THE FLORISTIC COMPOSITION AND BIOLOGICAL SPECTRUM OF VEGETATION IN THE MEYMEH REGION OF NORTHERN ISFAHAN PROVINCE, IRAN

KARGAR CHIGANI, H.[1] – AKBAR JAVADI, S.[1*] – ZAHEDI AMIRI, G.[2] – JAFARI, M.[2] – JAMALEDDIN KHAJEDDIN, S.[3]

[1]*Department of Range Management, Science and Research Branch, Islamic Azad University, Daneshgah Blvd, Simon Bulivar Blvd, Tehran, C.P. 1477893855, Iran*
(phone: +98-9131298514; fax: +98-2144868550-55)

[2]*Faculty of Natural Resources, University of Tehran, Karaj, Iran,*
(phone: +98 261 2223044-6; fax: +98 261 2227765)

[3]*Range and Watershed Management Division, Department of Natural Resources, Isfahan University of Technology, Isfahan, Iran*
(phone: +98-9131104624; fax: +98-2144640229)

[*]*Corresponding author*
e-mail: hadi_k1360@yahoo.com; phone: +98-9122443659; fax: +98-2144868550-55

(Received 27th Aug 2016; accepted 29th Oct 2016)

Abstract. This research details the flora of Meymeh, a region situated in the province of Isfahan in the central plateau of Iran and entirely within the Irano-Turanian phytogeographical region. In total, 164 species of flora belonging to 32 families and 108 genera were surveyed and identified in several field trips during the study period from 2013 to 2014. Based on the number of species, Asteraceae (30 species, 18.3%), Poaceae (20 species, 12.2%), and Papilionaceae (19 species, 11.6%) were the most important families. The largest genera were *Astragalus* (15 species), *Cousinia* (6 species), *Acanthophyllum*, and *Centaurea* (each with 5 species). In this study, the life-form spectra were classified on the basis of Raunkiaer's system. Then, the χ^2 test and correlation analysis were used to compare the biological spectrum with Raunkiaer's normal spectrum and with those in other floristic studies conducted in the Irano-Turanian growth zone. The results showed that the life-form spectrum in the present study was characteristic of a cool steppe climate region and dominated by hemicryptophytes (50% of the recorded species), followed by chamaephytes and therophytes. Findings also indicated that the effects of climate, altitude, and human activities such as overgrazing caused a reduction in phanerophytes from around 46 to 4%, increases in chamaephytes from about 9 to 26% and hemicryptophytes from 26 to 50% in comparison with Raunkiaer's normal spectrum. It can be concluded that hemicryptophytes and phanerophytes usually comprise the highest and lowest percentages of life forms in studies conducted in the Irano-Turanian growth zone.
Keywords: *flora; life form; endangered species; Irano-Turanian; biodiversity; ecology*

Introduction

Sustainable development requires the acquisition of basic information on terrestrial ecosystems. A major section of an ecosystem is vegetation where plant communities and species spread based on environmental factors (Nimais, 1985). Humans and most other animals directly and indirectly depend almost totally upon plants. Mismanagement and overexploitation have resulted in critical conditions and the degradation of vegetation. Therefore, understanding the distribution of plant species (floristic studies) is essential to the management and conservation of these ecosystems. In addition, flora studies of each region, including the list of species, the life-form spectrum, geographical

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/1501_415428

distribution, and the identification of threatened species is useful for ecological issues like biodiversity and determining growth capacities and potentials of a region. A life form is a group of plants which have the same general morphological features (Cain, 1950). Generally, plants are understood to be a growth form that displays an obvious relationship with key environmental factors (Mueller-Dombois et al., 1974). Some techniques for categorizing plant life form have been developed, among which Raunkiaer‘s system is still the simplest and, in many ways, the most satisfactory classifier of plant life forms (Asri, 2003). Raunkiaer (1934) provided this classification system based on the position and degree of protection of the renewing buds which are responsible for the renewal of the aerial plant body after an unfavorable season. Accordingly, plant species can be classified into five main classes: phanerophytes, chamaephytes, hemicryptophytes, cryptophytes and therophytes.

Identification of plant species, especially rare and threatened ones, is very important to the management, protection, reclamation, and development of natural ecosystems throughout the world. The International Union for Conservation of Nature and Natural Resources (IUCN) was formed to identify plant species and take the necessary measures to prevent their extinction (IUCN, 1981). In Iran, Jalili and Jamzad (1999) attempted to introduce species based on the IUCN criteria in the “Red Data Book of Iran." Accordingly, the threatened species of Iran include four categories: endangered, vulnerable, low risk, and data deficient.

Iran has one of the richest floras with a large number of endemic species (Zohary, 1963). A significant proportion of the species are belonging to the Irano-Turanian vegetation zone. The Irano-Turanian flora and vegetation is known by the following features (Djamali et al., 2012): (i) high species richness, (ii) high diversity, (iii) scarcity of forest vegetation, (iv) high endemism (exceeding 25%), (v) dominance of chamaephytes (mainly dwarf shrubs) and hemicryptophytes (mainly Poaceae), forming steppe vegetation, and (vi) development of several specific taxonomic groups, including the genera *Astragalus* (Fabaceae), *Cousinia* and *Centaurea* (Asteraceae), and *Acantholimon* (Plumbaginaceae).

Iran’s rich and diverse flora have been studied by foreign (Zohary, 1973; Rechinger, 1963-2010) and Iranian botanists (Mobayen, 1975-1996; Ghahraman, 1975-2005) for many years. Sources report that the number of plant species in Iran is around 9500-8500 which, in comparison, is near the total number of species in Europe (Akhani, 2006). The Meymeh region in the central plateau of Iran is an example of a cold steppe region with typical steppe plants. Part of the area is located in the Karkas Mountains, and species diversity there is high because of topographic and climatic conditions. The particular climate condition, drought, over-grazing, human activity, and the reduction in valuable species in the area provide enough reasons to study the flora of the region. There are no published studies regarding the vegetation of the area. Therefore, the main objectives of the present study were to enrich the knowledge of vegetation in the area by identifying total plant species and their life-form spectrum, life span, growth habits, and geographical distribution and too identify threatened species. In addition, the study can be very useful for bridging botanical gaps in Iran. Since the climate of the area is classified as Cold Mountain, it could be expected to find a high proportion of Hemicryptophytes. Also, because this area is an indicator of the cold steppe region in central Iran, it can be expected that a high percentage of species will be related to the Irano-Turanian growth zone. In this research, the following questions were asked: (i) What is the floristic composition and life-form spectrum of the study area? (ii) Which

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/1501_415428

life-form classes are significantly different from Raunkiaer's normal spectrum? (iii) Are the identified floristic spectra the same as those in other studies conducted in the Irano-Turanian growth zone?

Materials and methods

Study area

This study was conducted in the Meymeh region, located north of Isfahan in the central plateau of Iran (*Fig. 1*). The study area occupying approximately 83.4 km^2 is located between latitudes 33° 20' to 33° 41' N and longitudes 51° 6' to 51° 33' E and the elevation ranges between 2004 and 3157 m and the average slope is 18%. The annual precipitation of the study area influenced mainly by the Mediterranean atmospheric system is about 177 mm with a mean annual temperature of about 12 °C. Most rainfall (73%) was concentrated between November and May. The climate of the study area was, following Emberger method, cold-arid and following Köppen–Geiger climate classification system was cold steppe (cold semi-arid) climate with average annual temperature below 18°C 'Bsk'.

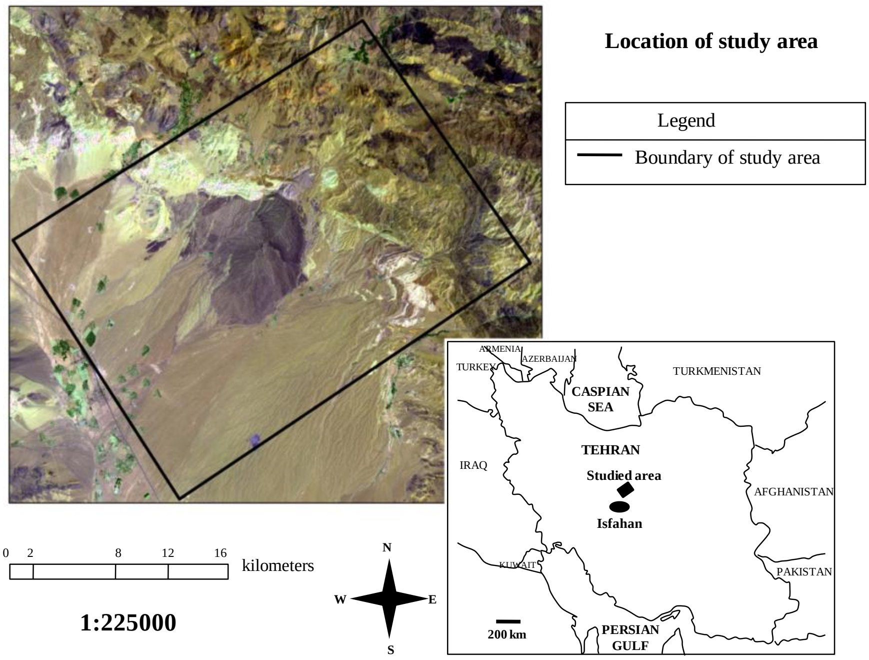

Figure 1. *Location of the study area.*

Data collection and statistical analysis

The flora was surveyed and identified in different seasons on several field trips taken during the period 2014 to 2015. The specimens collected were prepared according to standard herbarium techniques and recognized according to the Flora Iranica (Rechinger, 1963–2010), Flora of Turkey (Davis, 1965–1988), Flora of Iran (Mobayen, 1975-1996), *Astragalus* communities of Iran (Ramak Masomi, 1986-2000) Colored Flora of Iran (Ghahraman, 1975-2005), Flora of Iran (Assadi et al., 1988–2011), and the number of the available papers (Abbasi et al., 2012; Khajeddin et al., 2012). The

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/1501_415428

number of genera in each family and the number of species in each genus were determined using "The Plant Book" (Mabberley, 2008). All species were classified into annuals and perennials according to life spans and into herbs, shrubs, and trees according to their growth habits. The life forms of the identified species were assigned on the basis of definitions by Raunkiaer (1934). The geographical distribution and endemism of plant species were also determined according to mentioned Flora and "Biodiversity of Plant Species in Iran" (Ghahreman and Attar, 1998). The proportion of species in each life-form class (biological spectrum) was compared with Raunkiaer's normal spectrum using a χ^2 test (Moradi et al., 2010). Then, a pairwise comparison was made of the floristic biological spectra of the study and those in other floristic studies conducted in the Irano-Turanian growth zone in the vicinity of the area by using χ^2 tests and correlation analyses. The conservation status of the various species was evaluated using a series of criteria such as life span, geographical distribution, life form, population size, and the reproduction of plants in their natural habitats as well as the exploitation of the plant by humans, livestock, and wildlife. Finally, the threatened species in the area were classified on the basis of the method described by Jalili and Jamzad (1999).

Results

Floristic composition

In total, 164 species out of 108 genera and 32 families were collected and identified *(Table 1)*. In this plant collection, the families Asteraceae, Poaceae, and Papilionaceae were treated as the largest plant families respectively by allocating 18.3% (30 species), 12.2% (20 species), and 11.6% (19 species) of all the available species in the region *(Fig. 2)*. The genera with the highest species richness were *Astragalus* (with 15 species), *Cousinia* (with 6 species), *Acanthophyllum* and *Centaurea* (each with 5 species). Annuals and perennials accounted for 17% (28 species) and 83% (136 species) of total number of plant species, respectively. The evaluation of growth habits showed that 124 species (83%) made up a high proportion of the herb form, 20.7% (34 species) belonged to the shrub group, and 3.7% (6 species) belonged to tree species.

Table 1. *List of species, families and their life-form, growth habit, life span, and geographical distribution in Meymeh region, Abbreviations used in this article: He= Hemicryptophyte, Ch= Chamaephyte, Cr= Cryptophyte, Th= Therophyte, Ph= Phanerophyte (Raunkiaer, 1934), IT= Irano-Turanian, M= Mediterranean, ES= Euro-Siberian, Cosm= Cosmopolitan, SA= Saharo-Arabian, SS= Sahara-Sendiananan, Plur= Pluriregional, End= Endemic (Rechinger, 1963-2010), Vu= Vulnerable, LR= Lower risk (Jalili and Jamzad, 1999), A= Annual, P= Perennial, H= Herb, S= Shrub, T= Tree.*

	SCIENTIFIC NAME	Life form	Chorotype	Threatened species	Growth habit	Life Span
	Apiaceae					
1	*Echinophora platyloba* DC.	He	IT (End.)	LR	H	P
2	*Eryngium billardieri* F. Delaroche	He	IT, ES	-	H	P
3	*Eryngium bungei* Boiss.	He	IT (End.)	-	H	P
4	*Ferula ovina* (Boiss.) Boiss.	He	IT	Vu	H	P
	Asteraceae					
5	*Achillea wilhelmsii* C. Koch	He	IT, ES	-	H	P
6	*Artemisia aucheri* Boiss.	Ch	IT	-	S	P
7	*Artemisia sieberi* Besser.	Ch	IT, ES	-	S	P

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/1501_415428

8	*Centaurea albonitens* TURRILL	He	IT, ES	LR	H	P
9	*Centaurea gaubae* (Bornm.) Wagenitz	He	IT (End.)	LR	H	P
10	*Centaurea lurestanica*	He	IT (End.)	-	H	P
11	*Centaurea ispahanica* Boiss.	He	IT (End.)	-	H	P
12	*Centaurea virgata* Lam.	He	IT, ES	-	H	P
13	*Cirsium congestum* Fisch. & C.Amey. *Ex*	He	IT, M	-	H	P
14	*Cousinia bachtiarica* Boiss & Hausskn.	He	IT (End.)	-	H	P
15	*Cousinia cungesta*	He	IT (End.)	-	H	P
16	*Cousinia lactiflora* Rech. f.	He	IT (End.)	-	H	P
17	*Cousinia lasiolepis* Boiss	He	IT	-	H	P
18	*Cousinia multiloba* DC.	He	IT (End.)	-	H	P
19	*Cousinia piptocephala* Bunge	He	IT (End.)	Vu	H	P
20	*Echinops caphaletes*	He	IT	-	H	P
21	*Echinops elymaticus* Born	He	IT (End.)	-	H	P
22	*Echinops robustus* Bunge.	He	IT (End.)	-	H	P
23	*Gundelia tournefortii* L.	Ch	IT, M	-	H	P
24	*Hertia angustifolia* (DC.) O. Kuntze	Ch	IT	LR	S	P
25	*Lactuca glauciifolia* Boiss.	Th	IT	-	H	A
26	*Lunea spinosa*	He	IT	-	H	P
27	*Onopordon heteracanthum* C. A. Mey.	He	IT	-	S	P
28	*Outreya carduiformis* Jaub. & Spach	He	IT	-	S	P
29	*Scariola orientalis* (Boiss.) Sojak	Ch	IT	-	H	P
30	*Scorzonera mucida* Rech.f., Aellen &	He	IT (End.)	LR	H	P
31	*Scorzonera tortuosissima* Boiss.	He	IT (End.)	-	H	P
32	*Tanacetum polycephalum* Schultz-Bip.	He	IT, ES	LR	H	P
33	*Taraxacum bessarabicum* Fisch	He	IT	-	H	P
34	*Trapopogon caricifolius* Boiss	He	IT (End.)	-	H	P
	Boraginaceae					
35	*Lappula microcarpa* (Ledeb.) Gurke	Th	IT, ES	-	H	A
36	*Onosma elwendicum* Wettst.	He	IT	-	H	P
37	*Rochelia macrocalyx* Bunge	Th	IT	-	H	A
	Brassicaceae					
37	*Alyssum heterotrichum* Boiss	Th	IT, ES	-	H	A
39	*Alyssum linifolium* Stephan ex Willd.	Th	IT, M	-	H	A
40	*Alyssum bracteatum* Boiss. & Buhse	He	IT (End.)	-	H	A
41	*Alyssum szovitsianum* Fisch. & C.A.Mey	Th	IT	-	H	A
42	*Barbarea vulgaris-Beloris vulgaris*	Ph	-	-	T	P
43	*Clypeola dichotoma* Boiss.	Th	IT	-	H	A
44	*Descurainia sophia (*L.) Schur.	Th	Cosm	-	H	A
45	*Isatis cappodocica* Desv.	He	IT	Vu	H	P
46	*Lepidium persicum* Boiss.	He	IT, M	-	H	P
47	*Matthiola alyssifolia* (DC.) Bornm.	He	-	-	H	P
48	*Matthiola ovatifolia* (Boiss.) Boiss.	He	IT (End.)	LR	H	P
49	*Moriera spinosa* Boiss.	He	IT (End.)	-	H	P
50	*Sisymbrium irio* L.	Th	IT	-	H	A
	Capparidaceae					
51	*Capparis spinosa* L.	Ch	IT,M,SS	-	H	P
52	*Cleome coluteoides* Boiss.	He	-	-	H	P
	Caprifoliaceae					
53	*Lonicera nummulariifolia* Jaub. & Spach	Ph	IT, M	-	T	P
	Caryophyllaceae					
54	*Acanthophyllum bracteatum* Boiss.	Ch	IT (End.)	-	S	P
55	*Acanthophyllum crassifolium* Boiss	Ch	IT	LR	S	P
56	*Acanthophyllum microcephalum* Boiss.	Ch	IT	-	S	P
57	*Acanthophyllum squarrosum* Bioss	Ch	IT (End.)	-	S	P
58	*Acanthophyllu spinosum*	Ch	IT	-	S	P
59	*Buffonia macrocarpa* Ser.	He	IT (End.)	LR	H	P
60	*Dianthus orientalis* Adams	Ch	IT	-	S	P
61	*Dianthus crinitus* Sm.	He	IT	-	H	P

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/1501_415428

62	*Gypsophila acantholimoides* Bornm.	Ch	IT (End.)	LR	S	P
63	*Gypsophila virgata*	Ch	IT	LR	H	P
64	*Silene commelinifolia* Boiss.	He	IT	-	H	P
	Chenopodiaceae					
65	*Anabasis aphylla* L.	He	IT	-	H	P
66	*Eurotia ceratoides* (L.) C. A. Mey.	Ch	IT	-	S	P
67	*Kochia prostrate* Roth.	Ch	IT	-	S	P
68	*Kochia stellaris* Moq.	Th	IT	-	H	A
69	*Noaea mucronata* (Forsk.) Aschers. Et	Ch	IT, M	-	S	A
70	*Salsola tomentosa (*Moq.) Spach	He	IT	-	H	P
	Convolvulaceae					
71	*Convolvulus fruticosus* Pall.	Ch	IT	-	H	P
	Cyperaceae					
72	*Carex stenophylla* L.	Cr	IT	-	H	P
	Euphorbiaceae					
73	*Euphorbia cheiradenia*	He	IT	-	H	P
74	*Euphorbia decipiens* Boiss. & Buhse	He	IT (End.)	LR	H	P
75	*Euphorbia heteradena* Jaub. & Spach	He	IT	-	H	P
	Iridaceae					
76	*Iris songarica* Schrenk	Cr	IT	-	H	P
77	*Ixillarion tataricum*	He	IT	-	H	P
	Lamiaceae					
78	*Eremostachys macrophylla* Montbret & Aucher	He	IT	-	H	P
79	*Marrubium crassidens* Boiss.	He	IT	-	H	-
80	*Mentha longifolia* (L.) Huds.	He	IT, SS,	LR	H	P
81	*Nepeta oxyodonta* Boiss	He	IT (End.)	LR	H	P
82	*Nepeta persica* Boiss.	He	IT (End.)	-	H	P
83	*Phlomis olivieri* Benth.	He	IT	-	H	P
84	*Salvia macrosiphon* Boiss.	He	IT	-	H	P
85	*Salvia eremophila* Boiss.	He	IT (End.)	Vu	H	P
86	*Scutellaria multicaulis* Boiss. subsp.	He	IT (End.)	LR	H	P
87	*Stachys inflata* Benth.	He	IT, ES	-	H	P
88	*Teucrium orientale* L.	He	IT	-	H	P
89	*Thymus daenensis* Celak	Ch	IT (End.)	LR	H	P
90	*Zataria multiflora* Boiss.	Ch	IT (End.)	Vu	H	P
91	*Ziziphora tenuior* L.	Th	IT, ES	-	H	A
	Liliaceae					
92	*Eremurus spectabilis*	Cr	IT	-	H	P
93	*Tulipa biflora* Pall	Cr	IT	-	H	P
	Malvaceae					
94	*Alcea aucheri* (Boiss.) Alef.	He	-	-	H	P
95	*Malva silvestris*	He	IT	-	H	P
	Orobanchaceae					
96	*Orobanche alba* Stephan	Cr	-	-	H	P
	papaveraceae					
97	*Glusium oxylobum*	Cr	-	-	H	P
98	*Hypecoum pendulum* L.	Th	IT, ES	-	H	A
99	*Papaver macrostomum*	Th	IT (End.)	-	H	A
100	*Roemeria hybrida* (L.) DC.	Th	IT	-	H	A
	Papilionaceae					
101	*Alhagi camelorum* Fisch.	He	IT	-	H	P
102	*Astragalus callistachys* Boiss. et Buhse	Ch	IT	LR	S	P
103	*Astragalus campylathus* Boiss.	Ch	IT	LR	S	P
104	*Astragalus fisheri*	Ch	IT	-	S	P
105	*Astragalus globiflorus* Bioiss	Ch	IT	-	S	P
106	*Astragalus glucocanthus* Fisch.	Ch	IT	LR	S	P
107	*Astragalus glumaceus*	Ch	IT	-	S	P
108	*Astragalus gossypinus* Fisch	Ch	IT	-	S	P
109	*Astragalus hamosus*	Ch	IT	-	S	P

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/1501_415428

110	*Astragalus microphysa* Boiss.	Ch	IT	-	S	P
111	*Astragalus piptocephalus* Boiss	Ch	IT	-	S	P
112	*Astragalus podolobus* Bioiss. & Hohen	Ch	IT	-	S	P
113	*Astragalus pycnocephalus* Fischer	Ch	IT	-	S	P
114	*Astragalus schistosus* Boiss.&Hohen	He	IT	Vu	H	P
115	*Astragalus scleroclodus*	Ch	IT	Vu	S	P
116	*Astragalus verus* Boiss & Hausskn.	Ch	IT	LR	S	P
117	*Onobrychis cornuta* (L.) Desv.	Ch	IT	-	S	P
118	*Onobrychis melanotricuma* Boiss	He	IT	-	H	P
119	*Trigonella monantha* C.A. Mey.	Th	IT	-	H	A
	Phyllanthaceae					
120	*Andrachne telephioides* L.	He	IT, M	-	H	A
	Plantaginaceae					
121	*Plantago major* L.	He	-	-	H	P
	Plumbaginaceae					
122	*Acantholimon aspadanum* Bunge	Ch	IT (End.)	-	S	P
123	*Acantholimon festocaceum* (Jaub. at Sp.)	Ch	IT	-	S	P
124	*Acantholimon scorpius* (Jaub. & Spach)	Ch	IT (End.)	LR	S	P
125	*Acantholimon oliganthum* Boiss	Ch	IT	-	S	P
	Poaceae					
126	*Agropyrom intermedium* (Host) P.	He	-	-	H	P
127	*Agropyrom tauri* Boiss. & Bal.	He	-	-	H	P
128	*Boissiera squarrosa* Hochst. ex Steud	Th	IT, ES, M	-	H	A
129	*Bromus danthoniae* Trin. ex C.A.Mey.	Th	IT	-	H	A
130	*Bromus tectorum* L.	Th	IT, ES, M	-	H	A
131	*Bromus tomentellus* Boiss.	He	IT, ES	Vu	H	P
132	*Cynodon dactylon* (L.) Pers.	Cr	Cosm	-	H	P
133	*Dactylis glomerata* L.	He	IT, ES, M	-	H	P
134	*Eremopoa persica* (Trin.) Roshev.	Th	IT, M	-	H	A
135	*Eremopyrum bonaepartis* (Spreng.)	Th	IT	-	H	A
136	*Eremopyrum distans* (K.Koch) Nevski	Th	IT, ES	-	H	A
137	*Hordeum bulbosum* L.	Cr	IT	-	H	P
138	*Hordeum vulgare* L.	Th	IT	-	H	A
139	*Lolium rigidum* Gaudin	He	IT	-	H	P
140	*Melica persica* Kunth	He	IT (End.)	LR	H	P
141	*Oryzopsis holciformis* (M.B.) Hack	He	IT	-	H	P
142	*Poa bulbosa* L.	Cr	IT, ES	-	H	P
143	*Poa sinaica* Steud.	He	IT, SA	-	H	P
144	*Stipa barbata* Defs	He	IT, ES	-	H	P
145	*Stipagrostis plumosa* Munro ex	He	IT	-	H	P
	Polygonaceae					
146	*Atraphaxis spinosa* L.	Ph	IT	-	T	P
	Ranunculaceae					
147	*Adonis aestivalis* L.	Th	IT	-	H	A
148	*Thalictrum minus* L.	Cr	IT	-	H	A
	Resedaceae					
149	*Reseda buhseana* Mull.Arg	He	IT (End.)	-	H	P
150	*Reseda lutea* L.	He	IT (End.)	-	H	P
	Rosaceae					
151	*Amygdalus scoparia* Spach	Ph	IT	Vu	T	P
152	*Poterium sanguisorba* L.	He	IT (End.)	Vu	H	P
	Rubiaceae					
153	*Gaillonia bruguieri* A.Rich. ex DC.	Th	IT,SS	-	H	A
154	*Rubia florida* Boiss.	He	IT (End.)	LR	H	P
	Scrophulariaceae					
155	*Scrophularia leucoclada* Bunge	Ch	IT	-	H	P
156	*Scrophularia striata* Boiss.	Ch	IT	LR	H	P
157	*Verbascum songaricum* Schrenk	He	IT,ES	-	H	P
158	*Verbascum speciosum* Schrad.	He	IT, ES	-	H	P

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/1501_415428

	Solanacea					
159	*Hyoscyamus nigrum*	He	IT	LR	H	P
160	*Lycium depressum* Stocks.	Ph	IT	-	T	P
	Tamaricaceae					
161	*Tamarix ramosissima* Ledeb.	Ph	IT, ES	-	T	P
	Thymelaeaceae					
162	*Dendrostellera lessertii* (Wikstr.) Van Tigeh	Ch	IT	-	H	P
	Zygophyllaceae					
163	*Peganum harmala* L	He	IT, ES, M	-	H	P
164	*Zygophyllum fabago* L.	He	IT	LR	H	P

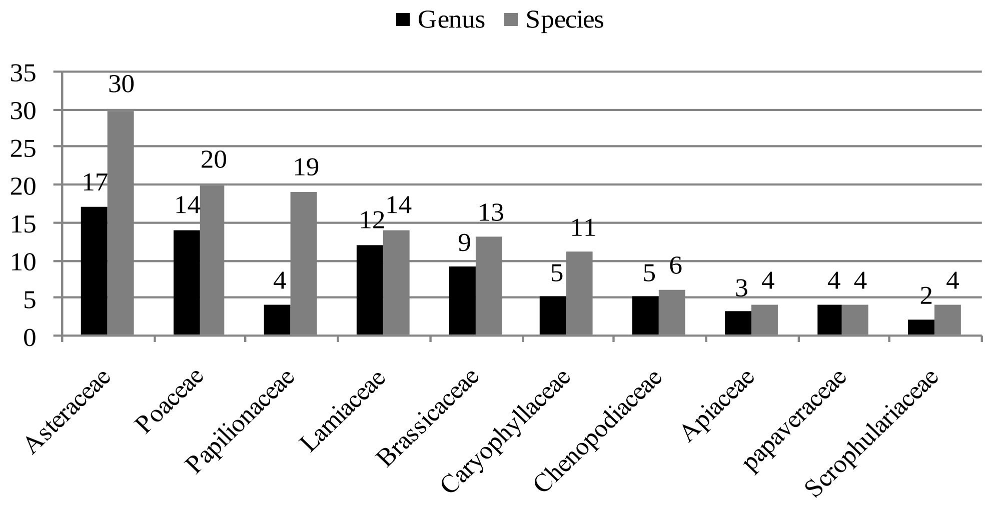

Figure 2. *The large ten families in terms of the number of genera and species in the area*

Biological spectrum

Hemicryptophytes were the dominant life forms accounting for 50% (82 species) of all species in the area, followed by chamaephytes (25.6%), therophytes (14.6%), cryptophytes (6.1%), and phanerophytes (3.7%). The comparison of the floristic life-form spectrum and Raunkiaer's normal spectrum pointed out a statistically significant difference between them ($p<0.05$). The observed proportions were higher than expected for the chamaephytes, hemicryptophytes, and therophytes, and they were lower for the phanerophytes. Phanerophytes, followed by chamaephytes and hemicryptophytes, had the highest individual values determined from the χ^2 test *(Table 2)*.

Table 2. *Comparison among life-form spectra and Raunkiaer's normal spectra in the Meymeh region (For Abbreviation, see Table 1).*

Life- form	**Ph**	**Ch**	**He**	**Cr**	**Th**	**Total**
Number of species	6	42	82	10	24	164
Percentage of plant species	4	26	50	6	14	100
Raunkiaer's normal spectrum (% of species)	46	9	26	6	13	100
Percentage Deviation	-42	17	24	0	1	-
χ^2	38.35	32.11	22.15	0.00	0.08	92.69

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/1501_415428

The comparison of the life form spectrum of the case study with different studies in the Irano-Turanian growth zone is presented in Table 3. There were some differences and likenesses between the studies. The results of the χ^2 test and correlation analysis demonstrated a significant correlation between the life-form spectrum in the area and those of other studies conducted in the vicinity of the area, particularly the Karkas hunting prohibited region ($\chi^2 = 8, P = 0.001$) and Yahya Abad region ($\chi^2 = 20.3, P = 0.01$).

Table 3. *Comparison of different items in the study area and other studies conducted in Irano-Turanian Region (For Abbreviation, see Table 1).*

References	**This study**	**Batooli *et al.*, 2003**	**Abbasi *et al.*, 2012**	**Khajeddin *et al.*, 2012**	**Yousofi *et al.*, 2011**	**Rahchamani *et al.*, 2014**
Location	Meymeh	Qazaan	Yahya Abad	karkas	Chadegan	Sarigol
Elevation	2004-3157	1600-3550	2000-2720	1389-3880	1950-3915	1400-2840
Annual rainfall (mm)	177	181.5	147.22	240	324.3	273
Annual temperature (°C)	12	6.8	15.41	2.1	9.8	14
Ph	4	10.8	1.6	7.9	5	7.4
Ch	26	8.2	18.4	16.9	11	10.5
H	50	35.4	44.7	51.8	44	33.9
Cr	6	8.5	6.3	5.7	13	13.3
Th	14	36.9	29	17.7	27	34.9
Total species	164	398	190	278	339	498
χ^2 with this study	0.0	66.5	20.3	8.0	29.9	57.4
Pearson Correlation	1.00	0.53	0.88*	0.96**	0.81	0.56

** Correlation is significant at the 0.01 level (*p<0:001*); *Correlation is significant at the 0.05 level (*p<0:01*).

Chorological affinities

About 74.4% of total plant species in the area belonged to the Irano-Turanian chorotype, whereas Irano Turanian-Euro Siberian, Irano Turanian-Mediterranean, and Irano Turanian-Euro Siberian-Mediterranean plant species contained 13.4%, 5.5%, and 2.4%, respectively, of all plant species. Less than 4.3% of the total plant species belonged to other chorotypes *(Table 4)*. The number of endemic species was 37, and the endemism rate was 22.6%.

Table 4. *The Chorological affinities of plant species in the Meymeh region (For Abbreviation, see Table 1).*

Chorotypes	**Number of species**	**Percentage of species**
Monoregional		
IT	85	51.8
Biregional		
IT, ES	22	13.4
IT, M	9	5.5
IT, SA	1	0.6
IT,SS	1	0.6
Pluriregional		
IT, ES, M	4	2.4
IT, SS, ES, M	1	0.6
IT,M,SS	1	0.6
Cosmopolitan	3	1.8
Endemic	37	22.6
Total	164	100

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/1501_415428

IUCN categories

The threatened species of the Meymeh region were evaluated on the basis of the criteria given by Jalili and Jamzad (1999) for assessing threat levels. Accordingly, 36 species (22%) were situated in the different stages of the method. Ten and 26 species were ranked as vulnerable and lower risk, respectively. The herbaceous perennial species accounted for 72% (26 species) of the total threatened species, and 47.2% (17 species) of them belonged to Irano-Turanian endemic species. Moreover, the families Asteraceae, Papilionaceae, and Poaceae were treated as the most important families as 16.7% (6 species) of their total species were allocated to the categories of threatened species *(Fig. 3).*

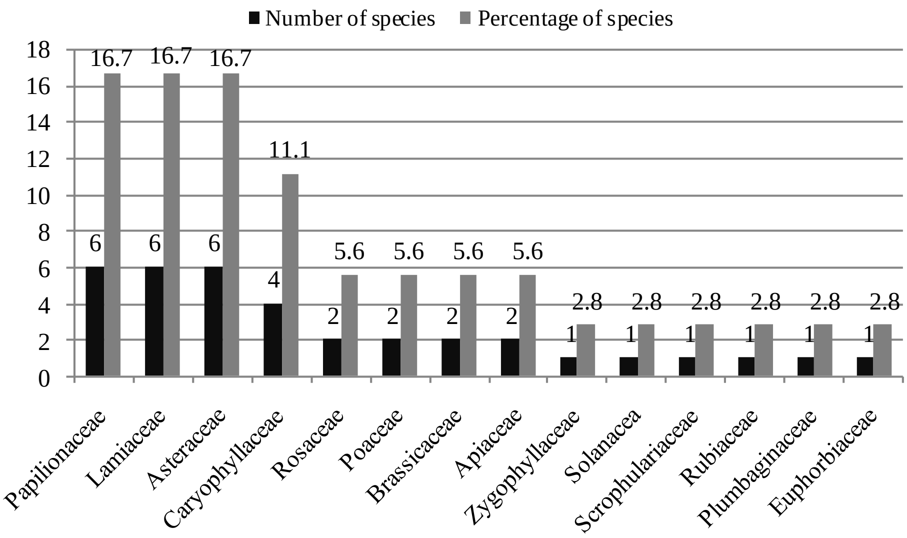

Figure 3. *The most important families in terms of having the largest number of species in the categories of threatened species.*

Discussion

The presence of 164 plant species belonging to 108 genera and 32 families indicates a considerable level of plant diversity in the study area. These species have formed diverse communities tailored to their ecological needs and the management imposed by humans over the past years. It seems that high plant diversity in the area is due to edaphic, topographic, and physiographic conditions. Of course, the climatic factor is also effective in this regard, but variations in climatic conditions of the area are less than the other factors (Khajeddin et al., 2012).

Asteraceae, Poaceae, and Papilionaceae were among the richest families in the area which is due to the high compatibility of these families with the arid and semiarid climate conditions. They are common compared to other plant families in the Irano-Turanian growth zone (Aghaei et al., 2013; Jafari et al., 2016), especially in the central region of Iran (Yousofi et al., 2011; Abbasi et al., 2012; Khajeddin et al., 2012). In addition, the high frequency of Asteraceae may be related to the high percentage of vegetation destruction in the area (Archibold, 1995). Compared with the nearby Karkas hunting-prohibited region (Khajeddin et al., 2012), there are fewer

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/1501_415428

species of flora in the Meymeh region. This is probably due to the higher habitat diversity along the Karkas Mountains.

In this study, the main fraction of species composition was *Artemisia aucheri*/*Artemisia sieberi* gradient. Distribution of these two species was contrasting, as *Artemisia sieberi* was the most dominant species at low altitude and that was gradually replaced by *Artemisia aucheri* at higher altitude. This finding is in agreement with the results of study conducted by Mousaei Sanjerehei et al., (2013), in which it was shown that distribution of these two species is associated to the complex environmental variations along the altitudinal gradient.

According to Raunkiaer's system, the life-form composition in the Meymeh region was dominated by hemicryptophytes followed by chamaephytes and therophytes in succession. The low percentages of cryptophytes and phanerophytes show that they are not adapted to climatic conditions in the region. A comparison of the life-form spectra of the area with those in the Karkas hunting-prohibited region (Khajeddin et al., 2012) and pastural region of Yahya Abad (Abbasi et al., 2012) showed the same results. In all the studies conducted in the Irano-Turanian growth zone, hemicryptophytes and phanerophytes usually comprise the highest and lowest percentages of life forms, respectively *(Table 3)*. Hemicryptophytes are a large and complex life-form group with the resting bud at or near the soil surface. The frequency of the life form in the flora of the area is characteristic of the cool steppe region (Cain, 1950) and also indicates the dominance of cold and mountainous climates (Arcihold, 1995). Furthermore, the high percentage of chamaephytes characterized the colder climate and high altitude (Braun-Blanquet, 1932). Chamaephytes are often protected in the unfavorable season by fallen leaves or by the dense growth of the plant itself. In this life form, the species that provide the greatest protection of the buds are undoubtedly the very compact cushion plants such as *Astragalus spp*, *Acanthophyllum spp*, and *Acantholimonsp spp* in certain dry steppes (Cain, 1950). This type of plants was fairly common in the area, comprising about 15% (24 species) of all the available species. The remarkably high percentages of hemicryptophytes and chamaephytes (76% for both) were also emphasized. Hemicryptophytes are always abundant in areas where chamaephytes are abundant, but they show no consistent trend (Cain, 1950).

Next in abundance were the therophytes, which indicate the existence of a heavy biotic pressure due to overgrazing and human interference. Low rainfall levels, high temperatures, consecutive droughts, a short growing season, and various factors of destruction such as overgrazing and agriculture were the most important factors for the increase of therophytes; this result was consistent with the results of studies conducted by Raunkiaer (1934) and Cain (1950), in which it was shown that the increase of therophytes reflects an effective strategy for avoiding water loss. Although therophytes occur abundantly in desert areas (Archibold, 1995), more or less, the high occurrence of the life form indicates there are some anthropogenic and overgrazing effects in the study areas (Grime, 2001; Ravanbakhsh et al., 2014).

Results of the χ^2 test showed that Raunkiaer's normal spectrum was significantly different from the amount of phanerophytes, hemicryptophytes, and chamaephytes, while the differences between the amounts of cryptophytes and therophytes are not significant. The phanerophytes showed a maximum divergence from the normal spectrum. There was less of them than that of Raunkiaer's normal spectrum, which may be related to dryness of the region. This change seems much more significant

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/1501_415428

and true to the climatic differences than those in other life forms, because the phanerophytes occur in the most favorable climates with high temperatures and humidity (Cain, 1950). The total number of chamaephytes was higher than that of Raunkiaer's normal spectrum. This finding can be related to the cold and mountainous conditions of the region and is in agreement with the results reported by Cain (1950) that demonstrated the positive correlation of this class' percentage with increasingly high altitudes, especially in areas with such widely diverse vegetation types as certain steppes. The hemicryptophytes reached a maximum in the area, where they were at about double the normal spectrum. This finding shows that they are adapted to the cold steppe climate of the area. Many species belonging to the Irano-Turanian phytogeographic region were found in this study, indicating that the study area belongs to this growth zone. In the flora of adjoining areas and even neighboring countries such as Turkey (Vural, 2005), Pakistan and Afghanistan (Rechinger, 1963–2010), Irano-Turanian elements compose a large proportion of the total species (Akhani, 2006), which represents the homogeneity of this growth zone (Abbasi et al., 2012).

The results of the assessment of threatened species showed that most belonged to herbaceous perennial species, which is consistent with the results reported in Jalili and Jamzad (1999) that demonstrated that herbaceous perennial species accounted for 71% of the total threatened species in Iran. Also, the same results were also obtained in Karkas hunting prohibited region (Khajeddin et al., 2012). Various factors caused the increase in numbers of vulnerable species in the area. Overgrazing was a major cause which led to the destruction of *Astragalus schistosus*, *Poterium sanguisorba*, *Ferula ovina* and *Bromus tomentellus* habitats. In contrast, finite population and low natural reproduction were determined to be the factors most effective on the vulnerability of *Astragalus scleroclodus* and *Salvia eremophila*. *Cousinia piptocephala* and *Zataria multiflora* the endemic species of the Irano-Turanian growth zone that established in individual habitats in terms of edaphic and biological characteristics. The most important factor that caused the deterioration of these species was human activity, such as overexploitation of the plant and land use change.

Conclusion

This study supports the general hypotheses; tests demonstrated that plant communities in areas that have a cold steppe climate with dry summers and relatively wet winters in the central plateau of Iran would have a high proportion of hemicryptophyte species belonging to the Irano-Turanian growth zone.

Besides the variations in species composition, the composition of life forms reflects the response of vegetation to variations in certain environmental factors. In this study, the dominance of hemicryptophytes, chamaephytes, and therophytes over other life forms seems to be a response to the cold steppe climate, high altitude, and human activities. Regardless of the type of ecosystem, it was noted that overgrazing in some parts of the area, especially in the lowlands, had led to the occupation of the area by invasive therophytes, indicating hyper-degradation. Therefore, overgrazing is viewed as a major cause of the deterioration of vegetation in the area. The best solution for sustainable management of the area would be to comply with the proper principles of range management aimed at reducing the intensity of grazing and prolonging exclosure.

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/1501_415428

This study provides fundamental data about the flora of the area by means of a thorough botanical inventory. These findings will have special significance for further ecological research and for recommendations of proper guidance for the management, reclamation, and development of the area and other similar regions.

REFERENCES

[1] Abbasi, S., Afsharzadeh, S., Mohajeri, A. (2012): Study of flora, life forms and chorotypes of plant elements in pastural region of Yahya Abad (Natanz). – Iranian Journal of Plant Biology 11(4): 1-12.
[2] Aghaei, R., Alvaninejad, S., Zolfaghari, R.,Gharehlar, M.R.M. (2013): Flora, life form and geographical distribution of plants in West-South forests of Iran (Case study: Vezg, Yasouj). – International Journal Farming and Allied Sciences 2(23): 1046-1053.
[3] Akhani, H. (2006): Flora Iranica: facts and figures and a list of publications by K.H. Rechinger on Iran and adjacent areas. – Rostaniha 7: 19–61.
[4] Archibold, O.W. (1995): Ecology of world vegetation. – Chapman and Hall Inc, London.
[5] Asri, Y. (2003): Plant Diversity in Touran Biosphere Reservoir. – Research Institute of Forests and Rangelands press, Tehran.
[6] Batooli, H. (2003): Biodiversity and species richness of plant elements in Qazaan reserve of Kashan. – Pajouheh & Sazandegi 61: 85-103.
[7] Braun-Blanquet, J. (1932): Plant sociology. – Macgran- Hill, New York/London.
[8] Cain, S.A. (1950): Life-forms and phytoclimate. – The Botanical Review 16(1): 1-32.
[9] Davis, P.H. (1965-1988): Flora of Turkey and the East Aegean Island. – Edinburgh University Press, London.
[10] Djamali, M., Brewer, S., Breckle, S.W., Jackson, S.T. (2012): Climatic determinism in phytogeographic regionalization: A test from the Irano-Turanian region, SW and Central Asia. – Flora 207: 237– 249.
[11] Ghahraman, A. (1975-2005): Colored Flora of Iran. – Research Institute of Forests and Rangelands Press, Tehran.
[12] Ghahreman, A., Attar, F. (1999): Biodiversity of Plant Species in Iran. – Vol. 1, Tehran University press, Iran.
[13] Grime, J.P. (2001): Plant strategies, vegetation processes and ecosystem properties. – John Wiley and Sons Inc, New York.
[14] IUCN. (1981): How to use the IUCN Red Data Book Categories. Threatened plants Committee Secretariat. – IUCN, Kew.
[15] Jafari, Z., Kianian, M.K., Aslani, F., Akbarlo, M. (2016): Floristic Composition, Life Forms and Geographical Distribution (Case Study: Lashgardar Rangelands of Malayer, Iran). – Journal of Environmental Science and Technology 9 (1): 140-148.
[16] Jalili, A., Jamzad, Z. (1999): Red data book of Iran. – Research institute of Forests and Rangelands. Tehran.
[17] Khajeddin, S.J., Yeganeh, H. (2012): The flora, life form and endangered species of karkas hunting prohibited region, Isfahan, Iran. – Iranian Journal of Biology 25 (1): 7-20.
[18] Mabberley, D.J. (2008): The Plant- Book, Aprotable dictionary of Higher Plants. – Cambridge University Press.
[19] Mobayen, S. (1975-1996): Flora of Iran, Vascular Plants. – Vol. 1-4, Tehran University Press, Iran.
[20] Moradi, G.h., Marvie, M.R., Zahedi, G.h., Shirvany, A., Zargham, N. (2010): Life form and geographical distribution of plants in Posthband region, Khonj, Fars Province, Iran. – Journal of Forestry Research 21(2): 201-206.

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/1501_415428

[21] Mousaei Sanjerehei., M. (2012): Soil-Vegetation Relationships in Arid Rangelands (Case Study: Nodushan Rangelands of Yazd, Iran). – World Academy of Science, Engineering and Technology 6: 7-23.
[22] Muller-Dombois, D., Ellenberg, H. (1974): Aims and Methods of Vegetation Ecology. – John Wiley and Sons, New York.
[23] Nimais, P.L. (1985): Structure and floristic composition of high-arctic tundra: Ny-Alesund (Svalbard Archipelag). – Nordic Journal of Botany 17: 47-58.
[24] Rahchamani, N., Ezazi, A., Ghahremaninejad, F. (2014): The flora of Sarigol National Park, Northern Khorassan Province. – Journal of Biodiversity and Environmental Sciences 4 (6): 278-307.
[25] Ramak Masoumi, A. (1986-2000): Astragalus communities of Iran. – Vol. 1-4, Publishing Research Institute of Forests and Rangelands Press, Tehran.
[26] Raunkiaer, C. (1934): The life forms of plants and statistical geographical. – Oxford: Clarendon Press.
[27] Ravanbakhsh, M., Amini, T. (2014): A Study on Floristic Composition, Chorology and Ecological Structure: A case Study from a Small-scale Forest Reserve, Talesh, Iran. – IUFS Journal of Biology 73(1): 43-51
[28] Rechinger, K.H. (1963-2010): Flora Iranica. – Vol. 1-178. Akademische Druck-U, Verlagsanstalt, Graz. Austria.
[29] Vural, C. (2005): The Flora of Erciyes DaÛÝ (Kayseri, Turkey). – Turkish Journal of Botany 29: 185-236.
[30] Yousofi, M., Safari, R., Nowroozi, M. (2011): An investigation of the flora of the Chadegan region in Isfahan province. – Journal of Plant Biology 3(19): 75-96.
[31] Zohary, M. (1963): On the geobotanical structure of Iran. – Weizmann Science Press of Israel, Jerusalem.
[32] Zohary, M. (1973): Geobotanical Foundation of the Middle-East. – Vol 1-2. Department of Botany, Gustav Fischer Verlag, Stuttgart.

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/1501_415428