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Angiosperms, Kuhdasht gypsum areas, Lorestan, Iran

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Abstract: There is a lack of information on flora of gypsophilous plants in gypsum habitat in Lorestan province. In this paper, we report a species list of the gypsum flora of Kuhdasht, Iran. The study took place between 2009 and 2010. Plant species were identified and their chorology and life form determined through laboratory examinations and using reference books. We recorded about 1,000 specimens belonging to 39 families, 137 genera, and 190 taxa. An overall of 14 taxa (7.36%) are endemic to Iran. Asteraceae (29 taxa), Poaceae (24 taxa), and Fabaceae (19 taxa) were the richest taxa. The two largest genera are *Gypsophila* L. and *Astragalus* L., with six and five species, respectively. Irano-Turanian elements were the most dominant chorotypes (48.43%). Also, therophytes (51.58%) and hemicryptophytes (30.53%) were the most abundant life forms.

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Introduction

Gypsophilous plants are one of the most specific xerophilous plants. They are usually rare and endangered species. Gypsum affects plant growth and development. The removal of gypsum layers prevents vegetation from increasing in density (Pueyo and Alados 2007). Gypsum presumably decreases moisture stress during droughts of early summer, due either to decreased water competition because of low densities or inherent characteristics of the gypsum soil (Meyer 1986).

Areas with gypsum soil cover about 9.816 million ha of Iran, which represents about 16% of country area. Gypsum ($CaSO_4$. $2H_2O$) is broadly scattered on the soil surface in arid areas with less than 400 mm mean annual rainfall (Eftekhari and Assadi 2001; Eftekhari *et al.* 2002), where gypsum resources are one of the customary and rich minerals of soils (FAO 1990). Gypsiferous soils are those with at least 5% of gypsum (Soil Survey Staff 1999).

Studies of flora in gypsum soils are scarce. Johnston (1941) first reported that vascular plants are rare in gypsum soil in the Chihuahuan Desert of northern Mexico. This pattern has been seen in several arid and semi-arid areas of the world (Parsons 1976). Nevertheless, the selective forces for the evolution of gypsophile endemics have not been clearly identified (Powell and Turner 1977).

Floristic surveys are particularly important in the Lorestan province, for its ecological and weather conditions. Additionally, floristic lists are a first step for protecting endangered plants and planning a sustainable use of, for example, medicinal plants. Several studies have been conducted on the flora of non-gypsum areas in Kuhdasht, Lorestan province, Iran (Azadbakht *et al.* 2007; Dehshiri *et al.* 2011). Some previous studies have also been conducted in gypsum areas in Iran, such as Eftekhari and Assadi (2001) in Semnan province, and Eftekhari *et al.* (2002) in Khorasan province. Here, we identified Gypsophilous plants in Kuhdasht, Lorestan province, Iran. Results of this study can also be useful for rangeland management and conservation.

Materials and Methods

Study site

The Lorestan province is in the Irano-Turanian phytogeographic region in western Iran. It has hot and dry summers, wet and cold winters. The Kuhdasht region is in western Lorestan. The studied area covers about 3962.8 ha in southwestern Kuhdasht (47°21′ and 47°30′ E; 33°22′ and 33°25′ N; Figure 1). The area has an arid and cold climate (Sabeti 1969) that is common in western Iran. The studied area has a rough footed topography and its altitude ranges from 1,500 to 1,800 m. Soil texture is sandy clay, silty clay or clay; pH is about 7.2–8.2; Electrical conductivity was 0.78–3.1 ds m^{-1}; lime is 5-38.6%; soil fertility is low; gypsum is 0.5–63.4%; nitrogen is highly limited, whereas potassium is nearly sufficient (Dehshiri *et al.* 2011).

Data collection

Plant specimens were collected from areas where gypsum is dense and clearly seen on the surface. We collected specimens of vascular plants in the study area during growth periods between 2009 and 2010. They were dried by means of standard herbarium methods. Specimens were identified by using the *Flora Iranica* (Rechinger 1965–2010), *Flora of Iran* (Assadi *et al.* 1988-2010; Ghahreman 1975-2006), and additional guides (Boissier 1867–1888; Komarov and Shishkin 1934–1960; Tutin *et al.* 1964–1980; Davis 1965–1988; Zohary 1966–1986; Townsend and Guest 1966–1985; Ghahreman 1990–1994; Maassoumi 1986–2005; Mozaffarian 2008). Threatened statuses are proposed for endemic taxa following Jalili and Jamzad (1999), and Ghahreman and Attar (1999). Life forms followed the Raunkiaer's life form specifications (Mueller-Dombois and Ellenberg 1974; Asri 2003). Phytogeographical regions were also determined by using several reference books (Rechinger 1965–2010; Assadi *et al.* 1988–2010; Akhani 2005; Davis 1965–1988; Komarov and Shishkin 1934–1960; Townsend and Guest 1966–1985; Tutin *et al.* 1964–1980; Zohary 1966–86; Zohary 1973; Takhtajan 1986). Specimens are deposited at the Central Herbarium of Islamic Azad University, Borujerd Branch.

Results and Discussion

Floristic richness and taxonomic diversity

About 250 plant species have been recorded in gypsum areas in Iran (e.g., Rechinger 1965–2010; Assadi *et al.* 1988-2010; Eftekhari and Assadi 2001; Eftekhari *et al.* 2002). However, information on habitats of some plants are either absent or not given in detail. We collected about 1,000 angiosperm plant specimens in the study area, comprising 190 taxa, belonging to 137 genera of 39 families (Tables 1–2). Of these, 31 were Monocotyledons and 159 taxa were Dicotyledons. Of all taxa, 165 have not been reported yet for Semnan and Khorasan provinces (Eftekhari and Assadi 2001; Eftekhari *et al.* 2002).

The largest nine families are Asteraceae 29, Poaceae 24, Fabaceae 19, Lamiaceae 14, Brassicaceae 12, Apiaceae 9, Caryophyllaceae 9, Boraginaceae 7, and Rosaceae 6 (Table 1). Approximately 67% of the taxa belong to these nine families. These families are also the largest families in the Iran and Irano-Turanian floras (Ghahreman and Attar 1999), which explains their higher representation. Conversely, species from Asteraceae, Poaceae, and Fabaceae are the main bulk of alien plants in Iran, and also in agro-ecosystems of adjacent countries, such as Saudi Arabia and Kuwait (Abd El-Ghani and El-Sawaf 2004; Abd El-Ghani and Abd El-Khalik 2006). This result was also found by previous studies (*e.g.,* Hoagland and Buthod 2005; Barber 2008; Akpulat and Celik 2005).

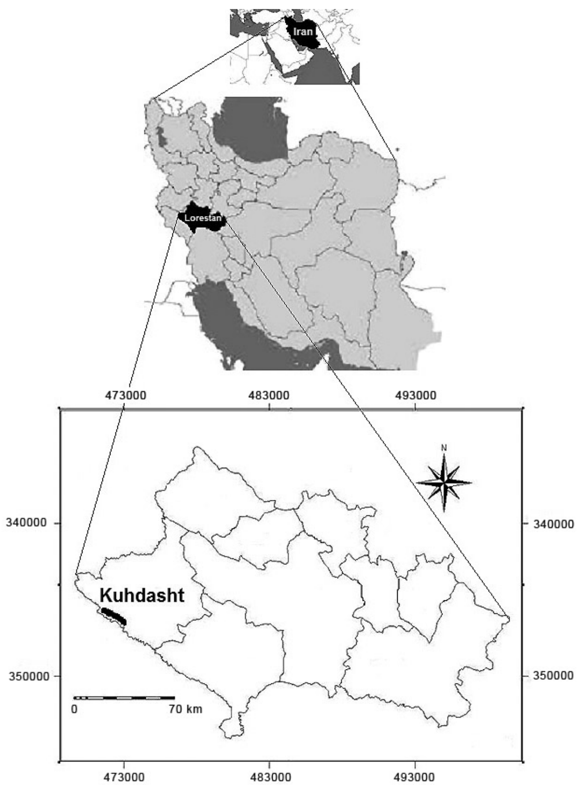

Figure 1. Location of the studied area (▬) in Iran and Lorestan province.

Asteraceae species have great ecological tolerance and break up their seeds easily (Akpulat and Celik 2005; Abd El-Ghani and Abd El-Khalik 2006). It is the second large family in the flora of Iran (Ghahreman and Attar 1999), and also the largest and most widespread family of flowering plants in the world (Good 1974). Additionally, the extensive occurrence of *Centaurea* and *Crepis* in gypsum soils contributed to this pattern.

Poaceae is third largest family in the flora of Iran (Ghahreman and Attar 1999). Species of this family tolerate soils with 40% of gypsum (Eftekhari and Assadi 2001; Eftekhari *et al.* 2002). In addition, *Hordeum* was the genus with highest occurrence. This provides evidence that monocotyledons are dominant groups in gypsum areas.

Fabaceae ranks as the third most speciose family in our study and is the largest family in the flora of Iran (Ghahreman and Attar 1999). Species of this family are calciphilous and grows easily in gypsum places (Eftekhari and Assadi 2001). In addition, the widespread presence of *Astragalus*, *Medicago*, *Onobrychis*, and *Trigonella* contributed to representation of the family.

Lamiaceae is the fourth most species rich family in our study and in the flora of Iran (Ghahreman and Attar 1999). Species of this family are calciphobic and excrete calcium (Eftekhari and Assadi, 2001; Eftekhari *et al.* 2002). The genera *Salvia*, *Phlomis*, and *Stachys* were the most common ones of this family.

A previous study in Turkey (Akpulat and Celik 2005) found that Liliaceae was the fourth most speciose family (25 taxa). No other study has recorded such high species richness for this family. They hypothesized that the commonness of *Allium* and *Iris* species in gypsum areas may be the main reason for that. Previous studies recorded only three Liliaceae species (*Allium bungei, Asparagus breslerianus*, and *Eremorus luteus*) in gypsum areas in Iran (Eftekhari and Assadi 2001). We found five Liliaceae species (3 species of *Allium*), while Azadbakht *et al.* (2007) has reported six Liliaceae species (2 species of *Allium*) in the adjacent non-gypsum area. Our literature review shows that 82 species of *Allium* exist in gypsum areas in Iran. This genus is one of the largest in the flora of Iran, which could explain its high representation in our study.

Eftekhari and Assadi (2001) and Eftekhari *et al.* (2002) found that Chenopodiaceae is the most abundant family (16 and 13 taxa, respectively). They suggested that Chenopodiaceae are successful in establishing and spreading in gypsum soils. We also found two Chenopodiaceae species, which disagrees with Eftekhari and Assadi (2001) and Eftekhari *et al.* (2002).

Astragalus has about 2,500 species in the world and is one of the largest genera of flowering plants. It is common in steppe areas, since excessive destruction provides new habitats for members of the genus. Therefore, these areas contains by far the greatest number of *Astragalus* species (Akpulat and Celik 2005). The estimated number of species of this genus for Iran is about 800 (Maassoumi 1986–2005). There are eight *Astragalus* species (*A. citrinus*, *A. fridae*, *A. semnanensis*, *A. iranicus*, *A. podolobus*, *A. kavirensis*, *A. verus,* and *A. reuterianus*) in gypsum areas

Table 1. Taxa list in the studied area. IT: Irano-Turanian; M: Mediterranean; ES: Euro-Siberian; SS: Saharo-Sindian; Pl: polyregional; Cosm: Cosmopolitan; 1: Endemic; 2: Lower risk; 3: Vulnerable; Th: Therophyte; Hem: Hemicryptophyte; Ge: Geophyte; Ch: Chamaephyte; Ph: Phanerophyte.

TAXA	LIFE FORM	CHROTYPE	VOUCHER NO.
Magnoliophyta			
Magnoliopsida			
Amaranthaceae			
Amaranthus blitoides S. Watson var. *halophilus* Aell.[1,2]	Th	IT	2524
Aristolochiaceae			
Aristolochia bottae Jaub. & Spach	Hem	IT	2547
Boraginaceae			
Anchusa italica Retz	Hem	IT-M-ES	2355
Anchusa strigosa Labill. subsp. *strigosa*	Hem	IT-M	2399
Arnebia decumbens (Vent.) Coss. & Karl subsp. *decumbens*	Th	IT-SS	2390
Onosma bulbotrichum DC.	Hem	IT	2385
Onosma albo-roseum Fisch. & C. A. Mey.	Ge	IT	2370
Onosma trachytrichum Boiss.	Hem	IT	2366
Paracaryum rugulosum (DC.) Boiss.	Hem	IT-SS	2377
Capparidaceae			
Capparis spinosa L.	Ch	IT-M-SS	2566
Caryophyllaceae			
Buffonia oliveriana Ser. in DC.	Th	IT	2310
Gypsophila bicolor (Freyn & Sint.) Grossh.	Hem	IT	2349
Gypsophila elymaitica Mozaff. [1,2]	Hem	IT	2345
Gypsophila linearifolia (Fisch. & C.A. Mey.) Boiss.	Th	IT	2333
Gypsophila obconica Barkoudah	Th	IT	2347
Gypsophila pallida Stapf var. *pallida*	Hem	IT	2326
Gypsophila pilosa Huds.	Th	IT	2330
Silene conoidea L.	Th	Pl	2339
Vaccaria grandiflora (Fisch. & DC.) Jaub. & Spach	Th	IT	2336
Chenopodiaceae			
Noaea mucronata (Forssk.) Aschers. et Schweinf.	Hem	IT-M	2599
Salsola nitraria Pall.	Th	IT-SS	2587
Cistaceae			
Helianthemum salicifolium (L.) Miller	Th	IT-M-SS	2623
Asteraceae			
Achillea wilhelmsii C. Koch	Hem	IT	2007
Anthemis cotula L.	Th	IT-ES-SS	2014
Atractylis cancellata L.	Th	IT-M	2025
Carduus arabicus Jacq. ex Murray	Th	IT-SS	2017
Carthamus oxyacantha M. B.	Th	IT	2020
Centaurea bruguierana (DC.) Hand.-Mzt.	Th	IT	2036
Centaurea koeieana Bornm.	Hem	IT	2049
Centaurea solstitialis L. subsp. *solstitialis*	Th	IT	2040
Centaurea virgata Lam. subsp. *squarossa* (Willd.) Gugler	Hem	IT	2024
Chardinia orientalis (L.) O. Kuntze	Th	IT	2047
Crepis kotschyana (Boiss.) Boiss.	Th	IT	2030
Crepis sancta (L.) Babocok	Th	IT	2022
Crepis foetida L. subsp. *foetida*	Th	IT-M-ES	2010
Crupina crupinastrum (Moris) Vis.	Th	IT-M	2016
Cymbolaena griffithii (A. Gray) Wagenitz	Th	IT	2021
Echinops viscidulus Mozaff.	Hem	IT	2003
Filago vulgaris Lam.	Th	IT-ES	2045
Gundelia tournefortii L.	Hem	IT	2029
Koelpinia chrysoglochis Rech. f.	Th	IT-SS	2038
Onopordon leptolepis DC.	Hem	IT	2043
Outreya carduiformis Jaub. & Spach	Hem	IT	2031
Pentanema divaricatum Cass.	Th	IT-SS	2001
Picris strigosa M. B. subsp. *kurdica* Lack	Hem	IT	2013
Postia bombycina Boiss. & Hausskn. [1,2]	Hem	SS	2018
Postia puberula Boiss. & Haussk. [1,2]	Hem	IT-SS	2034
Scariola orientalis (Boiss.) Sojak	Hem	IT	2019
Scorzonera luristanica Rech. f.	Hem	IT	2028

Table 1. *Continued.*

TAXA	LIFE FORM	CHROTYPE	VOUCHER NO.
Tanacetum polycephalum Schultz-Bip. subsp. *polycephalum*	Hem	IT	2042
Zoegea leptaurea L. subsp. *mianensis* (Boiss.) Rech. f. [1,2]	Th	IT	2048
Convolvulaceae			
Convolvulus commutatus Boiss.	Ch	IT	2645
Convolvulus dorycnium L.	Hem	IT	2637
Convolvulus reticulatus Choisy in DC.	Hem	IT	2649
Brassicaceae			
Allysum desertorum Stapf var. *desertorum*	Th	IT	2210
Biscutella didyma L.	Th	IT-M	2220
Clypeola jonthlaspi L.	Th	IT-M	2217
Diplotaxis harra (Forssk.) Boiss.	Th	IT-M-SS	2230
Eruca sativa Miller	Th	Pl	2240
Erucaria hispanica (L.) Druce	Th	IT-M-SS	2249
Isatis raphanifolia Boiss. [1,2]	Th	IT	2223
Malcolmia africana (L.) R. Br.	Th	IT-M-SS	2246
Matthiola longipetala (Vent.) DC.	Th	IT-M-SS	2215
Sinapis arvensis L.	Th	Pl	2219
Thlaspi perfoliatum L.	Th	IT-M-ES	2238
Torularia torulosa (Desf.) O.E. Schulz	Th	IT-SS	2244
Dipsacaceae			
Cephalaria dichaetophora Boiss.	Th	IT	2671
Pterocephalus plumosus (L.) Coult.	Th	IT-M	2665
Scabiosa olivieri Coult	Th	IT	2669
Scabiosa persica Boiss.	Th	IT	2655
Scabiosa sicula L.	Th	IT	2658
Euphorbiaceae			
Andrachne telephioides L.	Hem	IT-M-SS	2686
Chrozophora tinctoria (L.) A. Juss.	Th	IT-M	2699
Euphorbia craspedia Boiss. [1,2]	Hem	IT	2697
Euphorbia helioscopia L.	Th	Pl	2677
Euphorbia macroclada Boiss.	Hem	IT	2687
Euphorbia falcata L.	Th	IT-M	2688
Fagaceae			
Quercus brantii Lindl. var. *persica* (Jaub. & Spach) Zohary [1,2]	Ph	IT	2705
Geraniaceae			
Erodium cicutarium (L.) L'Her. ex Aiton	Th	IT-M-ES	2729
Geranium rotundifolium L.	Th	IT-M-ES	2748
Hyericaceae			
Hypericum helianthemoides (Spach) Boiss.	Hem	IT	2773
Lamiaceae			
Phlomis bruguieri Desf.	Hem	IT	2199
Phlomis polioxantha Rech. f.	Hem	IT	2157
Phlomis olivieri Benth.	Hem	IT	2190
Salvia compressa Vent.	Hem	IT	2173
Salvia macrosiphon Boiss.	Hem	IT	2179
Salvia palaestina Benth.	Hem	IT-M	2162
Salvia reuterana Boiss.	Hem	IT	2172
Scutellaria pinnatifida A. Hamilt. subsp. *pinnatifida*	Ch	IT	2152
Stachys benthamiana Boiss.	Hem	IT	2193
Stachys inflata Benth.	Hem	IT	2163
Stachys pilifera Benth. in DC. [1,2]	Hem	IT	2178
Teucrium orientale L.	Hem	IT	2166
Teucrium polium L.	Ch	IT-M	2187
Ziziphora capitata L. subsp. *orientalis* Samuelsson ex Rech. f.	Th	IT-M	2164
Linaceae			
Linum mucronatum Bertol. subsp. *mucronatum*	Ch	IT	2797
Linum strictum L. var. *spicatum* Pers.	Th	IT-M	2786
Malvaceae			
Alcea kurdica (Schlesht.) Alef	Hem	IT	2812

Table 1. *Continued.*

TAXA	LIFE FORM	CHROTYPE	VOUCHER NO.
Malva parviflora L.	Th	IT-M-SS	2824
Malva sylvestris L. var. *sylvestris*	Hem	IT-M-ES	2820
Malva verticillata L.	Th	IT-SS	2815
Mimosaceae			
Prosopis farcta (Banks & Soland.) Macbr.	Ch	IT-M-SS	2846
Moraceae			
Ficus carica L. subsp. *rupestris* (Hausskn. ex Boiss.) Browincz	Ph	IT-M	2872
Orobanchaceae			
Orobanche ramosa L.	Th	Pl	2891
Papaveraceae			
Chelidonium majus L.	Th	Pl	2923
Glaucium fimberilligerum Boiss.	Th	IT	2914
Glaucium grandiflorum Boiss. & Huet.	Hem	IT	2910
Papaver bracteatum Lindl.	Hem	IT	2906
Fabaceae			
Alhagi persarum Boiss. & Buhse	Hem	IT	2110
Astragalus crispocarpus Nabelek [2]	Th	IT	2102
Astragalus ecbatanus Bunge [1,2]	Ch	IT	2125
Astragalus eriosphaerus Boiss.	Ch	IT	2107
Astragalus fasciculifolius Boiss. subsp. *fasciculifolius* [1,2]	Ph	IT	2135
Astragalus kerkukiensis Bornm.	Th	IT	2145
Glycyrrhiza glabra L.[2]	Hem	IT-M	2132
Medicago orbicularis (L.) Bartalini [2]	Th	Pl	2139
Medicago polymorpha L.	Th	Cosm	2128
Medicago radiata L.	Th	IT-M	2146
Medicago rigidula (L.) All. [2]	Th	IT-M-ES	2138
Onobrychis caput-galli (L.) Lam.	Th	IT-M	2111
Onobrychis crista-galli (L.) Lam.	Th	IT-M-SS	2119
Onobrychis ptolemaica (Del.) DC.	Hem	IT-SS	2130
Trifolium campestre Schreb.	Th	IT-M-ES	2122
Trigonella elliptica Boiss. [1,2]	Ch	IT	2149
Trigonella monantha C.A. Mey.	Th	IT	2108
Trigonella persica Boiss. [1,2]	Th	IT	2129
Vicia peregrina L. var. *peregrina*	Th	IT-M	2142
Plantaginaceae			
Plantago lanceolata L.	Hem	IT-ES-SS	2947
Polygalaceae			
Polygala hehenackeriana Fisch. & C.A. Mey.	Hem	IT	2965
Polygonaceae			
Pteropyrum noeanum Boiss. & Meisner[3]	Ph	IT-SS	2979
Primulaceae			
Anagalis arvensis L.	Th	IT-M-ES	2231
Ranunculaceae			
Adonis aestivalis L.	Th	IT-M-ES	2046
Anemone biflora DC.	Ge	IT	2067
Delphinium cyphoplectrum Boiss.	Hem	IT-SS	2089
Thalictrum isopyroides C.A. Mey.	Hem	IT	2094
Rosaceae			
Amygdalus arabica Olivier	Ph	IT	2401
Amygdalus lycioides Spach var. *lycioides*	Ph	IT	2410
Crataegus meyeri A. Pojark.	Ph	IT-ES	2417
Crataegus monogyna Jacq.	Ph	IT-ES	2412
Rosa canina Boiss.	Ph	IT	2432
Sanguisorba minor Scop.	Hem	IT	2422
Rubiaceae			
Gaillonia bruguieri A. Rich. ex DC. [1,2]	Hem	IT	2557
Galium setaceum L.	Th	IT-M	2977
Callipeltis cucullaria (L.) Stev.	Th	IT-SS	2435

Table 1. *Continued.*

TAXA	LIFE FORM	CHROTYPE	VOUCHER NO.
Rutaceae			
Haplophyllum tuberculatum (Forssk.) Juss.	Hem	IT-SS	2298
Scrophulariaceae			
Albraunia fugax (Boiss. & Nöe) Speta	Th	IT	2174
Scrophularia striata Boiss.	Hem	IT	2195
Tamaricaceae			
Tamarix tetragyna Ehrenb. var. *meyeri* (Boiss.) Boiss.	Ph	IT-SS	2476
Thymelaeaceae			
Thymelaea passerina (L.) Cosson & Germ.	Th	IT-ES	2596
Apiaceae			
Anisosciadium orientale DC.	Th	IT-SS	2299
Bifora testiculata (L.) Spreng.	Th	IT-M	2295
Bunium cylindricum (Boiss. & Hohen.) Druce	Ge	IT	2261
Ferulago macrocarpa (Fenzl) Boiss.	Hem	IT	2290
Lagoecia cuminoides L. [2]	Th	IT-SS	2273
Pimpinella barbata (DC.) Boiss.	Th	IT-SS	2280
Pimpinella eriocarpa Banks. & Soland.	Th	IT-SS	2055
Torilis leptophylla (L.) Reichenb.	Th	IT-M-ES	2085
Turgenia latifolia (L.) Hoffm.	Th	IT-M-ES	2070
Valerianaceae			
Valerianella vesicaria (L.) Moench	Th	IT-M	2794
Liliopsida			
Poaceae			
Aegilops umbellulata Zhuk.	Th	IT	2051
Avena fatua L. var. *fatua*	Th	Pl	2057
Avena wiestii Steud.	Th	IT-M-SS	2054
Bromus danthoniae Trin. var. *danthoniae*	Th	IT	2063
Bromus tectorum L. var. *tectorum*	Th	Pl	2053
Crypsis schoenoides (L.) Lam.	Th	IT-M-ES	2078
Cynodon dactylon (L.) Pers.	Ge	Cosm	2099
Echinaria capitata (L.) Desf.	Th	IT-M	2081
Eremopoa persica (Trin.) Roshev. subsp. *persica*	Th	IT-M	2088
Eremopyrum bonaepartis (Spreng.) Nevski var. *bonaepartis*	Th	IT	2065
Heteranthelium piliferum (Banks & Soland.) Hochst	Th	IT	2087
Hordeum bulbosum L.	Ge	IT-M-SS	2077
Hordeum leporinum Link	Th	IT-M	2064
Hordeum spontaneum C. Koch	Th	IT-M	2091
Lolium temulentum L.	Th	Pl	2097
Melica jacquemontii Decne. ex Jacquem	Ge	IT	2069
Phalaris minor Retz.	Th	IT-M	2074
Phragmites australis (Cav.) Trin. ex Steud. subsp. *australis*	Ge	Cosm	2095
Poa bulbosa L.	Ge	IT-M-ES	2080
Polypogon monspeliensis (L.) Desf.	Th	Pl	2052
Secale montanum Guss.	Hem	IT-M	2050
Setaria viridis (L.) P. Beauv.	Th	Pl	2061
Stipa barbata Desf	Hem	IT	2092
Taeniatherum crinitum (Schreb.) Nevski	Th	IT-M	2086
Iridaceae			
Gynandriris sisyrinchium (L.) Parl.	Ge	IT-SS	2134
Iris hymenospatha Mathew & Wendelbo[2]	Ge	IT	2592
Liliaceae			
Allium longispalum Bertol.	Ge	IT	2499
Allium jesdianum Boiss. & Buhse	Ge	IT	2467
Allium rotundum L.	Ge	IT-ES	2475
Muscaria tenuiflorum Tausch	Ge	IT-ES	2477
Ornithogalum cuspidatum Bertol.	Ge	IT	2456

in Iran (Eftekhari and Assadi 2001; Eftekhari *et al.* 2002), but only two (*A. arpilobus* and *A. oxyglottis*) in gypsum areas in China (Langran and Podlech 2010). In addition, only three *Astragalus* species of the section *Hololeuce* Bunge (*A. bicolor* subsp. *karputanus*, *A. andrasovszkyi* and *A. stenosemius*) were reported in gypsum areas in Turkey (Ekücü and Eküm 2004). We found five *Astragalus* species, while there were 25 *Astragalus* species in adjacent non-gypsum areas. This genus is not halophytic and does not grow in salty areas (Akhani and Ghorbanli 1993). Our results show that *Astragalus*, with about 800 species in Iran, does not occur in gypsum areas. This result is in conflict with Akpulat and Celik (2005).

Phytogeographic regions

The proportions of taxa in each phytogeographic regions are as follows: 92 species from IT (48.43%), 1 species from SS (0.53%), 6 species from IT-ES (3.16%), 20 species from IT-SS (10.53%), 28 species from IT-M (14.74%), 14 species from IT-M-ES (7.37%), 12 species from IT-M-SS (6.31%), 2 species from IT-ES-SS (1.05%), 12 species from multi-regional (6.31%), 3 species from cosmopolitan (1.57%) (Tables 1–2). These results are in accordance with our expectation, since the study area is in the IT region (see also Eftekhari and Assadi, 2001; Eftekhari *et al.*, 2002). IT-M elements are present since the study area is open and steppe. Elements from two or more regions comprise more than half of the species, due to the low altitude (Noroozi *et al.* 2008).

We found 14 taxa (7.36%) endemic to Iran. However, *Gypsophila elymaitica* Mozaff. is obligatory gypsophyte. The other 13 taxa are preferential gypsophyte or indifferent plants. Endemism rate is lower than the average for Iran (23.91%), since the region is in lowland (Noroozi *et al.* 2008). This result is in disagreement with Akpulat and Celik (2005), who suggested that the reason for the high endemism in Turkey is the gypsum habitats. For example, *Astragalus aytatchii* only grows in deep soil, gypsum fields, and slopes in Turkey (Akan and Civelek 2001). In arid and semi-arid environments with less than 400 mm average annual rainfall, gypsum crystals sediment on upper surface of gypsiferous soils by evaporation (Pueyo and Alados 2007).

We found that 21 taxa were threatened (20 taxa LR and 1 taxon VU). We suggest that three taxa: *Euphorbia craspedia* Boiss., *Quercus brantii* Lindl. var. *persica* (Jaub. & Spach) Zohary, and *Gypsophila elymaitica* Mozaff., whose conservation status is unknown, must be assigned LR status in the study area, according to IUCN (2010). *Astragalus kerkukiensis*, previously a Data Deficient (DD) species (Jalili and Jamzad 1999) was very abundantly in the study area.

Life forms

Therophytes, hemicryptophytes, geophytes, phanerophytes, and chamaephytes included 51.58, 30.53, 7.89, 5.26, and 4.74% of the total species, respectively. Ninety-eight species were annuals and 73 perennials. From all species, 19 were woody plants.

The environment of the studied area, with arid and cold climate, favors therophytes and hemicryptophytes. The active growth periods of therophytes and hemicryptophytes are concurrent with the rainy season in late winter and early spring (Tavili *et al.* 2009). During most of the summer and all winter, hemicryptophytes loose their aboveground parts while therophytes remain as seed. Chamaephytes and phanerophytes only occur when gypsiferous soils are not open. Altitudinal variation can also be a determinant factor for the relative abundance and geographic distribution of different life forms, along with climate (Noroozi *et al.* 2008).

Hemicryptophytes were the most abundant life form in the studies of Eftekhari and Assadi (2001) and Eftekhari *et al.* (2002; 49.1% and 52.9%, respectively). They suggested that hemicryptophytes could adapt to harsh environmental conditions for growth and establishment, such as in gypsum habitats. Therophytes were the most abundant life form (51.58%) in the studied area. These plants avoid stresses from the summer drought and winter cold (Barbour *et al.* 1987). Moreover, the high proportion of therophytes could also attributed to human activities (Barbero *et al.*, 1990).

Table 2. Floristic properties of the studied area. IT: Irano-Turanian; M: Mediterranean; ES: Euro-Siberian; SS: Saharo-Sindian; Pl: polyregional; Cosm: Cosmopolitan; LR: Lower risk; VU: Vulnerable; Th: Therophyte; Hem: Hemicryptophyte; Ge: Geophyte; Ch: Chamaephyte; Ph: Phanerophyte.

	Dicotyledons	Monocotyledons	Total
Families	36	3	39
Genera	112	25	137
Species	159	31	190
Subspecies	14	4	18
Varieties	9	4	13
Endemic taxa	14	0	14
IT	82	10	92
SS	1	0	1
IT-ES	4	2	6
IT-SS	19	1	20
IT-M	21	7	28
IT-M-ES	12	2	14
IT-M-SS	10	2	12
IT-ES-SS	2	0	2
Pl	7	5	12
Cosm	1	2	3
LR	19	1	20
VU	1	0	1
Ph	10	0	10
Ch	9	0	9
Hem	56	2	58
Ge	3	12	15
Th	82	17	98

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