PHYTOPLANKTON DIVERSITY ASSESSMENT OF GANDOMAN WETLAND, WEST OF IRAN

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Gandoman wetland is one of the main aquatic ecosystems of Chaharmahal and Bakhtiari province in the mid western of Iran. It is located close to Choghakhor international wetland. The phytoplankton diversity of the Gandoman wetland was investigated in four consequensive seasons from September 2006 to August 2007. This is the first floristic study of phytoplankton in this wetland. Six divisions of algae, Bacillariophyta, Chlorophyta, Cyanobacteria, Euglenophyta, Dinophyta and Chrysophyta had the main abundance respectively in studied sites. In total 95 species and varieties belonging to 54 genera were recorded. Bacillariophyta was presented with 51 species and varieties as the most abundant group, followed by Chlorophyta, with 18 species and 12 genera. According to this study, Gandoman wetland present an acceptable diversity of phytoplanktons according to the published algal checklist of Iran.

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ارزیابی تنوع فیتوپلانکتونی تالاب گندمان، غرب ایران

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تالاب گندمان یکی از اکوسیستم‌های آبی مهم استان چهارمحال و بختیاری در غرب ایران می‌باشد. این تالاب در نزدکی تالاب بین‌المللی چغاخور واقع شده است. در این مطالعه تنوع فیتوپلانکتونی تالاب گندمان برای یک دوره یکساله بطور فصلی از شهریور ماه 1385 تا مرداد ماه 1386 مورد بررسی قرار گرفت. این نخستین مطالعه در ارتباط با فلور فیتوپلانکتونی تالاب گندمان به شمار می‌آید. تاکسون‌های مربوط به شش شاخه ازفیتوپلانکتون‌ها در این مطالعه مورد شناسایی قرار گرفت. باسیلاریوفیتا، کلروفیتا، سیانوفیتا، اوگلنوفیتا، داینوفیتا و کریزوفیتا بترتیب حائز بیشترین فراوانی بودند. در مجموع 95 گونه و واریته متعلق به 54 جنس به ثبت رسید. در میان تاکسون‌های شناسایی شده، شاخه باسیلاریوفیتا با حضور 51 گونه و واریته از بیشترین فراوانی برخوردار بود و پس از آن شاخه‌های کلروفیتا با 18 گونه و 12 جنس قرار داشت. بر حسب اطلاعات این پژوهش تالاب گندمان تنوع قابل قبولی از فیتوپلانکتون‌ها را در مقایسه با چک لیست‌های منتشره از جلبک های ایران ارائه می‌نماید.

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INTRODUCTION

Chemical analysis of water provides a good indication of the chemical quality of the aquatic systems, but does not integrate ecological factors such as altered riparian vegetation or altered flow regime and therefore, do not necessarily reflect the ecological state of the system (Karr et al., 2000). Biological assessment is a useful alternative for assessing the ecological quality of aquatic ecosystems since biological communities integrate the environmental effects of water chemistry, in addition to the physical and geomorphological characteristics of rivers and lakes (Stevenson & Pan, 1999). Phytoplankton encountered in the water body reflects the average ecological condition and therefore, they may be used as indicators of water quality (Bhatt, et al., 1999; Saha et al., 2000). Furthermore, taxonomic diversity is one of the most important characteristics of biological communities that reflects evolutionary processes, and maintains ecological functions and stability of ecosystems.

Wetlands are nutrient rich environments. There are many small and large lakes and wetlands in Iran. They are distributed in different geographical area, from coastal zones to the highlands. The study of such regional floras in the context of local physico-geographical environment is an important contribution to biodiversity assessments and floristic studies in Iran. The number of algological studies on inland water has increased considerably in recent years in Iran by various authors including (Dogadina et al. 2002, Afsharzadeh et al. 2003, Ramezanpoor 2004, Nejadsattari et al.2005 , Jamallou et al. 2005, Noroozi et al. 2009, Zarei-Darki 2009b, Zarei-Darki 2009a, Masoudi et al. 2012, Ramezannejad Ghadi et al. 2012 a, b). However, despite extensive floristic studies that have been carried out, the algal flora of many geographical areas are still poorly known. Therefore there is a need to determine the environmental conditions and water quality of these ecosystems.

No previous studies have been recorded for the algal flora of Gandoman wetland in Chaharmahal and Bakhtiari province, west of Iran. Therefore we report the phyco-diversity characterics, phytoplankton composition and seasonal dynamics of algae in Gandoman wetland.

MATERIALS AND METHODS

Study Site

Gandoman wetland is recorded as a valuable habitat for birds by the International Waterfowl Research Bureau (IWRB) in 1992 (Asadi Broujeni et al. 1992). Gandoman is a shallow wetland by an average depth of 2 meters, located 90 km. to Shahrekord in Chaharmahal and Bakhtiari province. The extent of this wetland is about 1.07×10^{7} m^2 and is located between 31° 49' N to 31° 53' N and 51° 05' E to 51° 07' E. Average altitude of 2219 meters above sea level (Fig. 1). Its average rainfall and temperature is 1800 mm and 13.5 °c , respectively.

Field sampling, collection and analysis

The water samples for the algae study and physico-chemical analysis were collected seasonally, from three sites of Gandoman wetland for a period of a year starting from September 2006 to August 2007. The three sites have been chosen based on water depth and distant (Table 1). Phytoplanktons samples were collected from the surface in a 1 liter polyethylene bottle and from a depth of 50 centimetre using Sibata sampler (Sourina, 1978; Watzel & Linkens, 1991). In addition, water samples were gathered by a tube in water shaft to decrease the sampling error (Goodwin & Goodard, 1974). Plankton net in size of 55 microns had used to collect algae by hand. For further analysis, the samples were fixed in 4% formaldehyde and concentrated by sedimentation (Stein, 1973).

All samples except to the Bacillariophyta were examined with temporary slides. Diatoms cleaning was carried out by an oxidation method with hydrogen peroxide and potassium dichromate (Komulaynen, 2009). Number algal species estimated by Sedgwick-Rafter (Wetzel & Limkens, 1991). Taxonomic study was carried out by light microscopy (Zeiss - Axioster plus microscope) at magnification 400 x and 1000 x and based on Dillard (1990-1993), Dillard (1999), Patrick & Reimer (1966- 1975), Prescott (1970), Desikachary (1987- 1988), Wehr & Sheath (2002), Tiffany & Britton (1971), Whitford & Schumacher (1984), Baker & Fabbro (2002) and John et al. (2002).

Several physico-chemical factors of water were recorded during the sampling period for each site. These include water temperature, dissolved oxygen (DO), pH, Electric conductivity (EC) and TDS, SO_4, PO_4 and BOD. These measurements carried out according to Descy et al. (1994). Some of these parameters measured in the field using a multimeters portable system (Consort C535). In order to investigate trophic conditions of aquatic habitat, it is important to measure these parameters because the principal application of BOD, COD and TSS is in characterizing of water quality and pollution (Heng et al, 2006). Biochemical Oxygen Demand (BOD) is the amount of dissolved oxygen needed by aerobic biological organisms in water to decompose organic material present in a water ecosystem. The BOD value is expressed in milligrams of oxygen consumed per liter of sample during 5 days of incubation at 20 °c (Nollet & Leo, 2000).

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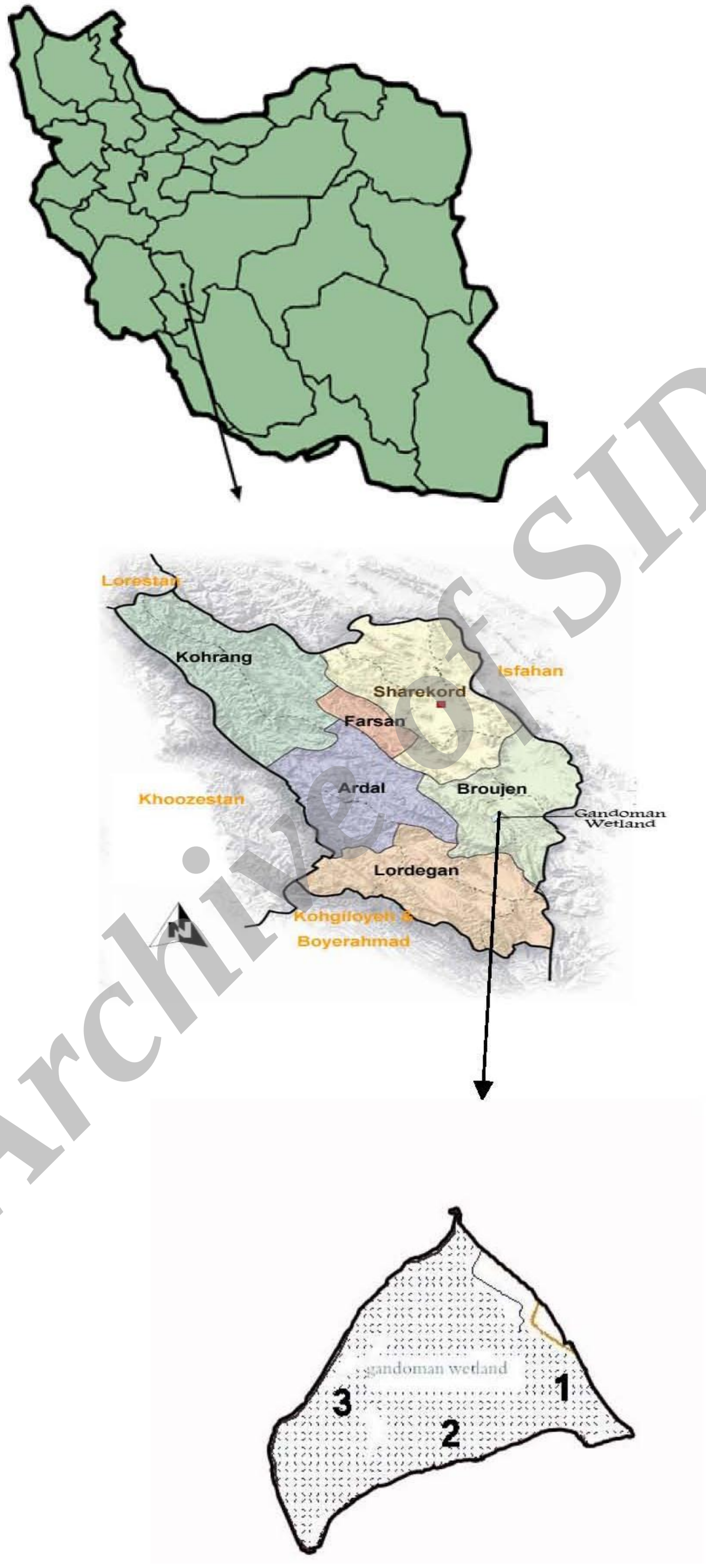

Fig. 1. Geographical location of Gandoman wetland (Iran Department of Environment).

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Table 1. Geographical coordinates of stations.

Stations	Latitude	Longtitude	Height (m)
Gol Khochak (1)	31° 49′ 305″ N	51° 05′ 865″ E	2231
Gol Bozorg (2)	31° 49′ 905″ N	51° 05′ 724″ E	2233
Moradan (3)	31° 49′ 115″ N	51° 05′ 614″ E	2234

Table 2. Average of the physical-chemical and biological characteristic of Gandoman wetland (DO= Dissolved Oxygen, BOD= Biochemical Oxygen Demand).

Season / **Parameter**	Spring	Summer	Fall	Winter
Temperature (°c)	19.3	18.1	8.3	11.3
pH	8.17	8.37	7.83	8.03
DO (mg/l)	5.85	5.93	9.00	8.43
EC (μS/cm)	268.33	290.33	238.33	268.00
NO3 (mg/l)	0.75	1.01	2.30	1.26
PO4 (mg/l)	0.07	0.09	0.91	0.03
BOD (mg/l)	2.50	4.53	1.00	1.20
COD (mg/l)	10.43	12.33	8.20	8.73
TS (mg/l)	226.3	207.7	177.0	198.3
TSS (mg/l)	27.33	25.33	14.00	17.66
TDS (mg/l)	202.66	182.00	166.00	180.66

RESULTS

Physico-chemical analysis results

The physical-chemical and biological properties of Gandoman wetland is shown in table 2. BOD was between 0.9 to 5 mg/l that the most amounts were in August, 2006 in the first station and the least amount in November, 2006 in the first station and third station. COD was between 7.2 to 12.6 mg that its most amounts were in summer in the third station and its least amount in fall, 2006 in the third station. Nitrate changes were between 0.5 to 2.6 mg/l that the most amount was in November, 2006 in the first and the second stations and its least amount was in April, 2007 in the third station. Phosphate changes were between 0.02 to 1.6 mg/l. The most amount of Phosphate 1.6 mg/1 observed in November and in the first station. Overall changes of total dissolved solid (TDS) were between 162 to 222 mg/l that its most amounts was gained in April, 2007 in the third station and its least amount in November, 2006 in the second station.

Phytoplankton flora

In the present study, a moderate diversity of phytoplankton flora was discovered in the Gandoman wetland with a total of 95 species and infra-species belonging to 54 genera in 6 divisions. A checklist of described algae is presented in Table 3. These species belong to Bacillariophyta (51 species), Chlorophyta (18 species), Cyanobacteria (16 species), Euglenophyta (6 species), Dinophyta (3 species) and Chrysophyta (1 species). Among these divisions Bacillariophyta were dominant with representing 52.6% of the algal community (Fig. 2). In this study, most of the diatoms were pennate, while some species belonging to order centrales were important quantitatively.

The genera *Navicula* Bory de Saint-Vincent, *Nitzschia* Hassall, *Cymbella* C. Agardh, *Synedra* Ehrenberg, *Scenedesmus* Meyen and *Oscillatoria* Vaucher ex Gomont were represented by diverse species. Some species of phytoplanktons were observed throughout the study period; *Cymbella affinis* Kützing., *Diatoma vulgaris* Bory, *Navicula radiosa* Kützing was the dominant species in each site seasonally. Quantitative counts showed clear seasonal variation in algal cell numbers with maxima during late spring and early summer (Fig. 3). The Bacillariophyta comprise most of the total abundance of all stations studied. Not all phytoplankton could be identified to species level. The result of diversity index is shown in table 4 and fig. 4. According to Shonnon – wanier's index the most of the phytoplankton diversity was in August, 2006 in the second station ($H' = 2.29$) and its lowest amount was in November, 2006 in the third station ($H' = 0.91$).

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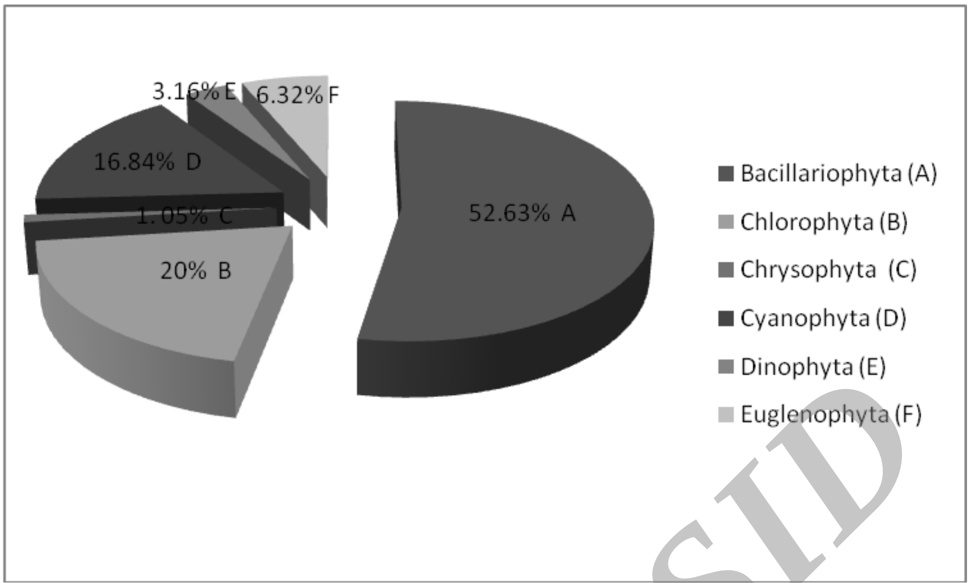

Fig. 2. The abundance of phytoplankton divisions in Gandoman wetland (cells/ml).

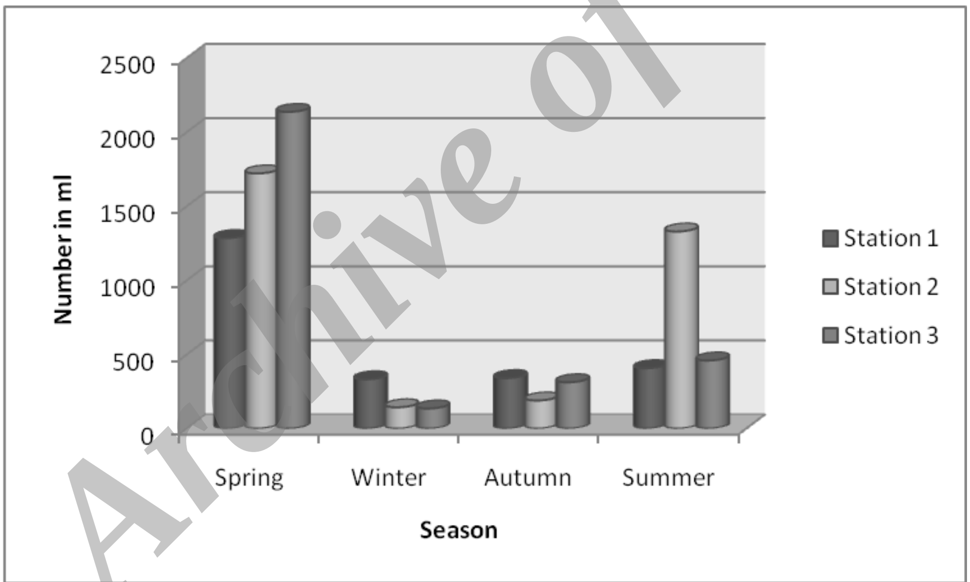

Fig. 3. Relative frequency of phytoplanktons in different stations of Gandoman wetland.

DISCUSSION

In this study 95 species belonging to 6 divisions of phytoplanktons were identified. Some phytoplanktons of Gandoman wetland has a wide distribution in Iran (Dogadina et al. 2002, Nejatkhah et al. 2003, Afsharzadeh 2003, Zarei-Darki, 2009a, Masoudi et al. 2012). According to distribution data on the Algae base website, some of them are widespread or cosmopolitan species too (Guiry & Guiry, 2012).

The high number of single-species families and few-species genera in this study are typical of most freshwater systems of Iran. In this study, it could be a symbol of the ongoing succession level or environmental factors created by human. Another reason could be higher species richness, which lead to extensive development of aquatic macrophytes and thus the availability of a large diversity of habitats and microhabitats. These diverse habitats are favorable for diverse species.

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Table 3: Checklist of identified phytoplankton taxa in this study.

Bacillariophyta
Amphora lybica Ehrenberg
Amphora ovalis (Kützing) Kützing
Asterionella formosa Hassall
Cocconeis pediculus Ehrenberg
Cocconeis placentula Ehrenberg
Cyclotella meneghiniana Kützing
Cymatopleura solea (Brébisson) W. Smith
Cymbella affinis Kützing
Cymbella helvetica Kützing
Cymbella aspera (Ehrenberg) Cleve
Cymbella lanceolata (C. Agardh) C. Agardh
Denticula kuetzingii Grunow
*Diatoma hyemalis (*Roth) Heiberg
Diatoma vulgaris Bory De saint-Vincent
Diatoma anceps (Ehrenberg) Kirchner
Diploneis ovalis (Hilse) Cleve
Delicata delicatulla (Kützing) Krammer
Epithemia adnanta (Kützing) Brébisson
Epithemia sorex Kützing
Frustulia rhomboides (Ehrenberg) De Toni
Fragilaria capucina Desmazieres
Fragilariforma virescens (Ralfs) Williams and Round
Fragilaria crotonensis Kitton
Gomphonema olivaceum (Hornemann) Brébisson
Gomphonema truncatum Ehrenberg
Gomphonema angustatum (Kützing) Rabenhorst
Gyrosigma acuminatum (Kützing) Rabenhorst
Martyana martyi (Heribaud) Round
Melosira sp.
Navicula radiosa Kützing
Navicula tenelloides Hustedt
Navicula rhynonocephala Kützing
Cymbella lanceolata (Agardh) Agardh
*Navicula oblonga (*Kützing) Kützing
Navicula sp.
Navicula salinarum Grunow
Navicula rhynchotella Lange- Bertalot
Navicula salinicola Lange -Bertalot
Nitzschia sp.
*Nitzschia palea (*Kützing) W. Smith
Nitzschia hantzschiana Rabenhorst
Pinnularia major (Kützing) Cleve
Pinnularia rupestris Hantzsch
Pinnularia sudetica (Hilse) Hilse
Pinnularia viridis (Nitzsch) Ehrenberg
Planthidium lanceolatum (Brébisson ex Kützing) Lange-Bertalot
Tetracyclus rupestris (Braun) Grunow
Surirella roba Leclercq
Synedra acus Kützing
*Synedra ulna (*Nitzsch) Ehrenberg
Ulnaria capitata (Ehrenberg) Compere

Chlorophyta
Ankistrodesmus falcatus (Corda*)* Ralfs
Ankistrodesmus fosiformis Corda ex Korshikow
Closterium sp.
Cosmarium sp.
Desmodesmus quadricaudatus (Turpin) Hegewald
Mougeotia sp.
Oedogonium sp.
Pediasterum sp.
Staurdium privum (Printz) Hegewald
Scenedesmus bijuga (Turpin) Lagerheim
Scendesmus sp.
Spirogyra sp.
Spirogyra weberi Kützing
Staurodesmus dejectus var. *apiculatus* (Brébisson) Croasdale
Tetradron lunula (Reinsch) Hansgirg
Volvox tertius Meyer
Zygnema sp.

Chrysophyta
Dinobryon divergens Imhof

Cyanobacteria
Anabaena sp.
Anacystis sp.
Anathece clathrata (W.West & G.S. West) Komárek, Kastovsky & Jezberová
Cyanoptyche gloecystis Pascher
Merismopedia elegans A. Braun ex Kützing
Merismopedia punctata Meyen
Microcyctis aeroginosa Kützing
Nostoc sp.
Nostoc paludosum Kützing ex Bornet & Flahault
Oscillatoria sp.
Oscillatoria anguina Bory ex Gomont
Pseudanabaena limnetica (Lemmermann) Komárek
Phormidium nigrum (Vaucher ex Gomont) Anagnostidis & Komárek
Planktolyngbya limnetica (Lemmermann) Komárková-Lagnerová & Cronberg
Rhabbdogloea smithii (R. Chodat & F. Chodat) Komárek
Spirulina major Kützing ex Gomont

Dinophyta
Ceratium hirundinella (Müller) Dujardin
Glenodinium quadridens (Stein.) Schiller
Peridinium cinctum (Müller) Ehrenberg

Euglenophyta
Euglenaria caudata (Hübner) A. Karnowska-Ishikawa, E. Linton & J. Kwiatowski
Lepocinclis fusca (Klebs) Kosmala & Zakrys
Lepocinclis globulus Perty
Trachelomonas acanthostoma Stokes
Trachelomonas australica (Playfair) Deflandre
Trachelomonas intermedia Dangeard

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Table 4: The amount of diversity index (H').

Seasons / stations	Fall	Winter	Spring	Summer	average
1	1.08	1.12	2.09	2.22	1.62
2	1.05	0.95	1.94	2.29	1.55
3	0.91	1.45	1.83	1.98	1.54
average	1.01	1.17	1.97	2.16	1.57

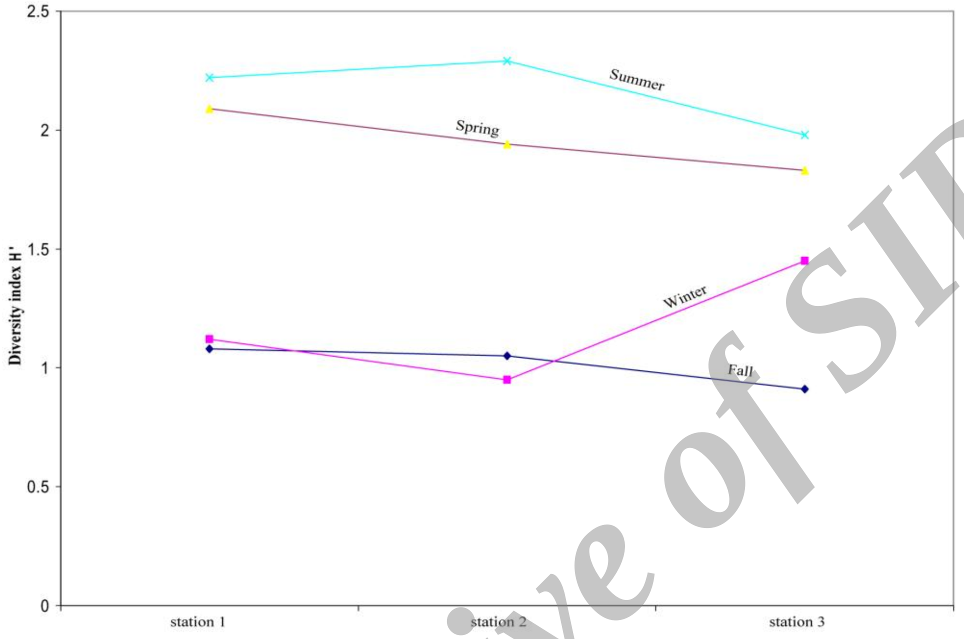

Fig. 4. The amount of diversity index in different stations.

Bacillariophyta formed dominant group in phytoplankton communities representing 53.6%, and *Navicula radiosa* was the dominant species. Similar conditions have been observed in other area of Iran (Dogadina et al. 2002; Afsharzadeh 2003, Zarei-Darki 2009a, Ramezannejad Ghadi et al. 2012a) and other parts of the world (Moore 1979). Moore pointed out that in more temperate areas diatoms are usually the most common elements of phytoplankton communities (Moore 1979). Pennate diatoms are richer in number of taxa than centric forms in this system, as expected for freshwater ecosystems (Kadri & Bulten, 2006). *Navicula radiosa* was the dominant species at all stations and founded during most of the studied period.

Chlorophyta were the second most important group. They contributed a large number of species (17.1%) but lower cell numbers compared with Bacillariophyta.

Cyanobacteria were the second subdominant group in this area. This group of algae have also many species in Gandoman wetland. They were dominant in summer and they were rare in autumn. This is an explainable case according Branco comment that Cyanobacteria are successful in a wide range of environments because they have a versatile metabolism (Branco et al. 2001).

Other divisions of phytoplankton with phytoplanktonic taxa (Euglenophyta, Dinophyta and Chrysophyta) were presented only seasonally and with minor numerical importance. In Dinophyta, *Glenodinium quadridens* (Stein.) Schiller., *Peridinium cinctum* (Muell.) Ehr., and *Ceratium hirundinella* (O. F. Muell.) Duj. showed the most abundance. From Chrysophyta, *Dinobryon* was found only in spring and summer. The lacking of high concentrations of nutrients required for Euglenophyta and stress conditions suppressing phytoflagellate development may be associated with the seasonal presence of Euglenophyta.

The phytoplankton species composition showed at the highest diversity in spring and the lowest in autumn

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(Fig. 3). Also, with respect to Shannon- wanier's index, the most species diversity was got in the summer, and the least in autumn that is similar to Barone & Flore (1994) studies, Shannon diversity is changed by water level vibrations or phytoplankton's pressure (Table 4). Generally average of diversity index increase from fall to summer (Fig.4). The environmental factors such as BOD, COD, pH, temperature, DO, EC, Nitrate and Phosphate has influenced phytoplanctonic species composition and distribution. The amount of DO in summer and spring is less than other seasons that this was becouse of increase in organic compound in these seasons. at the result is coused decrease phytoplankton's composition. The amount of BOD showed any difference between stations, but its maximum average was in summer and the minimum in winter. Since in this season, phosphate amount was low, therefore, we can comment that decrease in organic matters like phosphate and increase in turbidity, and decrease in temperature and light causes decrease in phytoplankton's composition in this season (winter) and then caused decrease in required oxygen for the oxidation of carbon and nitrogen compounds. COD amounts between stations showed any significant difference. COD amount in autumn showed a significant decrease than other seasons that this was because of decrease in organic compounds in these seasons and consequently caused decrease in phytoplankton's composition in autumn. On the whole, because of increase in composition of organic matters, mixture and communities of phytoplankton changes (Fig. 2).

Taxonomical survey is useful to indicate trophic conditions of lakes and rivers (Shubert 1984, Stoermer & Julius 2003). Some identified taxa in Gandoman wetland are characteristic of the oligotrophic lakes such as *Pinnularia* Ehrenberg, *Pediastrum* Meyen, *Cymbella affinis* Kützing, *Asterionella formosa* Hassall and *Fragilaria capucina* Desmazieres (Rawson, 1956). As expected, based on the analysis of the phytoplankton flora composition, and physico-chemical analysis, Gandoman wetland has an oligotrophic character.

REFERENCES

Afsharzadeh, S., Nejad Sattari, T., Rahiminejad, M. R. & Ebrahimnejad, M. 2003: Algal floristic study of Zayandehrood River. -Iranian Journal of Biology,14 (1-2): 32-45.

Asadi Broujeni, E., Raisi, F. & Shams, G. R. 1992: Investigation, identification and preparing a comprehensive managment plan for Gandoman wetland. -Reaserch report by the Department of Environment, Chaharmahal and Bakhtiari Province. 320 p.

Baker, P. D. & Fabbro, L. D. 2002: A guide to the identification of common blue-green algae (Cyanoprokaryotes) in Australian freshwaters. -Cooperative Research Centre for Freshwater Algae, 2nd. Edition, 650p.

Bhatt, L. R., Lacoul, P., Lekhal, H. D. & Jha, P. K. 1999: Physico-chemical characteristic and phytoplanktons for Taudha lake, Kathmandu. -Poll. Res. 18 (4): 353-358.

Branco, L. H., Juniori, O. N. & Branco,C. C. 2001: Ecological distribution of Cyanophyceae in lotic ecosystems of Sao Paulo State. -Revista Brasileria de Botanica 24 (1): 99-108.

Barone, R. & Flores, L. N. 1994: Phytoplankton dynamics in a shallow, hypertrophic reservoir (Lake Arancio, Scily). -Hydrobiologia, 289: 199-214.

Descy, J. P. & Gosselain, V. 1994: Development & ecological importance of phytoplankton in a large lowland river (River Meuse, Belgium). -Hydrobiologia, 289: 139-155.

Desikachary, T. V. 1987-1988: Atlas of Diatoms, Vol. II, III, IV, V. Madras. -Madras Sciences Foundation Publication.

Dillard, G. E. 1990- 1993: Freshwater algae of the southeastern United State Part 3, 4, 5, 6. (Section 1, 2, 3, 4). -J. Cramer. Berlin, Stuttgart.

Dillard, G. E. 1999: Common freshwater algae of the United States. -J. Cramer, Berlin, Stuttgart: 560 p.

Dogadina, T. V., Behrouz Zarei, D. & Gorbulin, O. S. 2002: Algae of Enzeli Swamp (Iran). -International Journal on Alge, 4 (4): 81-88.

Goodwin, M. H. & Goddard, C. I. 1974: An inexpensive multiple level water sampler. -Journal of Fisheries Research Broad of Canada, 31: 1667-1668.

Guiry, M. D. & Guiry, G. M. 2012: Algabase. World-wide electronic publication. -National University of Ireland, galway.http://www.algaebase.org.

Heng, L. Y., Abdullah, P., Yi, C. S., Mokhtar, M. & Ahmad, R. 2006: Development of possible indicators for sewage pollution for the assessment of langat river ecosystem health**.** -Malaysia Journal of Analytical Sciences, 10 (1): 15-26.

Iran Department of Environment (Chaharmahal and Bakhtiari province), Gandoman wetland 2012: http://www.doe.ir

Jamallou, F., Nejad Sattari, T., Fallahian, F. 2005: Epilithon diatoms of Jajrood River. Pajouhesh & Sazandegi 73: 2-11.

John, D. M., Whitton, B. A. & Brook, A. J. 2002: The freshwater algal flora of the British Isles. -Cambridge University Press, 702 p.

Kadri, A. & Bulten, S. 2006: Benthic diatom flora (Bacillariophyta) of Keban Reservoir (Elazig,

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www.SID.ir

Turkey). -International Journal on Algae, 8 (2): 162- 173.

Karr, J. R., Allen, J. D. & Benke, A. C. 2000: River conservation in the United States and Canada. In: Boon, P. J., Davies, B. R.& Petts, G. E. (eds.) Global perspectives on river conservation. Science, Policy, and Practice. -Wiley, New York. pp 3–39.

Komulaynen, S. 2009: Diatoms of periphyton assemblages in small rivers in Northwestern Russia. Studi Trentini di Scienze Naturali, 84: 153-160pp.

Masoudi, M., Ramezannejad Ghadi, R. & Riahi, H. 2012: Phytoplankton flora of Miankaleh wetland. -Iranian Journal of Botany ,18 (1): 141-148.

Moore, J. W. 1979: Distribution and abundance of attached, littoral algae in 21 lakes and streams in the Northwest Territories. -Canadian Journal of Botany, 57: 568-577.

Nejadsattari, T., Noroozi, M. & Fallahi, M. 2005: The composition and seasonal distribution of epiphytic algae in Anzali lagoon, Iran. -Cryptogamie, Algal. 26 (4): 387-398.

Nejatkhah, P. M., Oryan, S., Rostaian, A., Naghshineh, R. & Fatemi, S. M. R. 2003: Phytoplankton bloom in Anzali wetland and identification of toxic algae. -Iranian Journal of Fisherie Science, 12 (2): 95-110.

Nollet, I. & Leo, M. L. 2000: Handbook of Water Analysis. -Food Science andTechnology. -New York, Marcel Dekker, Inc. 921 p.

Noroozi, M., Naquinezhad, A. & Saeidi Mehrvarz, Sh. 2009: Algal flora on first Iranian land-Marine, the Boujagh National Park. -International Journal on Algae, 11: 276- 288.

Patrick, R. & Reimer, C. W. 1966-1975: The diatoms of the united state I & II. -Academy of Natural Sciences of Philadelphia, Philadelphia. No.13p.

Prescott, G. W. 1970: Algae of the western Great Lakes Area. -W. C. Brown Co. Dubuque. 977 p.

Ramezannejad Ghadi, R. & Kianianmomeni, A. 2012a: Attached and epipelic algae of the Miankaleh International Wetland (Northern Iran). -Jouranl of Environmental Science, 1(9): 61-72.

Ramezannejad Ghadi, R., Ghassemi, H. R., Atazadeh, I. & Zahedi, M. 2012b: Ecological studies of the seadwater of a thermal spring in Kilesephyd, Sar-e-Pol-e-Zohab in Kermanshah province, Iran.). -Journal of Environmental Science, 1 (9): 87-96.

Ramezanpoor, Z. 2004: Ecological study of phytoplankton of the Anzali lagoon. -Czech Phycology, Olomouc, 155-162.

Rawson, D. S. 1956: Algal indications of trophic Lake Thpes. -Limnology Oceanography, 1:18-25.

Saha, S. B., Bhattacharya, S. B. & Choudhury, A. 2000: Diversity of phytoplankton of sewage pollution brakish water tidal ecosystems. -Environmental Boilogy, 21 (1): 9-14.

Shubert, L. E. 1984: Algae as ecological indicators. -Academic Press, London, 434 p.

Sourina, A. 1978: Phtoplankton manual. UNESCO, Paris, 337 p.

Stein, J. R. 1973: Handbook of phycological methods, culture methods and growth measurements. -Cambridge University Press. 448 p.

Stevenson, R. J. & Pan, Y. 1999: Assessing environmental conditions in rivers and streams using diatoms. In: Stoermer, E. F.& Smol, J. P. (eds.) The diatoms applications for the environmental and earth sciences. -Cambridge University Press, Cambridge. pp. 11–40.

Stoermer, E. F. & Julius, M.L. 2003: Centric diatoms. In: Wehr, J. D. & Sheath, R. G. (eds.) Freshwater algae of North America. -Elsevier Science pp. 559-594.

Tiffany, L. H. & Britton, M. E. 1971: The algae of Illinois. -New York, Hafner Publication Company. 407 p.

Wetzel, R. G. & Linkens, G. E. 1991: Limnological analysis. Springer- Verlage, pp: 139-165.

Wehr, J. D. & Sheath, R. G. 2002: Freshwater algae of North America: ecology and classification. -Academic Press, San Diego, CA. 950 p.

Whitford, L. A. & Schumacher, G. J. 1969: A manual of the fresh-water algae in North Carolina. -The North Carolina Agricultural Experiment Station. pp:313

Zarei-Darki, B. 2009a: Algal flora of rivers in Iran. -Internationl Journal on Algae. 11 (2): 171- 180.

Zarei-Darki, B. 2009b: Marine species in the algal flora of the Anzali swamp (Iran). -Russian Journal of Marine Biology, 35 (3): 200-205.

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