Wetland flora and diversity of the Western Alborz Mountains, North Iran

Asghar Kamrani[1], Alireza Naqinezhad[2], Farideh Attar[3], Adel Jalili[4] & David Charlet[5]

[1] Department of Biology, Faculty of Basic Science, Shahed University, P. O. Box 18155-155, Tehran, Iran, e-mail: kamrani@shahed.ac.ir (corresponding author)

[2] Department of Biology, Faculty of Basic Science, University of Mazandaran, Babolsar, Mazandaran, Iran

[3] Department of Botany, School of Biology, University College of Sciences, University of Tehran, Iran

[4] Department of Botany, Research Institute of Forests and Rangelands, Tehran, Iran

[5] Department of Biology, College of Southern Nevada, Henderson, USA

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Abstract. The Alborz Mountains are the second largest mountain range in Iran and possess the tallest peak. Mountain wetlands on the arid southwestern slopes of the Alborz range, as compared to other parts of this range, are relatively unknown botanically. We present here the contemporary status of the flora, life forms, and phytogeographic characteristics represented by 90 sites in these wetlands of the arid mountains. Three hundred and fifty-four taxa were identified, belonging to 201 genera and 54 families. The largest families are *Asteraceae* (15.3 %), *Poaceae* (13.8 %) and *Cyperaceae* (8.5 %). The genera represented by the greatest number of species are *Carex* (12 species), *Galium* (9), *Epilobium* (9), and *Cirsium* (9). Hemicryptophytes prevail in number (34.2 %), followed by geophytes (29.0 %) and therophytes (20.6 %). From a chorological viewpoint, most of the flora belongs to the pluriregional elements (35.2 %). There are a large number of Irano-Turanian elements within these wetlands, and nearly 6 % of the flora consists of endemic and subendemic taxa. Four main groups of habitats were recognized, corresponding to wet meadows, springs, lakeshores, and river banks. Mountain wetland vegetation in the Alborz Mountains requires strong conservation and protection management policies since they are restricted, isolated, and productive ecosystems.

Key words: biodiversity, life-form, Mountain wetlands, North Iran, phytogeography

Introduction

The Alborz Mountains extend about 650 km from west to east along the border of Iran, at the southern shore of the Caspian Sea. This west-east axis produces dramatically different environments on the northern and southern slopes (Klein 2001). The northern slopes have rich Hyrcanian forests of beech, maple and oak and drain into the Caspian Sea, while the southern slopes, dominated by a semi-arid steppe, drain into the Dasht-e-Kavir desert. There are many small wetlands within the arid steppe on these southern slopes. These wetlands are extremely important contributors to biodiversity and are distinctly differentiated floristically from the adjacent steppe ecosystems. Mountain wetland habitats have been poorly investigated botanically in Iran. The initial vegetation researches into Iranian wetland habitats go back some 15 years to Klein & Lacoste (1995), Karami & al. (2001), Asri & Eftekhari (2002), Ejtehadi & al. (2003),

Ghahreman & Attar (2003), Ghahreman & al. (2004), Shokri & al. (2004), Naqinezhad & al. (2006), and Asri & al. (2007), who published their results about the Hyrcanian and Irano-Turanian areas. More recently, research was conducted into the wetlands of the central section of Alborz range (Naqinezhad & al. 2009; 2010). In spite of the latter study, detailed floristic accounts are still scarce, particularly of the wetland sites in the western section of the Alborz Mountains (Kamrani & al. 2010, 2011). Mountain wetland studies have been carried out in the neighbouring mountain systems (e.g. Hadač & Agnew 1963; Gilli 1971; Parolly 2004; Kavgaci & al. 2010), but a huge area in the Irano-Turanian region (sensu Zohary 1973) remains poorly explored. A comprehensive synthesis of the diversity of this vegetation in Europe and Asia cannot be carried out without filling in this vital gap in global biogeographic knowledge (Naqinezhad & al. 2009; Kavgaci & al. 2010).

The present study aims to identify the floristic composition, life forms, and chorology of the Southwestern Alborz Mountains wetland flora. The findings provide: (1) an overview of biodiversity of the Alborz Mountains wetland plants, (2) a check-list of all vascular plants found in the wetland sites, (3) life-form and chorology analysis for each species, (4) a comparison of this investigation with the one of the central Alborz Mountains, and (5) identification of threats to the conservation of wetland vegetation.

Material and methods

Study area

The study area is in the southern part of the Western Alborz Mountains, located between 49°24' and 51°19' E and between 35°56' and 36°45' N. (Fig. 1 and Appendix 1). This sector, which is nearly 250 km long and 70 km wide, reaches on Mount Siahlan an altitude of 4170 m. Generally, altitudes range from 350 m to 3200 m. The Alborz Mountains are a high mountain bridge between the Hindu Kush-Himalaya Mountains in the east and Anatolia and the Caucasus Mountains in the west. Therefore, this transition

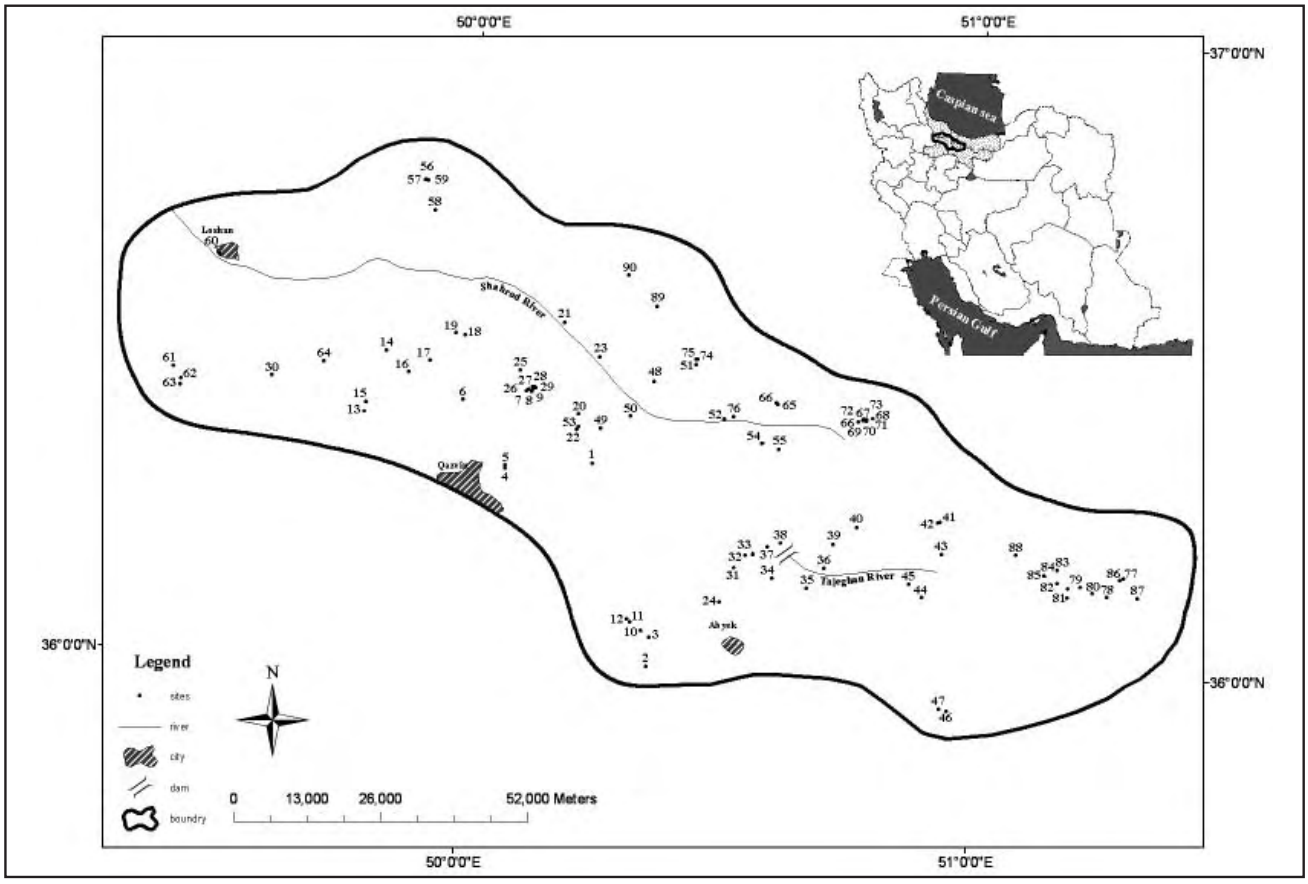

Fig. 1. Location of the studed wetland sites in the Alborz Mountains of Iran. The numbers on the map correspond to the wetland sites listed in Appendix I.

area exhibits some very important phytogeographycal aspects. In an earlier study (Naqinezhad & al. 2010), the central section of the Alborz Mountains was examined, which borders on the western section of this study area. It was located between 51°05' and 52°59' E and between 35°40'and 36°10' N. That sector is nearly 55 km long and 45 km wide. The area lies between two main roads, the Karaj-Chalus road in the west and

Appendix 1. Location of wetland sites in the southwestern part of the Alborz range. (see Fig. 1 for the location of each study site).

Site No	Latitude (N)	Longitude (E)	Area (m^2)	Altitude (m a.s.l.)	Site No	Latitude (N)	Longitude (E)	Area (m^2)	Altitude (m a.s.l.)
1	36° 19' 09.7"	50° 14' 51.4"	500	1700	46	35° 56' 47.7"	50° 56' 35.0"	1000	1750
2	36° 00' 02.0"	50° 22' 00.2"	2000	1200	47	35° 56' 36.1"	50° 57' 24.8"	3000	1800
3	36° 02' 47.2"	50° 22' 12.3"	1000	1200	48	36° 27' 13.8"	50° 21' 49.9"	10000	1200
4	36° 18' 45.7"	50° 04' 33.3"	500	1400	49	36° 22' 32.2"	50° 15' 40.1"	2500	2200
5	36° 18' 27.9"	50° 04' 33.3"	15000	1500	50	36° 23' 52.0"	50° 19' 09.5"	1500	1500
6	36° 24' 52.8"	49° 59' 17.6"	1000	1800	51	36° 28' 58.2"	50° 26' 44.5"	70000	1800
7	36° 26' 11.0"	50° 07' 53.5"	10000	2150	52	36° 23' 50.4"	50° 30' 18.9"	10000	1300
8	36° 26' 06.2"	50° 07' 33.7"	8000	2140	53	36° 22' 25.8"	50° 12' 52.4"	2500	2200
9	36° 25' 48.6"	50° 07' 24.6"	3000	2150	54	36° 21' 37.6"	50° 34' 50.2"	1500	1800
10	36° 03' 24.1"	50° 21' 15.1"	2000	1200	55	36° 21' 08.0"	50° 36' 48.0"	500	2200
11	36° 04' 13.7"	50° 19' 57.2"	2500	1200	56	36° 45' 41.0"	49° 53' 56.0"	3500	2020
12	36° 04' 27.8"	50° 19' 31.4"	2500	1200	57	36° 45' 41.4"	49° 54' 01.9"	5000	2000
13	36° 23' 21.9"	49° 47' 45.0"	10000	1555	58	36° 42' 47.8"	49° 55' 14.4"	1500	1550
14	36° 29' 16.6"	49° 50' 05.8"	10000	2000	59	36° 45' 33.5"	49° 54' 12.9"	6000	2050
15	36° 24' 15.1"	49° 47' 50.8"	15000	1600	60	36° 37' 47.1"	49° 29' 51.8"	100000	350
16	36° 27' 18.3"	49° 52' 47.4"	2500	1800	61	36° 26' 54.9"	49° 24' 58.4"	500	1500
17	36° 28' 29.4"	49° 55' 13.2"	500	2000	62	36° 25' 47.7"	49° 25' 55.0"	500	1600
18	36° 30' 57.4"	49° 59' 17.3"	4000	2150	63	36° 25' 10.9"	49° 25' 51.7"	3000	1700
19	36° 31' 10.5"	49° 58' 12.8"	3000	1950	64	36° 27' 57.3"	49° 42' 45.1"	1000	2000
20	36° 23' 51.2"	50° 13' 03.4"	500	2200	65	36° 25' 23.4"	50° 36' 35.0"	8000	2100
21	36° 32' 30.0"	50° 11' 01.7"	80000	900	66	36° 25' 33.9"	50° 36' 23.8"	10000	1800
22	36° 22' 39.1"	50° 13' 02.9"	600	2200	67	36° 24' 07.6"	50° 46' 36.9"	500	2800
23	36° 29' 20.4"	50° 15' 20.5"	90000	950	68	36° 24' 09.4"	50° 46' 46.3"	3500	2800
24	36° 06' 24.9"	50° 30' 23.7"	80000	1500	69	36° 24' 17.4"	50° 46' 40.8"	5000	2800
25	36° 27' 48.1"	50° 05' 56.5"	10000	2400	70	36° 24' 04.4"	50° 47' 02.2"	15000	2800
26	36° 26' 02.1"	50° 07' 04.3"	40000	2100	71	36° 24' 11.3"	50° 47' 05.3"	3500	2850
27	36° 25' 54.2"	50° 06' 46.5"	4000	2050	72	36° 24' 19.4"	50°47' 47.8"	60000	2900
28	36° 26' 17.7"	50° 07' 47.0"	200	2150	73	36° 23' 56.8"	50° 46' 07.5"	3000	2700
29	36° 26' 15.6"	50° 07' 27.7"	5000	2120	74	36° 29' 28.9"	50° 26' 42.1"	3000	1800
30	36° 26' 29.6"	49° 36' 41.0"	6000	1800	75	36° 29' 26.7"	50° 26' 54.0"	1500	1850
31	36° 09' 45.5"	50° 31' 56.8"	4000	2100	76	36° 24' 06.0"	50° 31' 23.2"	2000	1300
32	36° 10' 55.9"	50° 33' 12.2"	5000	2450	77	36° 09' 43.1"	51° 17' 53.5"	10000	3100
33	36° 10' 59.6"	50° 34' 06.3"	6000	2550	78	36° 07' 56.4"	51° 16' 00.2"	3000	2600
34	36° 08' 48.4"	50° 36' 29.7"	300	2050	79	36° 08' 46.9"	51° 12' 45.6"	1000	3000
35	36° 08' 00.1"	50° 40' 34.6"	400	2300	80	36° 08' 13.4"	51° 14' 14.9"	5000	2650
36	36° 09' 56.4"	50° 42' 35.6"	5000	1900	81	36° 07' 46.3"	51° 11' 18.7"	6000	3200
37	36° 11' 47.4"	50° 35' 47.4"	4000	1900	82	36° 08' 37.2"	51° 11' 19.9"	7000	3000
38	36° 12' 12.9"	50° 37' 18.2"	2500	1900	83	36° 10' 19.2"	51° 10' 00.7"	2000	3200
39	36° 12' 14.5"	50° 43' 31.9"	9000	2100	84	36° 09' 08.2"	51° 10' 04.4"	1000	2900
40	36° 13' 54.6"	50° 46' 17.6"	400	2300	85	36° 09' 50.0"	51° 08' 32.5"	3000	2700
41	36° 14' 38.6"	50° 56' 03.0"	8000	2600	86	36° 09' 32.9"	51° 17' 28.0"	5000	3100
42	36° 14' 34.0"	50° 55' 51.0"	2000	2700	87	36° 07' 51.5"	51° 19' 31.4"	500	2500
43	36° 11' 33.6"	50° 56' 21.1"	500	2550	88	36° 11' 42.0"	51° 05' 04.2"	8000	2700
44	36° 07' 24.8"	50° 54' 11.9"	10000	2900	89	36° 34' 21.8"	50° 21' 52.1"	3500	2700
45	36° 08' 39.9"	50° 52' 38.2"	2000	2500	90	36° 37' 13.7"	50° 18' 22.6"	3000	2400

the Firuzkuh road in the east that crosses the Alborz Mountains towards the Caspian Sea.

Eocene volcanic and volcaniclastic rocks form the most prominent geological feature of the southern section of the Alborz Mountains. However, in the northern section of the Alborz Mountains, Middle Jurassic to Upper Cretaceous limestone formations already become much more important and form some very high rock cliffs along the East-West directed thrust fault zones (Stöcklin 1974).

The study area has temperate and continental climate in the low and high altitudes respectively. The climatic data show that the higher altitudes of Alborz are affected by the north-westerly flow of polar air masses (Khalili 1973). The summer is arid, warm and sunny, with intensive radiation most of the time. During the arid season water is supplied mainly by the melting snow and springs. Annual temperature amplitudes can be high. At 1500 m, the mean annual temperature is 13 °C, in January it is 0.6 °C and in August is 26 °C. Precipitation is more abundant on the northern slopes influenced by the Caspian Sea, than on the more continental southern slopes. At 1500 m, the mean annual rainfall is 370 mm/m^2, in September it is 130 mm/m^2 and in March is 480 mm/m^2. Precipitation and length of the drought period vary across the region. Stations located at lower altitudes have a more extended drought period, rather lower precipitation and higher mean annual temperatures than at the higher altitudes. A strong negative correlation exists between elevation and temperature, as all temperature values decrease with altitude. Unfortunately, no meteorological data is available from the high elevations.

Data collection

On the southern slopes of the Western Alborz Mountains, 90 wetland study sites were found (Fig. 1) and sampled within the period 2005–2008. All roads in the study area were systematically explored to find all wetland vegetation. Google Earth was used to locate potential wetland sites off the roads, and these wetlands were reached on foot. The local people provided information on hidden and remote wetlands, which were included in the study. The authors are confident that few, if any, wetlands in the study area have not been found and sampled. The definition of wetlands follows that of the Ramsar Convention (Ramsar Convention Secretariat, 2006) and includes temporary wetlands. Apparently, they account for more than 95 % of all existing wetland sites in this sector. Wetland study sites varied in area from 200 m^2 to more than 10 ha. The combined area of all wetlands surveyed in this study amounted to 86.5 ha. The vascular flora of all wetland sites was recorded in 430 relevés from the 90 sites. The relevés followed the Braun-Blanquet approach (Braun-Blanquet 1964). For taxonomic records, all collected specimens were deposited into the Tehran University Herbarium (TUH) after identification according to *Flora Iranica* (Rechinger 1963–2005) and *Flora of Iran* (Assadi & al. 1988–2008). All species were classified according to their Raunkiaer life-form category (Raunkiaer 1934), while the geographical distribution of each species was following *Flora Iranica* (Rechinger 1963-2005). The terminology and delimitation of the main phytogeographical areas was according to the standard reference works of Zohary (1973) and Takhtajan (1986). The frequency of each species was calculated by dividing the number of relevés containing that species on the total number of relevés.

Results and discussion

Flora

The wetland flora of the Alborz Mountains consists of 354 vascular plants species, belonging to 201 genera and 54 families from all wetland sites in the current study (Appendix 2, Table 1). *Asteraceae* (27 genera/ 54 species) is the most common angiosperm family in the wetland flora, followed by *Poaceae* (31/ 49) and *Cyperaceae* (10/ 30) (Fig. 2). The largest wetland genera in the Alborz Mountains are *Carex* with 12 species, *Cirsium* (9), *Epilobium* (9), *Galium* (9), *Ranunculus* (7), *Rumex* (7), *Veronica* (6), and *Typha* (4). Mention deserves the fact that some of these genera contain a relatively high proportion (21 species or 5.9 % of all species) of endemic and sub-endemic species. Sub-endemic species also occur in the mountain wetlands of the adjacent countries, such as *Swertia longifolia* in Iraq.

Table 1. Floristic characteristics of the mountain wetland in western Alborz.

Taxon	No of families	No of genera	No of species	Endemic species No
Petridophytes	2	3	5	0
Dicots	33	136	240	19
Monocots	19	62	109	2
Total	54	202	354	21

Obligate wetland genera in the flora include *Potamogeton* (*Potamogetonaceae*) with four species, *Utricularia* (*Lentibulariaceae*) with two species, and *Batrachium* (*Ranunculaceae*), *Hippuris* (*Hippuridaceae*), *Lemna* (*Lemnaceae*), *Myriophyllum* (*Haloragaceae*), *Rorippa* (*Brassicaceae*), and *Ruppia* (*Ruppiaceae*) with one species each. Other obligate wetland plants include helophtyes in such genera as *Typha* (*Typhaceae*) with four species, *Carex* and *Eleocharis* (*Cyperaceae*) each with three species, *Bolboschoenus* and *Schoenoplectus* (*Cyperaceae*) each with two species, *Alisma* (*Alismaceae*) and *Catabrosa* (*Poaceae*), each with one species in the wetlands on the southern slopes of the Western Alborz Mountains.

Of the 354 vascular plant taxa encountered in this study, 110 taxa (30.1 %) grow only in one wetland site and thus are rare in the flora. Some of these rare wetland plants are *Ammannia baccifera, Carex pamirica, C. distans, Damasonium alisma, Inula helenium, Potamogeton pectinatus,* and *Ruppia maritima*. Likewise, 68 (19.2 %) plant taxa grow only in two wetland sites. Summarily, 292 plant taxa (82.3 %) occur in less than 10 percent of wetland sites. Conversely, *Juncus inflexus, J. articulatus*, *Mentha longifolia, Lotus corniculatus, Trifolium pratense, Phragmites australis,* and *Plantago lanceolata* are present in more than 50 % of the study sites. These plants are considered to be indicators of many plant communities in wetland vegetation here and in other geographical areas (Vural 1996; Klein 2001; Onipchenko 2002).

The 354 plant taxa found in this study exceed in number the 323 vascular plant taxa found in the central section of the Alborz Mountains (Naqinezhad & al. 2010). There are 156 taxa shared by the two study areas, in line with Sørensen's Index of Similarity (Sørensen 1948) of 23.0. A combined list of the two floras presents 521 wetland taxa in these adjacent areas to the Alborz Mountains. This indicates that despite their relatively small area, wetlands contribute greatly to species-richness on the arid southern slopes of the Alborz Mountains. The number of wetland sites and the total species richness is higher than in the earlier study of the Central Alborz, but the present study area is more than twice as large as the earlier study area. Within this larger area, several natural consequences conspire in raising the total number of species. First, in a larger area there are more wetlands and thus more opportunities for wetland plants. Second, the present study area has a higher elevation relief than the Central Alborz study area. In that study, elevation ranged from 1486 m to 3130 m a.s.l. (1644 m elevation gradient) and showed the strongest effect on species richness (Naqinezhad & al. 2009). In the Western Alborz Mountains, the highest wetland was at 3200 m a.s.l (2850 m elevation gradient). Thus, the combination of a larger area allowing for more wetlands and a greater elevation gradient are the likely factors that contribute to the higher species number in wetlands of the Western, as compared to the Central Alborz Mountains.

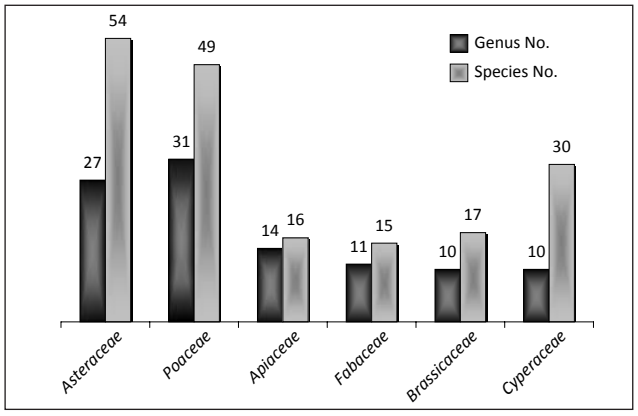

Fig. 2. The largest families across the wetland sites in the western Alborz Mountains.

Appendix 2. Plant Checklist of the southwestern slopes of Alborz wetland sites. Species (Life form–Chorotype–TUH No). Abbreviations: Cha = Chamaephyte, Geo = Geophyte, Hel = Helophyte, Hem = Hemicryptophyte, Hyd = Hydrophyte, Pha = Phanerophyte & Thr = Therophyte. Chorotype: ES = Euro-Sibirian, IT = Irano-Turanian, M = Mediterranean, PON = Pontic area, PL = Pluriregional, SS = Sahara-Sindian, Afgh. = Afghanistan, Turco. = Turcomania, EN = Endemics, SEN = Subendemics, U = unidentified.

Plant taxa	Life form	Chorotype	TUH No
Petridophytes			
Equisetaceae			
Equisetum arvense L.	Geo	PL	38764
E. palustre L.	Geo	PL	38765
E. ramosissimum Desf.	Geo	PL	38766
Ophioglossaceae			
Botrychium lunaria (L.) Sw.	Geo	PL	38767
Ophioglossum vulgatum L.	Geo	PL	38768
Dicots			
Apiaceae			
Apium graveolens L.	Hem	PL	38796
Berula angustifolia (L.) Mertens & W. D. Koch	Hel	PL	38770
Bupleurum gerardi All.	Thr	IT, M, PON	38771
Carum carvi L.	Hem	ES, IT	38772
Cervaria cervarifolia (C. A. Mey.) M. Pimen	Hem	IT, PON	38773

Appendix 2. Continuation

Plant taxa	Life form	Chorotype	TUH No
Chaerophyllum crinitum Boiss.	Hem	IT, PON	38774
C. macrospermum (Spreng.) Fisch. & C.A.Mey	Hem	IT, M, PON	38775
Daucus carota L.	Hem	IT, M, SS	38777
Diplotenia cachrydifolia Boiss.	Hem	IT	38776
Heracleum persicum Desf. ex Fischer	Hem	IT	38778
Physospermum cornubiense (L.) DC.	Hem	ES, IT, M	38779
Pimpinella puberella (DC.) Boiss.	Thr	IT	38780
P. tragium Vill.	Hem	ES, IT, M	38781
Sium sisaroideum DC.	Hel	ES, IT	38782
Torilis arvensis (Huds.) Link	Thr	PL	38783
Turgenia latifolia (L.) Hoffm.	Thr	ES, IT, M	38784
Apocynaceae			
Trachomitum venetum (L.) Woods subsp. *armenium* (Pobedimova) Rech f.	Hem	ES, IT, M	38785
Asclepiadaceae			
Cynanchum acutum L.	Pha	PL	38786
Vincetoxicum funebre Boiss. & Ky.	Cha	IT, PON	38787
Asteraceae			
Achillea kellaensis Boiss. & Hausskn.	Hem	EN	38788
A. millefolium L.	Hem	ES, IT	38789
A. oligocephala DC.	Hem	IT	38790
Bidens tripartita L.	Thr	PL	38791
Centaurea iberica Trevir. ex Spreng	Thr	IT, M	38792
C. virgata Lam. subsp. *squarrosa* (Willd.) Gugler	Hem	ES, IT, M	38793
Cichorium intybus L.	Hem	PL	38794
Cirsium arvense (L.) Scop. var. *incanum* (S.G.Gmelin) Ledeb.	Geo	IT	38795
C. creticum (Lam.) d'Urv.	Hem	IT, M	38796
C. elodes M. B.	Hem	IT, PON	38797
C. hygrophilum Boiss.	Hel	IT, PON	38798
C. libanoticum DC.	Hem	IT, M, PON	38799
C. obvallatum (M. B.) M. B.	Hem	IT, PON	38800
C. rhizocephalum C. A. Mey.	Hem	IT, PON	38801
C. turkestanicum(Regel) Petrak	Hem	IT	38802
C. vulgare (Savi) Ten.	Hem	PL	38803
Crepis micrantha Czer.	Thr	IT, M, PON	38804
C. willemetiodes Boiss.	Geo	SEN (Iran & Turco.)	39138
Echinops orientalis Trautv	Hem	IT, PON	38805
Erigeron acer L.	Hem	PL	38806
Eupahorium cannabinum L.	Cha	PL	38807
Galinsoga parviflora Cav.	Thr	PL	38808
Heteropappus altaicus (Willd.) Novopokr	Hem	PL	38809
Inula britannica L.	Hem	PL	38810
I. helenium L.	Geo	ES, IT, M	39139
I. salicina L. subsp. *aspera* (Poir.) Hayek	Geo	PL	38811
Inula thapsoides (M. B. ex Willd.) Spreng.	Geo	IT, M, PON	39140
Lactuca scarioloides Boiss.	Hem	IT	38812
L. communis L.	Hem	ES, IT	38814
Lapsana grandiflora M.B.	Hem	IT, PON	38813
Leontodon hispidus L.	Geo	ES, IT, M	38815
Ligularia persica Boiss.	Hem	EN (Alborz)	38816
Scorzonera cinera Boiss.	Hem	IT, PON	38818
S. nivalis Boiss. & Hausskn.	Geo	EN	38819
S. parviflora Jacq.	Geo	ES, IT	38817
Senecio paulsenii O. Hoffm. subsp. *khorasanicus* (Rech. F. & Aell.) B. Nord.	Hem	IT	38820
S. pseudo-orientalis Schischk.	Hem	IT, PON	38821
S. vernalis Waldst. & Kit.	Thr	ES, IT, M	38822
Serattula sp.	Hem	U	38823
Sigesbeckia orientalis L.	Thr	PL	38824
Sonchus asper (L.) Hill. subsp. *glaucescens* (Jordan) Ball	Hem	IT, M	38825
S. maritimus L.	Geo	PL	38826
S. oleraceus L.	Thr	PL	38827
Tanacetum balsamita L. subsp. *balsamitoides* (Schultz-Bip.) Grierson	Geo	IT	38828
T. parthenium (L.) Schultz- Bip.	Geo	PL	38829
Taraxacum sp.1	Hem	U	38830
Taraxacum sp.2	Hem	U	38831
Taraxacum sp.3	Hem	U	38832
Tragopogon buphthalmoides (DC.) Boiss.	Hem	IT, M, PON	38839
T. graminifolus DC.	Hem	IT, PON	38840
Tripleourospermum sevanens (Manden.) Pobed.	Hem	IT, PON	38841
Tripleurospermum disciforme (C. A. Mey.) Schultz- Bip.	Thr	IT, PON	38842
Tussilago farfara L.	Hem	PL	38843
Xanthium strumarium L.	Thr	ES, IT, M	38844
Boraginaceae			
Anchusa italica Retz.	Hem	PL	38845
Asperugo procumbens L.	Thr	PL	38846
Cerinte minor L.	Hem	ES, IT, M	38847
Lappula microcarpa (Ledeb.) Gürke	Thr	IT	38848
Lithospermum officinalis L.	Hem	ES, IT, M	38849
Myosotis alpestris F. W. Schmidt	Hem	PL	38850
M. asiatica (Vesterg.) Schischk. & Serg.	Hem	ES, IT, PON	38851
M. caespitosa Schults	Hem	PL	38852
M. koelzii H. Riedl.	Thr	EN	38853
Myosotis lithospermifolia (Willd.) Hornem.	Hem	IT, PON	38854
M. palustris (L.) Nath.	Hem	PL	38855
Solenanthus circinatus Ledeb.	Hem	ES, IT	38856
Brassicaceae			
Barbarea plantaginea DC.	Hem	IT, PON	38857

Appendix 2. Continuation

Plant taxa	Life form	Chorotype	TUH No
Capsella bursa-pastoris (L.) Medicus	Hem	PL	38858
Cardamine impatiens L.	Hel	IT, M, PON	38859
C. uliginosa M. B.	Thr	ES, IT, M	38860
Draba nemorosa L.	Thr	PL	38861
Euclidium syriacum (L.) R. Br.	Thr	ES, IT, M	38862
E. tenuissimum (Pall.) B. Fedtsch.	Thr	IT	38863
Lepidium draba L.	Hem	ES, IT, M	38864
L. latifolium L.	Geo	PL	38865
L. perfoliatum L.	Thr	PL	38866
Nasturtium microphyllum Boenn. ex Rechb.	Hel	PL	38867
N. officinale R. Br.	Hel	PL	38868
Neslia apiculata Fisch.	Thr	IT, M	38869
Rorippa amphibia (L.) Besser	Hyd	ES, IT, M	38870
Sinapis arvensis L.	Thr	ES, IT, M	38871
S. irio L.	Thr	PL	38872
Sisymbrium integrrinum Rech. F. & Aell.	Thr	EN	38873
Campanulaceae			
Campanula glomerata L.	Hem	PL	38874
Caryophyllaceae			
Arenaria gipsophiloides L.	Hem	ES, IT	38875
Cerastium dichotomum L.	Thr	IT, M	38876
C. fragillimum Boiss.	Thr	IT, M	38877
C. nemorale M.B.	Thr	PON	38878
Gypsophila elegans M. B.	Thr	PL	38879
Holosteum umbellatum L.	Thr	ES, IT, M	38880
Lepyrodiclis stellarioides Schrenk ex Fisch. & C.A. Mey.	Thr	IT, PON	38881
Silene vulgaris (Moech) Garcke	Hem	ES, IT, M	38882
*Spergula fallax (*Lowe) E.H.L. Krause	Thr	PL	38883
Spergularia bocconii (Scheele) Ascherson & Graebner	Hem	IT, M	38884
Stellaria scaturiginella Rech. F.	Thr	EN	38885
Chenopodiaceae			
Atriplex sp.	Thr	U	38886
Chenopodium sp.	Thr	U	38887
Salicornia eoropaea L.	Thr	PL	38889
Convolvulaceae			
Convolvulus arvensis L.	Hem	PL	38890
Datiscaceae			
Datisca cannabina L.	Hem	IT, M, PON	38901
Euphorbiaceae			
Euphorbia falcata L.	Thr	ES, IT, M	38902
E. seguieriana Neck.	Hem	ES, IT	38903
Frankeniaceae			
Frankenia hirsuta L.	Cha	IT, M	38904
Fumariaceae			
Fumaria parviflora Lam.	Thr	ES, IT, M	38905
Gentianaceae			
Centaurium erythraea Rafn	Hem	ES, IT, M	38906
Gentiana oliveri Griseb.	Hem	IT, M	38907
G. septemfida Pall.	Hem	IT, PON	38908
Swertia longifolia Boiss.	Hem	SEN (Iran & Iraq)	38909
Geraniaceae			
Geranium persicum Schonbeck-Temesy	Hem	IT	38910
Haloragaceae			
Myriophyllum spicatum L.	Hyd	PL	39502
Hippuridaceae			
Hippuris vulgaris L.	Hyd	PL	39503
Hypericaceae			
Hypericum perforatum L.	Hem	PL	38911
H. scabrum L.	Hem	IT, PON	38912
Lamiaceae			
Lamium album L.	Geo	ES, IT	38913
Leonurus cardiaca L.	Geo	PL	38914
Mentha longifolia (L.) Hudson var. *asiatica* (Boiss.) Rech. F.	Hel	IT	39036
M.longifolia (L.) Hudson var. *kotschyana* (Boiss.) Briquet	Hel	IT, M	38915
Prunella vulgaris L.	Geo	PL	38916
Salvia nemorosa L.	Hem	ES, IT	38917
Stachys setifera C. A. Mey. subsp. *setifera*	Geo	IT, PON	38918
Thuspeinanta brahuica (Boiss.) Briq.	Thr	SEN (Iran & Afgh.)	38919
Ziziphora clinopodioides Lam.	Hem	IT, M	38920
Lentibulariaceae			
Utricularia australis R. Br.	Hyd	PL	39062
U. minor L.	Hyd	PL	39063
Lythraceae			
Ammannia baccifera L.	Thr	ES, IT	38921
Lythrum salicaria L.	Hem	PL	38922
Onagraceae			
Epilobium confusum Hausskn.	Geo	IT, PON	38923
E. frigidium Hausskn.	Geo	IT, PON	38924
E. hirsutum L.	Hel	PL	38925
E. minutiflorum Hausskn.	Geo	IT, PON	38926
E. montanum L.	Geo	PL	38927
E. palustre L.	Geo	PL	38928
E. ponticum Hausskn.	Geo	IT, PON	38929
E. rechingeri Raven	Geo	SEN	38930
E. roseum Schreb. subsp. *subsessile* (Boiss.) Raven	Geo	IT, M, PON	38931
Papilionaceae			
Astragalus odoratus Lam.	Hem	IT, M, PON	38932
Glycerrhiza glabra L.	Hem	ES, IT, M	38933
Lathyrus pratensis L.	Geo	PL	38934
Lotus corniculatus L. subsp. *corniculatus* var. *corniculatus*	Hem	ES, IT, M	38935
Medicago lupulina L.	Thr	PL	38936
M. sativa L.	Hem	IT	38937
Melilotus indicus (L.) All.	Thr	PL	38938

Appendix 2. Continuation

Plant taxa	Life form	Chorotype	TUH No
M. lilotus officinalis (L.) Pall.	Hem	PL	38939
Onobrychis bongei Boiss.	Hem	PON	38940
Ononis spinosa L. subsp. *leiosperma* (Boiss.) Sirj.	Cha	IT, M	38941
Sequigera varia Lassen	Hem	ES, IT, M	38942
Sophora alopecuroides L.	Hem	IT	38943
Trifolium repens L. var. *repens*	Geo	ES, IT, M	38944
T. pratense L.	Hem	PL	38945
Vicia persica Boiss.	Hem	PON	38946
Plantaginaceae			
Plantago gentianoides Sibth. & Sm. subsp. *griffithii* (Decne.) Rech. F.	Hem	IT	39071
P. lanceolata L.	Hem	ES, IT, M	39072
P. maior L.	Hem	PL	39073
Polygalaceae			
Polygala monspeliaca L.	Hem	IT, M	38947
Polygonaceae			
Polygonum amphibium L.	Hyd	PL	38948
P. hyrcanicum Rech. F.	Hem	EN	38949
P. lapahifoliaum L. subsp. *brittingeri* (Opiz.) Rech. F.	Thr	ES, IT, M	38950
P. patulum M. B.	Hem	IT, M	38951
Polygonum persicaria L.	Thr	ES, IT, M	38952
P. polycnemoides Jaub. & Spach	Hem	IT, M	38953
Rumex alveolatus Los.	Hem	IT	38954
R. chalepensis Miller	Hem	IT, M, PON	38955
R. crispus L.	Hem	PL	38956
R. elborsensis Boiss.	Hem	EN	38957
R. kandavanicus (Rech. F.) Rech. F.	Hem	EN (Alborz)	38958
R. patientia Boiss. subsp. *pamiricus* (Rech.f.) Rech. F.	Hem	IT	38959
R. scutatus L.	Geo	ES, IT, M	38960
Primulaceae			
Glaux maritima L.	Geo	PL	38961
Primula auriculata Lam.	Hem	IT, PON	38962
P. macrocalyx Bge.	Hem	ES, IT	38963
Samolus valerandi L.	Hem	ES, IT, M	38964
Ranunculaceae			
Aquilegia olympica Boiss.	Geo	IT, PON	38965
Batrachium trichophyllum (Chaix) Bosch	Hyd	PL	38966
Clematis orientalis L.	Cha	PL	38967
Ranunculus amblyolobus Boiss. & Hohen.	Geo	EN (Alborz)	38968
R. arvensis L.	Thr	ES, IT, M	38969
R. bulbosus L.	Hem	IT, M, PON	38970
R. elymaiticus Boiss. & Hausskn.	Geo	EN	38971
R. grandiflorus L.	Geo	IT, PON	38972
R. polyanthemos L.	Geo	PL	38973
R. sahendicus Boiss. & Buhse	Geo	EN	38974
Thralictrum minus L.	Geo	PL	38975
Resedaceae			
Reseda lutea L.	Hem	ES, IT, M	38976
Rosaceae			
Agrimonia eupatoria L.	Hem	ES, IT, M	38977
Alchemilla persica Rothm.	Geo	IT, PON	38978
A. rigida Buser	Hem	IT, PON	38979
Potentilla recta L.	Hem	PL	38980
P. reptans L.	Hem	ES,IT, M	38981
P. szovitsii Th. Wolf	Hem	IT, PON	38982
Rosa iberica Stev.	Pha	IT, PON	38983
Rubus sanctus Schreb.	Pha	ES, IT	38984
Sanguisorba minor Scop.	Hem	PL	38985
Rubiaceae			
Asperula setosa Jaub. & Spach	Thr	IT, M, PON	38986
Galium anguineum Ehrend. & Schonb.	Geo	SEN (Iran & Iraq)	38987
G. aparine L.	Thr	PL	38988
G. consangineum Boiss.	Geo	IT, M, PON	38989
G. elongatum Presl.	Geo	PL	38990
G. humifusum M. B.	Geo	ES, IT, M	38991
G. odoratum (L.) Scop.	Geo	PL	38992
G. spurium L. subsp. *ibicinum* (Boiss. & Hausskn.) Ehrend.	Thr	IT, M	38993
G. tricornutum Dandy	Thr	PL	38994
G. verum L. subsp. *verum* F. Verum	Geo	PL	38995
Scrophulariaceae			
Euphrasia pectinata Ten.	Thr	ES, IT	38996
Pedicularis rhinanthoides Schrenkin & C.A. Mey. subsp. *rotundata* Vved. I	Hem	IT	38997
Pedicularis sibthorpii Boiss.	Hem	IT, PON	38998
Scrophularia nervosa Benth.	Hem	EN	38999
S. umbrosa Dumort.	Geo	ES, IT	39000
Verbascum agrimoniifolium (C. Koch) Hub. Mor.	Hem	IT, PON	39001
V. corduchorum Bornm.	Hem	IT	39002
V. spiciosum Schrad.	Hem	IT, M, PON	39003
Veronica anagalis-aquatica L. subsp. *oxycarpa* (Boiss.) A. Jelen.	Hel	IT, M, PON	39004
V. anagalloides Guss. subsp. h*eureka* M. A. Fischer	Thr	IT	39005
V. biloba Schreb.	Thr	IT	39006
V. gentianoides Vahl	Thr	PL	39007
V. pusilla Kotschy & Boiss.	Thr	IT	39008
V. reuterana Boiss.	Thr	IT, M	39009
Solonaceae			
Lycium ruthenicum Murr.	Pha	ES, IT	39010
Tamaricaceae			
Tamarix arceuthoides Beg.	Pha	IT	39011
T. ramosissima Ledeb.	Pha	IT	39012
Urticaceae			
Urtica dioica L. subsp. *kurdistanica* Chrtek	Geo	SEN (Iran & Iraq)	39013
Verbenaceae			
Verbena officinalis L.	Hem	PL	39014

Appendix 2. Continuation

Plant taxa	Life form	Chorotype	TUH No
Monocots			
Alismaceae			
Alisma lanceolatum With.	Hel	ES, IT, M	39015
Damasonium alisma Miller	Hel	IT, M	39016
Alliaceae			
Allium robellum M. B.	Geo	IT, PON	39017
A. subvineale Wendelbo	Geo	EN	39018
Butomaceae			
Butomus umbellatus L.	Hel	ES, IT, M	39019
Colchicaceae			
Colchicum sp.	Geo	U	39020
Cyperaceae			
Blysmus compressus (L.) Panzer subsp. *compressus*	Geo	ES, IT	39021
Bolboschoenus affinis (Roth.) Drob.	Hel	PL	39022
B. maritimus (L.) Palla	Hel	PL	39023
Carex acutiformis Ehrh.	Hel	PL	39024
C. demissa Hornem. subsp. *iranica* Kukkonen	Geo	IT	39025
C. diluta M.B.	Geo	PL	39026
C. distans L.	Geo	ES, IT, M	39027
C. divisa Huds.	Geo	ES, IT, M	39028
C. hordeistichyos Vill.	Geo	ES, IT, M	39029
C. melanostachya M.B. ex Willd.	Geo	ES, IT	39030
C. orbicularis Boott subsp. *kotschyana* (Boiss. & Hohen.) Kukkonen	Geo	IT, PON	39031
C. pamirica (O.Fedtsch.) O. & B.Fedtsch. ex B.Fedtsch	Hel	IT	39032
C. pseudofoetida Kük subsp. *acrifolia* (V. Krecz.) Kukkonen	Geo	IT, PON	39033
C. riparia Curt.	Hel	ES, IT	39034
C. songorica Kar. & Kir.	Geo	IT, PON	39035
Cladium mariscus (L.) R.Br.	Hel	PL	39037
Cyperus diformis L.	Thr	PL	39038
C. distachyos All.	Geo	ES, IT, M	39039
C. fuscus L.	Thr	PL	39040
C. glaber L.	Thr	ES, IT, M	39041
C. rotundus L.	Geo	PL	39042
Eleocharis mitracarpa Steud.	Hel	PL	39043
E. palustris (L.) Roemer & Schultes subsp. *palustris*	Hel	IT	39044
E. quinqueflora (F.X. Hartmann) O. Schwarz	Geo	PL	39045
E. uniglumis (Link) Schultes	Hel	PL	39046
Pycreus flavidus (Retz.) Koyama	Thr	PL	39047
Schoenoplectus lacustris (L.) Palla	Hel	PL	39048
S. mucronatus (L.) Palla	Hel	PL	39049
Sciropoides holoschoenus (L.) Soják	Geo	ES, IT, M	39050
Trichophorum pumilum (Vahl) Schinz & Thellung	Geo	PL	39051
Juncaceae			
Juncus articulatus L.	Geo	PL	39054
J. gerardi Loisel.	Geo	IT	39055
J. inflexus L.	Hel	PL	39056
J. minutulus Albert & Jahandiez	Thr	PL	39057
Juncus sp.	Thr	U	39058
Juncaginaceae			
Triglochin maritima L.	Geo	PL	39059
T. palustre L.	Geo	PL	39060
Lemnaceae			
Lemna minor L.	Hyd	PL	39061
Liliaceae			
Bellevalia cyanopoda Wendelbo	Geo	EN	39064
Ornithogalum arcuatum Stev.	Geo	IT, M, PON	39065
O. persicum Haussk. Ex Bornm.	Geo	IT	39066
Orchidaceae			
Dactylorhiza umbrosa (Kar. & Kir.) Nevski	Geo	IT	39067
Epipactis veratifolia Boiss. & Hohen.	Geo	PL	39069
Epipactis sp.	Geo	U	39068
Orchis anatolica Boiss.	Geo	IT, M	39070
Poaceae			
Agropyrum leptourum (Nevski) Grossh	Geo	IT, PON	39078
Agrostis olympica (Boiss.) Bor.	Geo	IT, PON	39074
A. stolonifera L.	Geo	ES, IT, M	39075
Alopecurus arundinaceus Poir. var. *arundinaceus*	Geo	PL	39076
A. myosuroides Hudson	Thr	PL	39077
Arundo donax L.	Hem	PL	39080
Brachypodium sylvaticum (Hudson) P. Beauv.	Hem	PL	39081
Bromus scoparious L.	Thr	ES, IT, M	39082
B. tomentosus Trin	Geo	IT, PON	39083
Calamagrostis epigejos (L.) Roth	Geo	PL	39084
C. glauca (M. B.) Reichenb.	Geo	ES,IT, M	39085
C. pseudophragmites (Hall. F.) Koel.	Geo	ES, IT, M	39086
Catabrosa aquatica (L.) P. Beauv.	Hel	PL	39087
C.	Hem	IT	39088
Cynodon dactylon (L.) Pers.	Geo	PL	39089
Dactylis glomerata L.	Hem	PL	39090
Deschampsia caespitosa (L.) P. Beauv.	Geo	PL	39091
D. flexuosa (L.) Trin.	Geo	ES, IT	39092
Echinochloa crus-galli (L.) P. Beauv.	Thr	PL	39093
Elymus sp.	Geo	U	39094
Eremopoa persica (Trin.) Roshev. var. *persica*	Thr	IT, M	39095
Festuca arundinacea Schreb.	Hem	PL	39096
F. pratensis Hudson	Geo	ES, IT, M	39097
F. rubra L.	Hem	PL	39098
Glyceria arundinacea (M. B.) Kunth	Hem	PL	39099
G. plicata Fries	Hel	ES, IT	39100
Hordeum marinum Hudson	Thr	IT, M	39101
H. violaceum Boiss. & Huet	Hem,	IT, PON	39102
Lolium perenne L.	Geo	PL	39104

Appendix 2. Continuation

Plant taxa	Life form	Chorotype	TUH No
Milium pedicellare (Bornm.) Roshev. ex Melderis	Thr	IT, M	39105
Orysopsis sp.	Geo	U	39106
Paspalum distichum L.	Geo	PL	39107
Phalaris arundinacea L.	Geo	PL	39108
Phleum alpinum L.	Geo	PL	39109
P. bertolonii DC.	Geo	ES, IT	39110
Phragmites australis (Cav.) Trin. ex Steud. var. *austalis*	Hel	PL	39111
Poa bulbosa L.	Geo	ES, IT, M	39112
P. pratensis L.	Geo	PL	39113
P. trivialis L.	Geo	PL	39114
Polypogon fugax Nees ex Steud.	Thr	PL	39115
P. maritimus Willd.	Thr	ES, IT, M	39116
P. monspeliensis (L.) Desf.	Thr	PL	39117
P. semiverticillatus (Forssk.) Hyl.	Thr	PL	39118
Puccinella grossheimiana (V. Krecz.) V. Krecz	Geo	IT, PON	39119
P. sevagensis Grossh.	Geo	IT, PON	39120
Saccharum sp.	Geo	U	39121
Sclerochloa dura (L.) Beauv.	Thr	PL	39122
Sorghum halepense (L.) Pers.	Geo	PL	39123
Zingeria trichopoda (Boiss.) P. Smirn.	Thr	IT, M, PON	39136
Potamogetonaceae			
Potamogeton lucens L.	Hyd	PL	39124
P. nudosus Poir.	Hyd	PL	39125
P. pectinatus L.	Hyd	PL	39126
P. perfoliatus L.	Hyd	PL	39127
Ruppiaceae			
Ruppia maritima L.	Hyd	PL	38996
Typhaceae			
Typha caspica Pobed.	Hel	PON	39130
T. laxmannii Lepech.	Hel	PL	39131
T. minima Funck.	Hel	ES, IT, PON	39132
T. turcomanica Pobed.	Hel	IT	39129
Zannichelliaceae			
Zannichellia palustris L.	Hyd	PL	39135

Life forms

Life form analysis is a widely used and useful tool for describing vegetation (Raunkiaer 1934). Hemicryptophytes are the dominant life form in this study and constitute 121 taxa of the flora, followed by geophytes (103) and therophytes (73) (Fig. 3). The life form results are very close to those found in the wetlands of the Central Alborz Mountains (Naqinezhad & al. 2010). This indicates quite similar vegetation structure in the wetlands of the Alborz Mountains.

The hemicryptophytes fall into two subgroups:

a) Graminoids: species belonging to *Juncaceae* (e.g., *Juncus articulatus*) and *Poaceae* (e.g., *Deschampsia flexuosa)*. This life form occurs in several wetland habitats on higher altitudes.

b) Tall herbs: plants ca. 50–100 cm high belonging to *Rosaceae*, *Apiaceae*, *Asteraceae*, and some other families which often grow in the subalpine zone. Some examples are *Agrimonia eupatoria*, *Heracleum persicum*, and *Ligularia persica*.

Geophytes belong mainly to *Poaceae* (25.2 %), *Cyperaceae* (14.6 %), and *Asteraceae* (10.8 %). Some geophyte species that are restricted to wetland habitats are *Calamagrostis pseudophragmites, Trichophorum pumilum,* and *Inula helenium*.

Therophytes: Although annual species generally decrease with altitude increase and become quite rare at higher altitudes (Körner 1999), here in contrast they are evenly distributed across the elevation gradients. Examples of wetland annuals in wetland habitats on the southern slopes of the Alborz Mountains include *Echinochloa crus-galli*, *Euphrasia pectinata, Gypsophila elegans, Juncus minutulus,* and *Veronica anagalloides* subsp. *heureka*.

The occurrence of a high proportion of hemicryptophytes and geophytes in the studied sites is typical of a cold mountain climate (Klimeš 2003). Although the proportion of geophytes recorded in subalpine or alpine steppe areas in the Alborz Mountains is 6 % (Noroozi & al. 2008), the occurrence of a relatively high proportion of geophytes (29.0 %) in the studied wetlands reflects a long period of humidity in the wetland sites during the growing season and frequent snow cover (Danin & Oarshan 1990). Apparently, variation of geophytes in wetland ecosystems should have a different trend than in drier ecosystems, as this life form is more adapted to mesic habitats than to dry habitats (Jónsdóttir 2001). However, geophytes can occur in

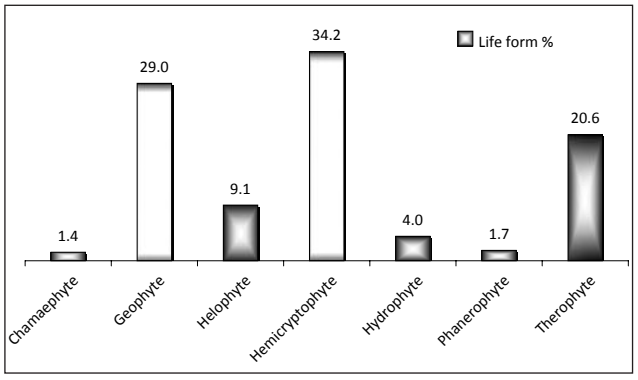

Fig. 3. Life form spectrum across the wetland sites in the western Alborz Mountains.

many habitats (Esler & al. 1999; Procheş & al. 2006). Therophytes have the strongest presence after hemicryptophytes and geophytes. This can be partly explained by the seasonal character of water supply that supports the annual plants (Archibald 1995; Naqinezhad & al. 2010).

Phytogeography

The phytogeographical pattern of wetland habitats in Alborz differs from that of the adjacent steppe ecosystem (e.g. Noroozi & al. 2008; Naqinezhad & al. 2010). The phytogeographical elements can be subdivided into four categories, PE_1 – Broadly Pluriregional Phytogeographical Elements (35.9 %), PE_2 – Narrowly Pluriregional Phytogeographical Elements (33.6 %), PE_3 – Irano-Turanian Phytogeographical Elements (21.5 %), and PE_4 – Endemic and Subendemic Phytogeographical Elements (5.9 %). The detailed description of these elements is presented in Fig. 4. The most important phytogeographical aspect of these ecosystems is the high level of broadly pluriregional phytogeographical and Irano-Turanian endemic elements at lower and higher altitudes respectively. The chorological spectrum of wetlands is very different from the adjacent steppe vegetation, where a high proportion of Irano-Turanian elements can be found (Zohary 1973). Since the Eastern, Western and Central Alborz are linked with the highlands of mountains in Azerbaijan, Caucasus and Khorasan-Kopet Dagh Mountains, the Alborz Mountains act as a corridor for migration of the flora along the west-east axis and, therefore, is very rich in species, both in the dry and the wet part of the range (e.g. Noroozi & al. 2008)

The chorotypes, exceeding five percent in occurrence, are classified into the following groups (Fig. 5):

***Pluriregional species* (PL).** Similarly to the earlier results from the Central Alborz Mountains (Naqinezhad & al. 2010), pluriregional species are the largest phytogeographical group, with members distributed widely across three phytogeographical regions. In the present study area, most species belong to *Poaceae* (19.7 %), *Cyperaceae* (11.8 %), and *Asteraceae* (11.0 %). Examples are *Catabrosa aquatica*, *Bolboschoenus affinis,* and *Eupatorium cannabinum*.

***Euro-Siberian / Irano-Turanian / Mediterranean species* (ES-IT-M).** The plants in this group are encountered in Europe, Siberia, Iran, Central Asia, Anatolia, and the Mediterranean region and mostly belong to *Poaceae* (14.0 %) and *Cyperaceae* (12.0 %). Examples are *Calamagrostis glauca* and *Cyperus distachyos*.

***Irano-Turanian/Pontic species* (IT/PON).** The Irano-Turanian/Pontic phytogeographical group is distributed from Iran to Caucasia. The wetland plants of the Iranian flora in this group mostly belong to *Asteraceae* (25.6 %) and are distributed from Iran to Caucasia. Examples of these species are *Carex songorica* and *Cirsium hygrophilum*.

***Irano-Turanian species* (IT).** This group is distributed across most of Iran, outside the northern slopes of the Alborz Mountains, the northern shores of the Persian Gulf and the Oman Sea. Most of the species in the wetland flora of the Western Alborz Mountains belong to *Asteraceae* (18.2 %) and *Scrophulariaceae*

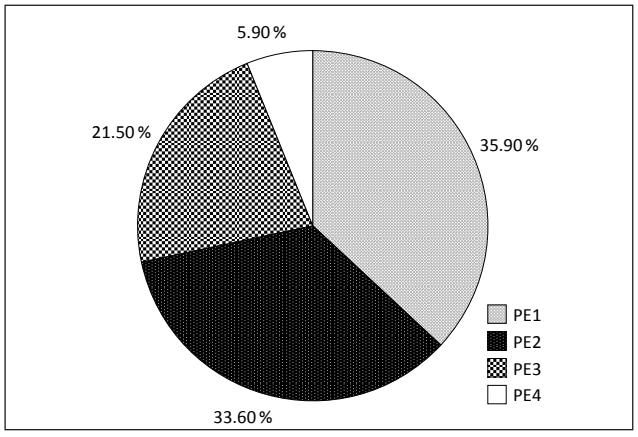

Fig. 4. The proportion of classified phytogeographic elements across wetland sites in the western Alborz Mountains. PE_1 = widely pluriregional, PE_2 = narrowly pluriregional, PE_3 = Irano-Turanian, and PE_4 = endemic and subendemic phytogeographical elements.

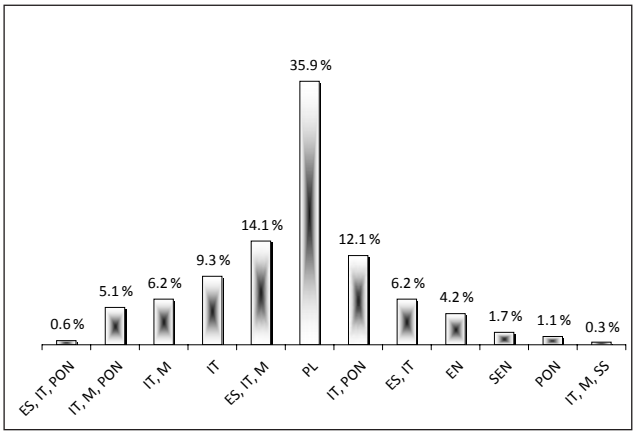

Fig. 5. Chorotype percentages of wetland flora in the western Alborz Mountains. ES = Euro-Sibirian, IT = Irano-Turanian, M = Mediterranean, PON = Pontic area, PL = Pluriregional, SS = Sahara-Sindian, EN = Endemics, SEN = Subendemics..

(15.2 %). Some examples of these species are *Cirsium arvense* var. *incanum* and *Veronica biloba*.

***Euro-Siberian / Irano-Turanian species* (ES-IT)**. This group includes species that are widely distributed from Europe to Iran and which may also occur further east in Central Asia, the Himalayas and Siberia. Examples of the species of this group in the Iranian wetland flora are *Blysmus compressus* subsp. *compressus, Carex riparia, Glyceria plicata,* and *Solenanthus circinatus*.

***Irano-Turanian/Mediterranean species* (IT/M).** Members of this phytogeographical group are found across Iran, Central Asia, Anatolia, and the Mediterranean regions. Examples are *Damasonium alisma, Gentiana oliveri,* and *Mentha longifolia* subsp. *kotschiana*.

***Irano-Turanian/Mediterranean/Pontic species* (IT/M/PON).** These plant taxa include species shared by Iran, Central Asia, Anatolia, the Mediterranean region, and Caucasia. Examples are *Datisca cannabina, Rumex chalepensis,* and *Veronica anagalis-aquatica*.

***Iranian endemics*.** Approximately six percent of the wetland species are endemic or sub-endemic to Iran. The endemics can be divided into two groups: 1) *Alborz endemic species*. The number of endemic species in the Alborz range is about 126 (Noorozi & al. 2008). Of these, eight taxa are restricted to the wetland habitats. Examples are *Ligularia persica, Rumex kandavanicus,* and *Stellaria scaturiginella*. The frequency of endemic species on the southern slopes of the Alborz Mountains and their life forms are listed in Table 2. A total of 24 endemic species were determined across the wetland sites on the southern slopes of Alborz. Five plant taxa are common for both the western and central sections of Alborz. The rest are restricted to Western and Central Alborz: 10 and 9 (Naqinezhad & al. 2010), respectively. *Ligularia persica, Ranunculus amblyolobus,* and *Rumex kandevanicus* are endemics occurring exclusively in the Alborz Mountains. The high level of endemism in the Alborz Mountains was explained by the relict persistence of many taxa during the Pleistocene glaciations (Agakhanjanz & Breckle 1995). 2) *Sub-endemic species.* These species extend their distribution range from the Alborz Mountains to Iraq (*Swertia longifolia* and *Urtica dioica* subsp. *kurdistaica*), Afghanistan *(Thuspienanta brahuica*) and Turcomania *(Crepis willemetoides). Diplotenia cachrydifoila* has its distribution centre in the Alborz Mountains, but disjuncts occur in the southern parts of Central Anatolia.

Frequency and habitats

Distribution patterns of the plant taxa vary across the wetland sites independently of their numbers. Dominant plants in the wetland sites have hydrophyte, helophyte, and geophyte life forms. Such geophytes as *Mentha longifolia* and *Juncus inflexus,* with frequency values of 81.11 % and 73.33 % respectively, were more frequent plant taxa in the wetland sites. *Batrachium trichophyllum*, a hydrophyte with frequency value of 7.7 %, was the third most frequent plant species. Species from the families *Potamogetonaceae* (hydrophyte) and *Cyperaceae* (helophyte and geophyte) occur more frequently than the others.

The wetland sites are classified into river banks, lakeshores, wet meadows and spring habitats (Kam-

Table 2. Endemic plant taxa and their frequence across the wetland sites of central and western (W) sections of the Alborz Mountains.

Species Name	Locality	Frequency (C)	Frequency (W)
*Astragalus firuzkuhensis**	Center	2.2	0
Cerastium persicum	Center	6.7	0
*Deyeuxia parsana**	Center	6.7	0
Galium diplopion	Center	4.4	0
Juncus gerardi subsp. *persicum*	Center	13.3	0
Ranunculus kotschyi	Center	13.3	0
Taraxacum azerbaijanicum	Center	2.2	0
*Veronica aucheri**	Center	2.2	0
*Veronica chionantha**	Center	2.2	0
Achillea kellalensis	West	0	2.2
Allium subvineale	West	0	16.7
Bellevalia cyanopoda	West	0	6.7
Polygonum hyrcanicum	West	0	2.2
Ranunculus elymaiticus	West	0	2.2
Ranunculus sahendicus	West	0	1.1
Scorzonera nivalis	West	0	1.1
Sisymberium integrrimum	West	0	4.4
Scrophularia nervosa	West	0	
*Stellaria scaturiginella**	West	0	4.4
*Ligularia persica**	West & Center	22.2	17.8
Myosotis koelzii	West & Center	2.2	3.3
*Ranunculus amblyolobus**	West & Center	51.1	2.2
*Rumex kandavanicus**	West & Center	2.2	3.3
Rumex elborsensis	West & Center	4.4	2.2

Note: species endemic exclusively to Alborz range are marked with an asterisk.

rani & al. 2010). Some plants are considered as emergent on lakeshores. The peripheral parts of the wet meadows are normally drier and show plants considered as intermediates between the wetland habitats and the surrounding steppes. Most of the wetland plant species grow in wet meadows.

Threats and conservation implications

The occurrence of wetlands in arid or semiarid mountains and especially in deserts is conservationally important in terms of plant biodiversity and endemic species. This paper clearly shows that many wetlands have high value in terms of floristic biodiversity and scientific importance on the arid southern slopes of the Alborz Mountains. Many of these ecosystems have sufficient food and water potential and thus are used as summer pastures, with little or no regulation. Such lack of regulation leads to overgrazing which destroys the vegetation and causes soil erosion and loss of plant diversity. Other wetland sites are drained to promote agricultural production. Some other aspects of intensified agriculture, such as high fertilization, have a markedly negative effect on the amount and composition of water in wetland areas. Recently, a very important threat to all ecosystems in Iran, especially to wetland habitats, is road construction in many mountain areas. Such roads not only directly destroy large parts of the wetland areas, but also ease access to high altitudes for grazing animals and thus road construction leads indirectly also to greater degradation of wetlands. High mountain wetland habitats such as wet meadows have been less affected by human activities, as compared to low elevation wetlands, because the harsh conditions and physical barriers limit human settlements and intensive agricultural activities. However, if current trends continue, they will imperil these mountain wetlands. Their protection would guarantee the survival of many unique plant populations and, therefore, legal protection should become a priority. So conservation of these ecosystems (as well as of all other vegetation types in Iran) must be seriously considered.

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