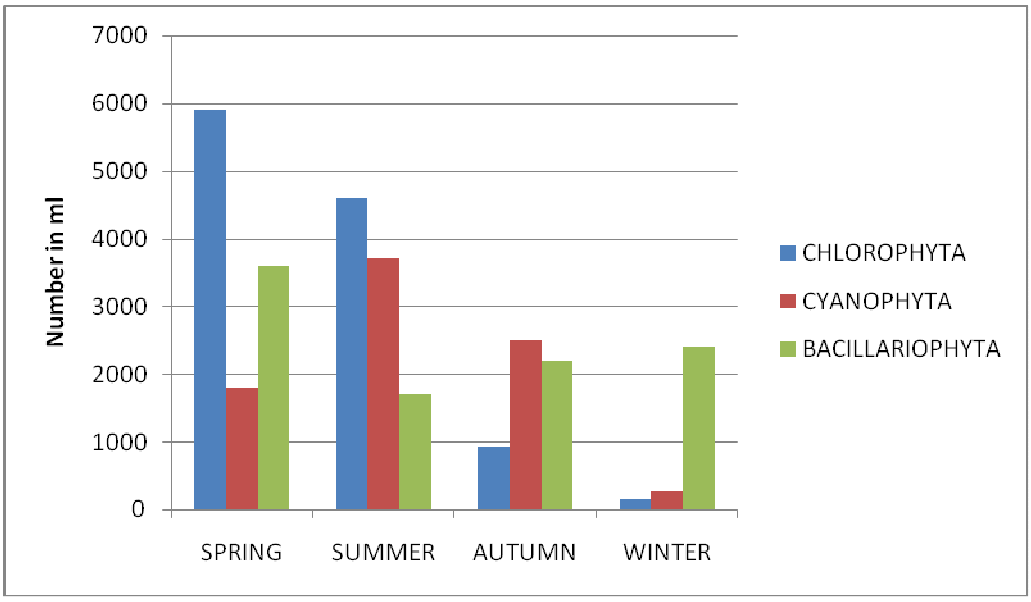

Fig. 3. Composition of algal flora in different seasons of Miankaleh Wetland.

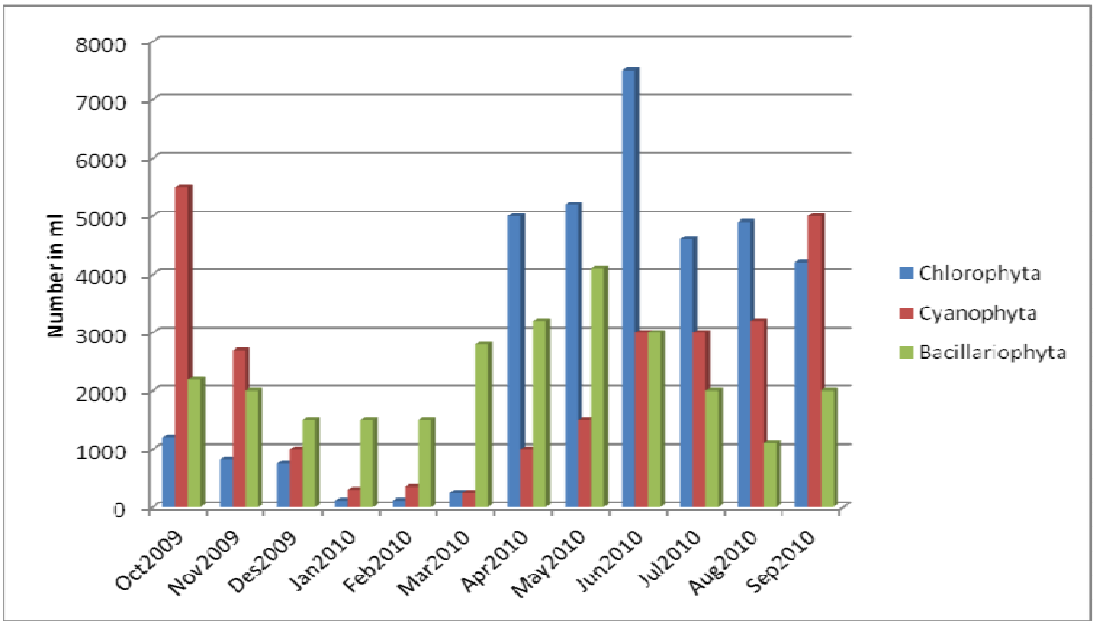

Fig. 4. Relative frequency of occurrence of *Cyanobacteria*, *Chlorophyta* and *Bacillariophyta* in different month in Miankaleh Wetland.

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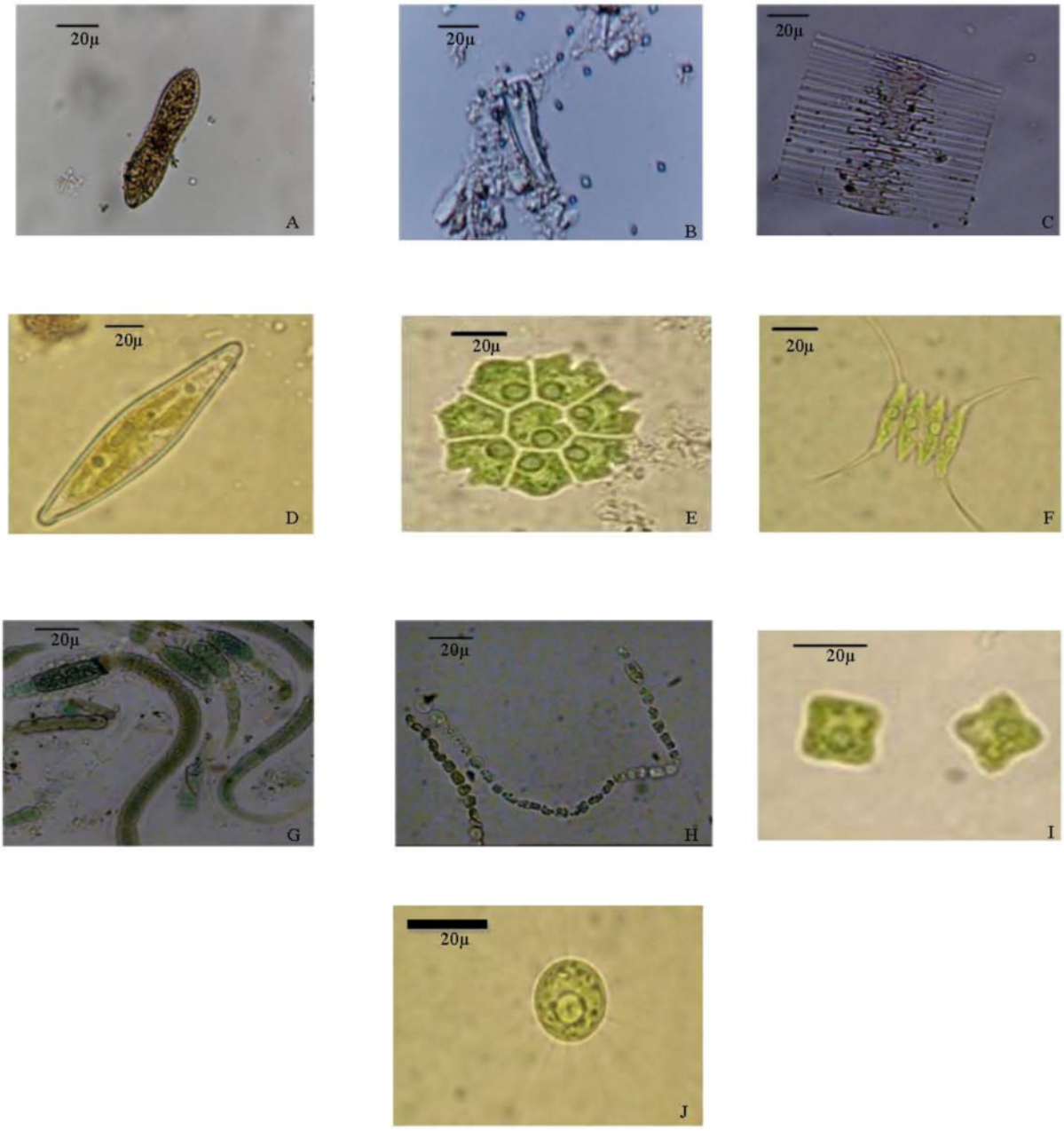

Fig.5: **A.** *Cymatopleura librile* (x1000)**, B.** *Rhoicosphenia abbreviata* (x1000); **C.** *Fragilaria crotonensis* (x1000); **D**. *Navicula cuspidata* (x1000); **E.** *Pediastrum tetras* var. *tetraodon* (x1000); **F.** *Scenedesmus opoliensis* (x1000); **G.** *Calothrix ghosei* (x400); **H.** *Cylindrospermum indicum* (x400); **I.** *Tetraedron minimum* (x1000); **J.** *Franceia droescheri* (x1000)

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