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Diversity of macrophytes and microphytes in an urban wetland, Babol, Mazandaran Province, Iran; toward a conservation policy

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ABSTRACT

Despite to its importance for retaining biodiversity and human health, urban wetlands have received much less attention than other wetland types in northern Iran. This study deals with the floristic characteristics of one of the largest urban wetlands in Central Mazandaran, Roshanabad wetland in Babol. All vascular plants were collected during two growing seasons of 2014 and 2015 and water sampling was performed seasonally (autumn 2014 to summer 2015). We encountered 102 plant species belonging to 80 genera and 39 families. The largest families in the studied area were Poaceae with (11.7%) followed by Cyperaceae and Asteraceae (9.8%) and Fabaceae and Polygonaceae (5.9%). Genera represented by the greatest number of species were *Cyperus* (7 sp.), *Polygonum* (4 sp.), *Ranunculus* (3 sp.) and *Typha* (3 sp.). Classification based on life form, indicated that the therophytes (47%) comprised the largest proportion of the plants in the studied area. From chorological point of view, the largest proportion of the flora belonged to the pluriregional elements (62.3%). Various habitats of the wetland are discussed. Moreover, 63 genera of fresh water algae, belonging to eight phyla were identified in the study area. Cholorophyta with 28 genera was the most abundant phylum followed by Bacillariophyta (19 genera), Cyanophyta (6 genera), Euglenophyta (4 genera), Chrysophyta, Dinophyta (2 genera), and Charophyta, Xanthophyta (each with one genus). Moreover, a comparison between the data as well as ratios of species/genera and genera/families collected from this wetland and from the other wetlands in north Iran has been provided. Roshanabad wetland had fewer aquatic species compared to some other wetlands in north of Iran, because of anthropogenic effects such as penetration of agricultural and urban sewage which has large quantities of nitrate and phosphate, and distribution of exotic aquatic plant, *Azolla filiculoides*. Moreover, Palmer Index of pollution shows that the wetland has high ratio of pollution in all seasons. This urban wetland site may be considered as a pilot site for the interaction of human effects and biodiversity pool. This is among the first attempts for restoration of such an important and sensitive ecosystem in north of Iran.

Key words: Urban wetland, Macrophytes, Microphytes, Life form, Chorology, Invasive plants.

INTRODUCTION

Wetlands are valuable components of natural landscapes which provide abundant services and materials with economic value, not only to the adjacent local populations but also to regional communities. The first recognized ecological service of each wetland is being considered as wildlife habitat for a variety of aquatic organisms (Shaw & Fredine 1939). Several other ecological services have also been reported, including water quality improvement, flood mitigation, erosion control and recreational enrichment (Mitsch & Gosselink 2000). Destroying wetlands by means of drainage and pollution, which have derived from wastewater of agriculture and industries are substantial problems for the world wetlands.

At the most basic level, wetland plants are an important component of a wetland system. Many waterfowl consume the seeds or the tubers of wetlands plants. More importantly, much of the plant material enters the food chain which is then consumed by fish and wildlife. A variety of organisms also use plants as cover or habitat. Wetlands plants also improve water quality removing nutrients and some toxins from the water and storing them.

Moreover, wetland plants can reduce peak flood events and stabilize soils. On the other hand, other green components of wetlands, the algae are regarded as valuable component of wetlands too, since they make an important role in biological diversity and productivity of wetlands. Their importance in terms of productivity and as a food source in higher trophic levels is well known (Burkholder & Wetzel, 1990). To benefit from algae in freshwater ecosystems, it is necessary to study the floristic composition of them. A floristic study on the fresh water algal flora reveals the species composition and taxonomic diversity of biological communities in an ecosystem (Andrejic *et al.* 2012). In addition, it reflects the seasonal variations (Ezekiel *et al.* 2011), evolutionary processes, ecological functions and stability of aquatic ecosystems (Komulaynen 2009). Urbanization of areas surrounding a wetland frequently has serious consequences for the ecosystem. The value of wetlands in urban areas can be viewed not only from an economic perspective, but ecologically and aesthetically as well.

The effects of urban-induced degradation on natural ecosystems are increasingly recognized as critical areas of ecological research (Limburg & Schmidt 1990; Matson 1990; Blair 1996). Urban wetlands, although subjected to many disturbances, still provide many functions which make their restoration important. These include provision of habitat for commercially important fish and wildlife species (Simenstad & Thom 1992, 1996). Urban wetlands have suffered many abuses, including destruction of vegetation by off-road vehicles and use as dumps; they are also highly susceptible to invasion by horticultural escapes, pets, and feral animals. Researches show that land-use patterns and degree of urbanization influence species composition of wetland plant (Erhenfeld & Schneider 1991, Cooke & Azous 1993). One of the most visible aspects of altered structure is the invasion of native communities by non-native plant species (Ehrenfeld & Schneider 1993). For some wetland ecosystems, the influx of introduced plant species has been shown to be associated with altered hydrology and increasing intensity of surrounding land-use (Houck 1996). Some introduced plant species particularly *Azolla filiculoides* Lam. and water Hyacinth (*Eichhornia crassipes* Solms) make an increasing destroying alarms of many natural and artificial wetlands across the Caspian Shore. Despite being in arid country, Iran possess different types of wetlands from south and west parts of Iran (Karami *et al.* 2001; Dolatkhahi *et al.* 2010) to south Caspian area (e.g. Ghahreman *et al.* 2004; Naqinezhad 2012; Zahed *et al.* 2013) & Alborz Mts. (Jalili *et al.* 2014). Some recent important algal flora studies in Iran are (Nejadsattari *et al.* 2005; Zarei-Darki 2009; Noroozi *et al.* 2009; Masoudi *et al.* 2011).

Despite to its importance, urban wetlands in the Caspian area has received less attention. Nevertheless, natural threat of these wetlands are high particularly its capacity for receiving many exotic plant species such as water Hyacith which is now a dangerous aquatic weed in many important wetlands like Siah-Keshim Protected Area, Sorkhankol Wildlife Refuge and Einak wetland in Guilan Province. We assumed that urban wetlands in northern Iran have the highest capacity to being polluted by these exotic species.

The aims of the study were to present: (1) a checklist of all vascular plants and algae across the wetland with detailed information about the habitats, life form and chorology for each species, (2) a comparison between the results of Roshanabad wetland as an urban wetland and other wetland types studied in Iran and (3) a solution for protection of this wetland against serious destruction.

MATERIALS AND METHODS

Study area

The wetland is located in Babol, Mazandaran Province, northern Iran, between 36º28′18.8″ N and 36°28′41.6″ N and between 52°42′00.7″ E and 52°42′25.7″ E.

There are many cultivated places and also some irrigation canal around the studied wetland. These canals carry water from wetland to cultivated farms, such as rice fields, citrus plantation. The total surface of the Roshanabad wetland was more than 100 ha in the past but now it is reducing its surface due to urbanization and anthropogenic effects Fig. 1. The ombrothermic diagram of the studied area was prepared according to climate data obtained from the Gharakheil meteorological station Fig. 2.

The mean annual precipitation is 724.9 mm and the mean annual temperature is 17 °C. The rainiest month occurs in October. The maximum and minimum mean monthly temperatures are 21.6 °C, and 12.4 °C, respectively. Babol River is considered as the water source for this wetland and then transfers its water into the Caspian Sea.

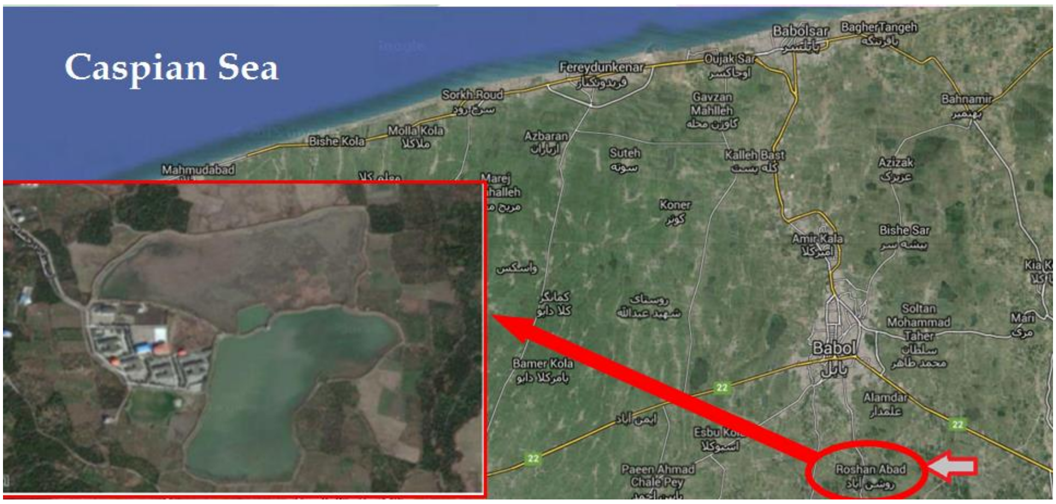

Fig. 1. Location of Roshanabad wetland around Babol city.

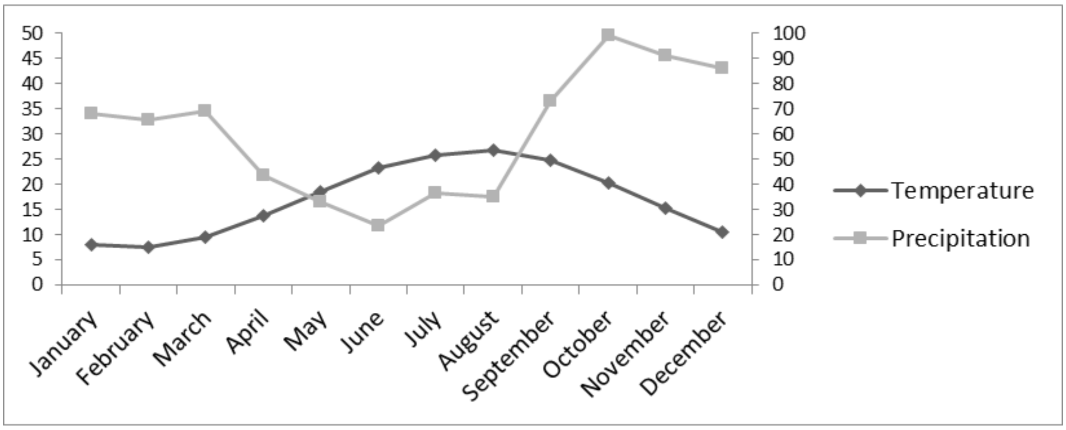

Fig. 2. The ombrothermic diagram of the wetland from the Gharakheil meteorological station covering the years 1980- 2014.

Data collection

In order to survey the flora of Roshanabad wetland, topographic map was provided at first. Then, the specimens were collected in the growing seasons of 2014 and 2015. The collected samples were then identified based on the classification and terminology applied in the various Flora, such as: Flora Iranica (Rechinger, 1963-1998), Flora of Iran (Assadi 1988 - 2011) and Flora of Turkey (Davis 1965 - 1988). Life forms were named following the Raunkiaer's classification (Raunkiaer 1934) and chorology of species is based on Zohary (1973) & Takhtajan (1986) viewpoints. The habitat and flower color of each species were carefully noted in the field. In order to survey algal flora, the samples were collected on a seasonally basis from autumn 2014 to summer 2015, between 11 am and 13:30 pm (Faghir & Shafii 2013).

Three stations were selected in the wetland according to different ecological conditions. Water samples were taken in polyethylene bottles and fixed immediately with 4% Formalin (Stein 1973). Algal flora identification were carried out using available literatures (Prescott 1978; George 1976; Salmoni 2006) and the samples were photographed by an Olympus Bx51 microscope.

RESULTS

Floristic results

In this study, a total of 102 species of vascular plants and 63 genera of fresh water algae were identified from Roshanabad wetland. Vascular plants belong to 39 families and 80 genera. 73 species are dicotyledonous and 28 species are monocotyledonous and one species is pteridophytic macrophyte. There were different number of families, genera and species among various taxonomic groups (Table 1). The richest families in terms of the number of taxa were Poaceae (12), Cyperaceae and Asteraceae (10) and Fabaceae and Polygonaceae (6) respectively. Considering species richness, genera with three and exceeding species were: *Cyperus* (7 sp.), *Polygonum* (4 sp.), Ranunculus (3 sp.) and *Typha* (3 sp.) (Table 1). In the total assessment of life from spectrum, therophytes made up 47.0% of the vegetation and were the dominant biological type in the studied area, followed by hemicryptophytes with 15.7%, as the second dominant life form (Fig. 3). The chorotype distributions of species in this wetland are as given in Fig. 4. As shown in this figure, the flora of the study areas is much affected by pluriregional elements. The results of this study exhibited the existence of three different habitats in the studied area shown in Fig. 5:

1- Habitat for marginal plants: These habitats were usually situated on wet places near to the wetland, plains, rivers, etc. i.e., *Polygonum hydropiper, Polygonum lapathifolium*, *Plantago major, Cyperus difformis.*

2- Habitat for the emergent plants, these habitats contained marshlands and places out of open water area. Plants of this habitat had the high ability to absorb large amount of water.

These habitats placed at second stage after the marginal habitat. Some species of this habitat were: *Hydrocotyle vulgaris, Oenanthe aquatica, Sparganium erectum, Typha latifolia, Polygonum barbatum, Nelumbium nuciferum*

3- Habitat for open water plants: These parts were characterized with some floating and submerged plants and generally is a species-poor habitat. Species adapted to these habitats were: *Ceratophyllum demersum, Ranunculus trichophyllus.*

A column in Table 1 is relevant to habitat diversity of plant species. The number of plant species (in number) which can be found in each habitat is summarized in Fig. 5.

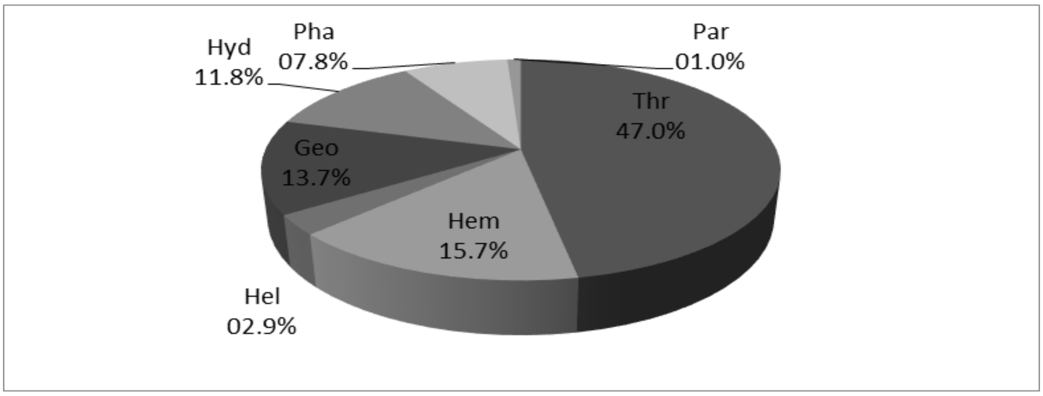

Fig. 3. Proportion of different life forms (%). Abbreviations: Thr= therophyte, Hem= Hemicryptophyte, Pha= Phanerophyte, Hel= Helophyte, Geo= Geophyte, Par= parasite.

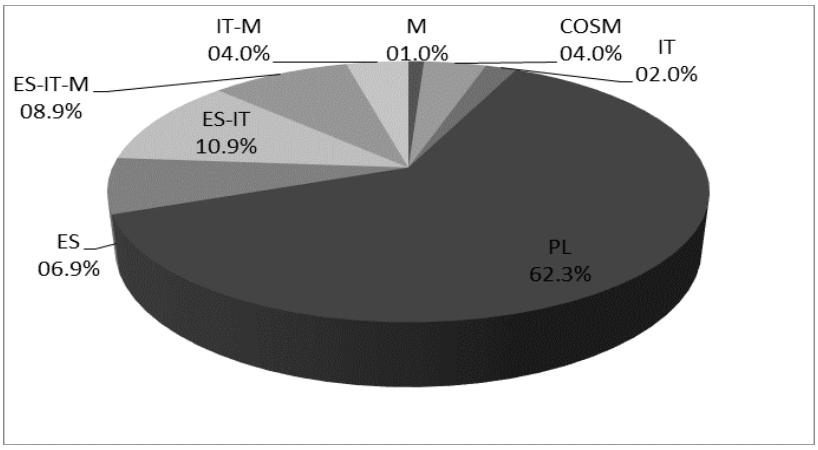

Fig. 4. Proportion of various chorotypes (%). Abbreviations: IT= Irano- Turanian, M=Mediterranean, ES= Euro-Siberian, PL= Plurireginal, COSM= Cosmopolitan.

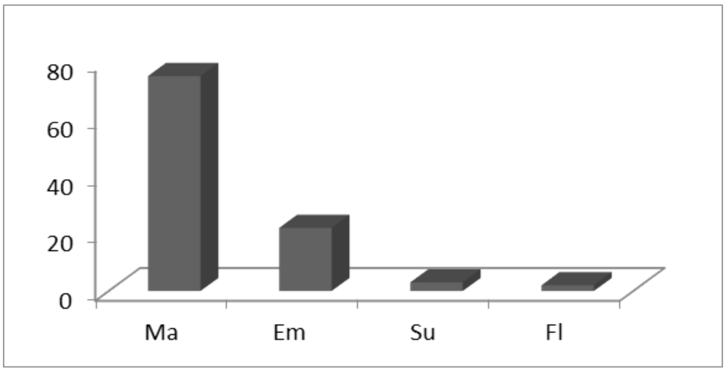

Fig. 5. Proportion of species richness in different habitats of Roshanabad wetland. Em (Emergent plant), Fl (Floating plant), Ma (Marginal plant), Su (Submerged plant).

Table 1. A list of vascular plants in Roshanabad wetland of Babol.

Taxa	Habitat	Life form	Chorotype
Azollaceae			
Azolla filiculoides Lam.	Fl	Hyd	PL
Spermatophyta			
Angiospermae			
Dicotyledones			
Amaranthaceae			
Alternanthera sessilis (L.) R. Br.	Ma	Thr	PL
Amaranthus blitoides S.Watson var. *blitoides*	Ma	Thr	PL
A. viridis L.	Ma	Thr	PL
Apiaceae			
Hydrocotyle vulgaris L.	Em	Hel	ES
Oenanthe aquatica (L.) Poir.	Em	Hem	ES-IT
Pimpinella affinis Ledeb.	Ma	Hem	PL
Asteraceae			
Artemisia annua L.	Ma	Thr	ES, IT, M
Carduus arabicus Jacq.	Ma	Thr	ES, IT, M
Centaurea iberica Trevir. ex Spreng.	Ma	Thr	PL
Cirsium vulgare (Savi) Ten.	Ma	Hem	PL
Conyza bonariensis (L.) Cronquist.	Ma	Thr	PL
Eclipta prostrata (L.) L.	Em	Thr	PL
Senecio vernalis Waldst. & Kit.	Ma	Thr	ES, IT

Sonchus asper (L.) Hill. subsp. *glaucescens* (Jordan) Ball.	Ma	Hem	PL
S. oleraceus L.	Ma	Thr	PL
Xanthium spinosum L.	Ma	Thr	PL
Boraginaceae			
Nonnea lutea (Desr.) Reichenb. ex Dc.	Ma	Thr	ES
Brassicaceae			
Capsella bursa-pastoris (L.) Medicus	Ma	Hem	PL
Raphanus raphanistrum L. subsp. *raphanistrum*	Ma	Thr	PL
Sisymbrium irio L.	Ma	Thr	PL
Caprifoliaceae			
Sambucus ebulus L.	Ma	Hem	PL
Caryophyllaceae			
Cerastium glutinosum Fries	Ma	Thr	PL
Stellaria media (L.) Vill	Ma	Thr	PL
Ceratophyllaceae			
Ceratophyllum demersum L.	Su	Hyd	PL
Chenopodiaceae			
Chenopodium album L.	Ma	Thr	PL
Convolvulaceae			
Calystegia sepium (L.) R. Br.	Ma	Geo	PL
Convolvulus arvensis L.	Ma	Hem	COSM
Cuscutaceae			
Cuscuta campestris Yunck.	Ma	Thr	COSM
Euphorbiaceae			
Acalypha australis L.	Ma	Thr	PL
Chrozophora oblique (Vahl) Juss. ex Spreng.	Ma	Thr	IT
Euphorbia helioscopia L.	Ma	Thr	ES, IT, M
Fabaceae			
Glycyrrhiza echinata L.	Ma	Geo	ES, IT, M
Lotus corniculatus L.	Ma	Hem	PL
Medicago sativa L.	Ma	Hem	IT
M. polymorpha L.	Ma	Thr	IT, M
Melilotus indicus (L.) All.	Ma	Thr	PL
Trifolium resupinatum L.	Ma	Thr	ES, IT, M
Lamiaceae			
Lycopus europaeus L.	Em	Geo	PL
Mentha aquatica L.	Em	Geo	ES
Lythraceae			
Lythrum salicaria L.	Em	Hel	PL
Malvaceae			
Abutilon theophrasti Medik.	Em	Thr	PL
Malva neglecta Wallr.	Ma	Thr	PL
Moraceae			
Ficus carica L. subsp. *carica*	Ma	Pha	IT-M
Nelumbonaceae			
Nelumbium nuciferum Gaertn.	Fl	Hyd	PL
Orobanchaceae			
Orobanche sp.	Ma	Par	
Oxalidaceae			
Oxalis corniculata L.	Ma	Thr	PL
Phytolaccaceae			
Phytolacca americana L.	Ma	Hem	PL
Plantaginaceae			
Plantago major L.	Ma	Hem	PL
Polygonaceae			
Polygonum barbatum L.	Em	Geo	PL
P. hydropiper L.	Ma	Thr	ES, IT
P. lapathifolium L. subsp. *lapathifolium*	Ma	Thr	ES, IT
P. persicaria L.	Em	Thr	PL
Rumex pulcher L.	Ma	Hem	ES, IT, M

R. sanguineus L.	Ma	Hem	ES
Primulaceae			
Anagalis arvensis L.	Ma	Thr	PL
Punicaceae			
Punica granatum L.	Ma	Pha	ES, IT
Ranunculaceae			
Ranunculus trichophyllus Chaix	Su	Hyd	PL
R. dolosus Fisch & C.A. Mey.	Ma	Hel	ES
R. marginatus d'Urv.	Em	Thr	IT, M
R. scleratus L.	Em	Thr	PL
Rosaceae			
Rubus caesius L.	Ma	Pha	ES, IT
R. sanctus Schreb.	Ma	Pha	ES, IT
Salicaceae			
Populus nigra L.	Ma	Pha	ES, IT, M
Salix alba L.	Ma	Pha	ES, IT
S. excelsa S. G. Gmelin	Ma	Pha	IT, M
Scrophulariaceae			
Kickxia elatine (L.) Dumort.	Ma	Thr	M
Veronica persica Poir.	Ma	Thr	PL
V. polita Fr.	Ma	Thr	PL
Solanaceae			
Solanum persicum Willd. ex Roem. & Schult. subsp. *persicum*	Ma	Pha	ES, IT
S. nigrum L.	Ma	Thr	PL
Urticaceae			
Urtica dioica L.	Ma	Hem	PL
Verbenaceae			
Phyla nodiflora (L.) Greene	Ma	Hem	PL
Verbena officinalis L.	Ma	Hem	PL
Monocotyledones			
Cyperaceae			
Cyperus difformis L.	Ma	Thr	PL
C. fuscus L.	Em	Thr	PL
C. longus L.	Ma	Geo	ES-IT-M
C. odoratus L. subsp. *transcaucasicus* (Kuk.) Kukkonen	Ma	Geo	ES, IT
C. pygmaeus Rottb.	Ma	Thr	PL
C. rotundus L.	Ma	Geo	PL
C. serotinus Rottb.	Em	Hyd	PL
Pycreus flavidus (Retz.) T. Koyama	Em	Thr	PL
Schoenoplectus lacustris (L.) Palla	Em	Hyd	ES, IT
S. mucronatus (L.) Palla	Em	Hyd	PL
Juncaceae			
Juncus articulatus L.	Ma	Geo	PL
Poaceae			
Arundo donax L.	Ma	Geo	ES-IT-M
Bromus japanicus Thunb.var. *japonicus*	Ma	Thr	PL
Cynodon dactylon (L.) Pers.	Ma	Geo	PL
Digitaria sanguinalis (L.) Scop.	Ma	Thr	PL
Eleusine indica (L.) Gaertn.	Ma	Thr	PL
Paspalum distichum L.	Em	Geo	COSM
Phleum paniculatum Huds. var. *ciliatum* (Boiss.) Bor	Ma	Thr	ES
Phragmites australis (Cav.) Steud.	Em	Hyd	PL
Polypogon monspeliensis (L.) Desf.	Ma	Thr	PL
Setaria glauca (L.) P. Beauv.	Ma	Thr	PL
Sorghum halepense (L.) Pers.	Ma	Geo	PL
Hordeum leporinum Link.	Ma	Thr	PL
Potamogetonaceae			
Potamogeton crispus L.	Su	Hyd	PL
Sparganiaceae			
Sparganium erectum L. subsp. *neglectum* (Beeby) K. Richter	Em	Geo	ES

Typhaceae			
Typha angustifolia L.	Em	Hyd	PL
T. domingensis Pers.	Em	Hyd	PL
T. latifolia L.	Em	Hyd	COSM

Symbols and abbreviations used in the Table:
Life form: Geo (Geophyte), Hel (Helophyte), Hem (Hemicryptophyte), Hyd (Hydrophyte), Pha (Phanerophyte), Thr (Therophyte), Par (Parasite).
Chorotype: COSM (Cosmopolitan), ES (Euro-Sibirian), IT (Irano-Turanian), M (Mediterranean), PL (Pluriregional).
Habitat and Ecology: Em (Emergent plant), Fl (Floating plant), Hyg (Hygrophyte), Ma (Marginal plant), Su (Submerged plant).

Algae diversity of the wetland

The taxonomic composition of freshwater algae is presented in Table 2. A total of 63 genera of fresh water algae, were identified belonging to 8 phyla (Fig. 2). Cholorophyta with 28 genera was the most abundant Phylum followed by Bacillariophyta (19 genera), Cyanophyta (6 genera), Euglenophyta (4 genera), Chrysophyta, Dinophyta (2 genera), and Charophyta, Xanthophyta (each with one genus) Table 2.

Table 2. Floristic list of algae in the Roshanabad wetland.

Phylum	Genera
	Achnanthes, Amphora, Caloneis, Cocconeis, Cyclotella
Bacillariophyta	*Cymatopleura, Diploneis, Epithemia, Gomphonema*
	Gyrosigma, Mastogloia, Melosira, Navicula, Nitzschia
	Pinnularia, Rhopalodia, Stephanodiscus, Surirella, Synedra
Charophyta	*Chara*
	Ankistrodesmus, Asterococcus, Chlamydomonas, Chlorella, Codatella, Coelastrum, Cosmarium, Crusigenia,
	Dictyosphaerium, Golenkinia, Gonium,
Chlorophyta	*Kirchneriella, Lagerheimia, Micractinium, Monoraphidium, Mougeotia, Nephrocytium, Oedogonium, Oocystis, Pandorina*
	Pediastrum, Selenastrum, Scenedesmus, Schroederia
	Staurastrum, Tetrastrum, Tetraedron, Westella
Chrysophyta	*Dinobryon, Synura*
Cyanophyta	*Anabaena, Aphanizomenon, Chroococcus*
	Merismopedia, Microcystis, Oscillatoria
Dinophyta	*Peridinium, Ceratium*
Euglenophyta	*Euglena, Lepocinclis, Phacus, Trachelomonas*
Xanthophyta	*Ophiocytium*

According to the occurrence of different genera in different seasons, Palmer pollution index is showed in Table 3. Pollution index was evaluated for each separate genus in different seasons. Summer had the highest pollution index and winter had the lowest one.

Table 3. Palmer pollution index table based on identified algal flora.

Algal genera	Pollution Index	Spring	Summer	Autumn	Winter
Ankistrodesmus	2	2	2	2	-
Chlamydomonas	4	4	4	4	4
Chlorella	3	3	3	-	-
Cyclotella	1	1	1	1	-
Euglena	5	5	5	5	5
Gomphonema	1	1	-	-	1
Lepocinclis	1	1	1	1	-
Melosira	1	-	-	-	1
Micractinium	1	1	1	-	-
Navicula	3	3	3	3	3
Nitzschia	3	3	3	3	3
Oscillatoria	5	5	5	5	5
Pandorina	-	-	-	-	1
Phacus	2	2	2	2	2
Scenedesmus	4	4	4	4	4
Synedra	2	-	2	2	-
Sum		35	36	32	29

DISCUSSION

Urban wetlands are considered as one of the most sensitive ecosystems. Introducing invasive aquatic weeds into these wetlands is the big concern these days particularity in the south Caspian plain where the climate makes suitable conditions for growing and distribution of these plants. One tragedy example is the distribution of water hyacinth which is now known as a problematic issue in many wetlands of Guilan Province. This is also an alarm for other more intact wetlands (Mozaffarian & Yaghoubi 2015).

The main structure of vegetation of the studied wetland was relatively similar to the vegetation of other wetlands of the northern Iran (e.g. Naqinezhad *et al.*, 2006; Naqinezhad & Hosseinzadeh, 2014). The special characteristic of this wetland was the occurrence of high density of *Nelumbium nuciferum* which has been observed in the most ancient and diverse wetlands such as Anzali, Amirkelayeh and Fereydonkenar wetlands. The ratios of species/genera and genera/families for the Roshanabad wetland was compared with other wetland areas, nevertheless, the studied wetland had fewer aquatic species than some other wetlands, because of anthropogenic effects and urbanization Table 3. These ratio indicate the importance value of lower taxa and its diversity among flora of studied area. The number of taxa is similar to Selkeh wetland and close to number of taxa in Gomishan and Sorkhankol wetlands. Instead, wetlands of Boujagh and Fereydoonkenar possess higher number of plants due to occurrence of diverse habitats. The effect of agricultural and urban Sewage which has large quantities of nitrate and phosphate, and distribution of non-native aquatic plant e.g. *Azolla filiculoides,* has prevented the growth of many submerged and floating species in this wetland. In this condition plants such as *Phragmites australis*, *Nelumbium nuciferum* and *Schoenoplectus lacustris* has increased. This is the case in other wetlands where *Azolla* affects the vegetation. These plants have hard stems and leaves and are difficult to decompose. Cellulosic debris left over from their non-productive and very hard rhizome increases sediments on the bottom of the wetland. We determined two floating species, three submerged species, and 22 emergent species. Therefore, the number of species is gradually increasing from floating type to emergent type. This trend of floristic composition indicates an intermediate seral stage in hydrosere which progressively converts a water body initially into a mesic and finally to a xeric habitat (Parveen *et al.* 2014).

For the life form, therophytes were the dominant biological type in the studied area. Although, therophytes occurred abundantly in desert areas (Archibold 1995), its high presence is attributed to human activities such as fish pond activities and agriculture, and destruction of ecosystem.

This effect was previously observed in other studied wetland ecosystems as well (Ghahreman *et al.* 2006; Ejtehadi *et al.* 2003; Khodadadi *et al.* 2009). Pluriregional elements were the dominant chorotype in the area. It is because of higher number of aquatic and wetland plants which distribute various wet and azonal habitat. On the other hand, human activities can be considered as another reason that are responsible for the establishment of widespread weeds (Archibald 1995; Naqinezhad *et al.* 2006).

Table 4. Comparative floristic richness and taxonomic diversity. Boujagh (Naqinezhad *et al.* 2006); Gomishan (Karimi 2009); Selkeh (Zahed *et al.* 2013); Fereydoonkenar (Naqinezhad & Hosseinzadeh 2014); Sorkhankol (Saeidi & Ashouri 2015).

	Present study	Boujagh	Gomishan	Selkeh	Fereydoonkenar	Sorkhankol
Total number of taxa (S)	102	248	116	102	248	81
Total number of genera (G)	80	164	72	84	176	68
Total number of families (F)	39	62	33	46	73	35
S/G	1.2	1.5	1.61	1.21	1.4	1.19
G/F	2.05	2.6	2.18	1.82	2.4	1.94

There was some similarities between the algal flora of the studied area and other freshwater ecosystems in the North of Iran (Masoudi *et al.* 2011; Ramezannejad Ghadi & Kianian Momeni 2012). The seasonal variations of phytoplankton are related to different environmental factors that regulate the growth and distribution of these organisms (Thebault & Rabouille 2003). The Palmer Index shows that the wetland has high ratio of pollution in all seasons that can be due to penetration of toxins such as nitrogen and phosphor from surrounding agricultural fields (Palmer, 1969). Wetland has sign of eutrophication, mainly due to the presence of cyanobacteria such as *Anabaena*, *Microcystis*, *Aphanizomenon* (Mann 2000). This could potentially result in harmful algal blooms as well as anoxic conditions that have negative impacts on birds that use this wetland for foraging and shelter (Gordon *et al.* 2011). It has been emphasized by many researchers that algal communities as a whole are reliable indicators of pollution rather than single algae (Patrick 1965; Palmer 1969; Taylor *et al.* 2004). Recent approach for assessment of `pollution therefore, tends to use algal communities as indices rather than single algal indicator as it was true in the present study. Roshanabad wetland has great economic importance for residents due to its roles for the supply of water for agricultural field and fish pond. In conclusion, there is the urgent need to prevent the penetration of agricultural and urban sewage to this wetland.

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تنوع ماکروفیت‌ها و میکروفیت‌ها در یک تالاب شهری در بابل، مازندران، ایران: به سوی اتخاذ یک سیاست حفاظتی

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چکیده

به رغم اهمیت تالاب‌های شهری در حفظ تنوع زیستی و سلامت انسان، این نوع اکوسیستم‌ها نسبت به انواع دیگر تالاب‌ها از توجه کمتری برخوردار شده است. این مطالعه در مورد ویژگی فلوریستیک تالاب روشن‌آباد، یکی از بزرگترین تالاب‌های شهری در مرکز مازندران در شهرستان بابل به انجام رسیده است. تمامی گیاهان آوندی در طول دو فصل رویشی (۱۳۹۳-۹۴) جمع آوری شدند و نمونه‌برداری آب به صورت فصلی از پاییز ۹۳ تا تابستان ۹۴ انجام شد. ۱۰۲ گونه گیاهی آوندی متعلق به ۸۰ جنس و ۳۹ خانواده شناسایی شدند. بزرگترین خانواده در منطقه مورد مطالعه Poaceae با (۱۱/۷٪) بود و پس از Cyperaceae و Asteraceae (۹/۸ درصد) و Fabaceae وPolygonaceae (۵/۹ ٪) غالب‌ترین خانواده‌های گیاهی منطقه بودند. بزرگترین جنس از نظر تعداد گونه Cyperus (7 sp.) و Polygonum (4 sp.) و Ranunculus (3 sp.) و Typha (3 sp.) بودند. طبقه‌بندی بر اساس شکل زیستی منطقه نشان داد که تروفیت (۴۷٪) شامل بزرگترین گروه شکل زیستی گیاهان در منطقه مورد مطالعه است. از نقطه نظرکورولوژی بزرگترین سهم از فلور منطقه به عناصر چند ناحیه‌ای با ۶۲/۳ ٪ تعلق داشت. زیستگاه های مختلف تالاب مورد بحث قرار گرفت. علاوه بر این، ۶۳ جنس جلبک آب شیرین، متعلق به ۸ شاخه در منطقه مورد مطالعه شناسایی شد. Cholorophyta با ۲۸ جنس بزرگترین شاخه بوده و به دنبال آن شاخه Bacillariophyta (۱۹ جنس)، شاخه Cyanophyta (۶ جنس)، Euglenophyta (۴ جنس)، شاخه Chrysophyta، Dinophyta (۲ جنس) و Charophyta ، Xanthophyta (هر کدام با یک جنس) بودند. علاوه بر این، یک مقایسه بین داده‌ها و نسبت گونه / جنس و جنس / خانواده جمع‌آوری شده از این تالاب و دیگر تالاب‌های شمال ایران، ارائه شده است. تالاب روشن‌آباد گونه‌های آبزی کمتری نسبت به برخی دیگر از تالاب‌های شمال ایران دارد که این به دلیل عوارض انسانی مانند نفوذ فاضلاب کشاورزی و شهری است که مقدار زیادی از نیترات و فسفات را داراست و توزیع گیاه آبزی غیر بومی آزولا را باعث شده است. علاوه بر این، شاخص آلودگی پالمر نشان می‌دهد که تالاب نسبت بالایی از آلودگی را در تمام فصول سال داراست. این تالاب شهری می‌تواند به عنوان یک سایت آزمایشی برای بررسی اثرات متقابل انسان و محتوای تنوع زیستی مورد توجه قرار بگیرد. این اولین تلاش برای بازسازی این نوع اکوسیستم های مهم و حساس در شمال ایران است.

*مولف مسئول