



Flora of Jahanbin Mountain Area: A Contribution to Flora of the Central Zagros Region of Iran

Masoumeh Jalali¹, Majid Sharifi-Tehrani^{1*} and Hamze-Ali Shirmardi²

¹Department of Biology, University of Shahrekord, Shahrekord, Iran

²Research Institute of Agriculture and Natural Resources, Shahrekord, Iran

*Corresponding author: sharifi-m@sci.sku.ac.ir

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Abstract

Flora of Jahanbin mountain area in Chaharmahal and Bakhtiari province, located between Shahrekord and Hafshejan cities, with 12'187 hectares and 2'150 to 3'300 m elevation above sea level, is investigated. Vegetation of this area comprises of 273 species, 189 genera and 42 families. Asteraceae (37 species, 13.5%), Poaceae (31 species, 11.3%) and Fabaceae (25 species, 9.1%) were the most important families regarding the number of species. The largest genera were *Astragalus* (9 species), *Euphorbia* (8 species), *Silene*, *Hordeum*, *Ranunculus*, *Salvia* (5 species each) and *Galium*, *Centaurea*, *Scorzonera*, *Bunium* (4 species each). Dominant life forms in this area were Hemicryptophytes and Therophytes. 149 species (55%) were native to Irano-Turanian region, 77 species (28%) pluri-regional, and 41 species (15%) shared elements between IT and neighboring regions (Euro-Siberian, Mediterranean, or Saharo-Sindian). This study reports also results of the first multivariate analysis of presence/absence data of floristic data in Iran, for a 14 flora x 1541 species matrix. Three main clusters of local floras emerged in resultant plots, separating the floras in western and eastern hillsides of Zagros, and based also on the climatic differences in northern and southern parts of the province in the eastern hillside. Our study demonstrated the applications of multivariate technics for comparative floristic analyses.

Key words: Distribution; Endemics; Flora; Jahanbin; Life forms; Zagros

Introduction

Zagros region of Iran has been a mountain steppe during the last glaciation of the earth, with *Cousinia* and *Tulipa* species as abundant elements in this flora (Djamali et al., 2009; Djamali et al., 2011). Plant biodiversity in Zagros was affected by changes in species ranges in post-glacial rebound, and its species richness was increased. The extent of this mountain chain in Chaharmahal and Bakhtiari province spans from NW to SE and Zardkuh-Bakhtiari peaks (4548 m) in Bazoft is covered by permanent snow (Omidvar et al., 2010). The oldest rocks in this region belong to Precambrian and consists of igneous and metamorphic rocks, and the newest sediments are related to Quaternary (Omidvar et al., 2010). The climate of this region is cold semi-humid. Annual average temperature is 11.29 °C and annual precipitation is 770 mm. A prominent feature of this region is the absence of forest vegetation and the presence of annual grasses and forbs. Temperature, precipitation,

and radiation are major factors affecting the distribution of species habitats (Soltani and Modarres, 2006; Soltani et al., 2007). Rainfall diet in this region is Mediterranean and the dry period coincides with the summer months and much of the rainfall occurs in early December to late April. The reported rainfall from different stations in the province including Koohrang; 1414 mm, Borujen; 542 mm, Shahrekord; 319 mm, and Lordegan; 905 mm (Soltani and Modarres, 2006). Variations in micro-climates, altitude (900-4200 m), topography and soil type in Chaharmahal and Bakhtiari, has helped the floristic richness, despite overgrazing and excessive exploitation of vegetation. Previous floristic studies in this region (Fig. 1 and Table 1) have been mainly carried out with an emphasis on protected and under-management areas (Shahrokhi, 2005; Pairanj et al., 2011; Heydari-Ghahfarokhi et al., 2013; Shirmardi et al., 2014a; Shirmardi et al., 2014b; Dehghani, 2015).

Table 1. Adjacent local floras to Mt. Jahanbin. Numbers matching to number on Fig. 1B.

#	Flora	Coordinates	Temp.	Prec.	Alt.	Area (ha)	Spec.	Year publ.
1	Chadegan	N 32.80, E 50.66	9.8	324.3	1950-3915	10000	339	2011
2	Sheida	N 32.58, E 50.66	10.8	435	2100-3165	22164	316	unpubl.
3	Karsanak	N 32.53, E 50.47	12	425	2603	573	188	2011, unpubl.
4	Mt Sheet	N 32.34, E 50.87	13.18	349	2110-2660	1100	213	2015
5	Shimbar	N 32.13, E 49.48	6-34	412	400-3400	53000	189	2015
6	Gheysari	N 32.16, E 50.34	-	-	1811-3541	9816	487	2014, 2011
7	Mt Jahanbin	N 32.17, E 50.75	(-8)-22.8	324.35	2150-3300	12187	273	2016
8	Tang-e Sayad	N 32.50, E 50.98	11.6	304.6	2720	27000	236	2012
9	Mt Kallar	N 31.82, E 50.95	10.45	511.4	1900-3814	-	514	2012
10	Helen PA	N 32.72, E 50.66	-	-	-	40231	392	2014
11	Vanak	N 31.47, E 51.27	(-19)-38	398	1450-4034	40000	649	2004
12	Hana	N 31.05, E 51.67	10.8	382.5	2389-3050	20452	307	2010
13	Alaa	N 31.12, E 49.67	-	-	339-3597	229903	382	2011
14	Ban	N 30.66, E 50.22	24.5	350	540-1701	2125	202	2010

Many parts of the region, especially in areas that are not under management, are not studied. A solid understanding of the status of diversity in the Central Zagros region of Iran requires sufficient floristic inventory and diversity assessment studies. Mountain Jahanbin and its surrounding hillsides (2150-3300 m) with an area of 12187 ha (Fig. 1) is located in North of Hafshejan City, 20 km from Shahrekord. The climate of the region is very humid according to De Marton's classification or Elevations according to Amberje (Soltani and Modarres, 2006). The study area is not under management and suffers from certain human exploitations (harvesting of medicinal plants and grazing of livestock). There are three main springs at foothills which are used as promenades: Cheshmeh-Zaneh at south, Cheshmeh-Vaghtossae at SW and Cheshmeh Sarab at N foothills. In this study, we investigated the flora of Mt. Jahanbin, for an introduction to the medicinal, range, rare and endangered species, as well as presenting a checklist of plant species. Multivariate analysis of occurrence (presence/absence of plant species) data in 14 neighboring local floras in the Central Zagros Region is performed for the first time, showing relative floristic similarities between the local flora.

Materials and Methods

The boundaries of the studied area (N32.255, E50.654 - N32.113, E50.835) were determined by using satellite maps in the GoogleEarth software package (Google, 2013). A total of 616 plant specimens were collected from April

2014 to June 2015, then identified and deposited in the herbarium at the University of Shahrekord (SKU). Determination of specimens was performed by referring to available identification keys mainly in Flora Iranica (Rechinger, 1963-2012), Flora of Iran (Assadi, 1989-2012) and Flora of Turkey (Davis, 1965-1985). An inventory of species names for the study area was created and the correct spelling of names were checked by using a recently published database software 'CheckName' (Sharifi-Tehrani, 2014), comprising names, authority, and publication bibliographic records for plants of Iran, retrieved from IPNI database (IPNI, 2015). Chorotype and life-form of each species were extracted from available literature (Rechinger, 1963-2012 among others). Floristic inventories of 13 adjacent local floras (Table 1) were collected into a dataset and were checked for spelling (Sharifi-Tehrani, 2014) and compared to our checklist (Table 2) using the developing iHerbs floristic database (Sharifi-Tehrani and Rahiminejad-Ranjbar, 2013). Exclusive species found in our study, analysis of floristic data and pie plots, and a data matrix comprising species occurrence data in the 14 related local flora (Table 1) were retrieved by using iHerbs database. Data matrix was analyzed using Dice [$S_{Dice} = 2a / (2a + b + c)$] and SMC ($SM = m/n$) coefficients for qualitative data. Analyses were conducted in NTSYSpc software package (Rohlf, 2000). Exploratory data analysis for finding the correct number of clusters in the multivariate analysis was performed by CLUTO software package (Karypis, 2003) and maximizing internal similarity inside each group while minimizing between groups similarities (Table 3).

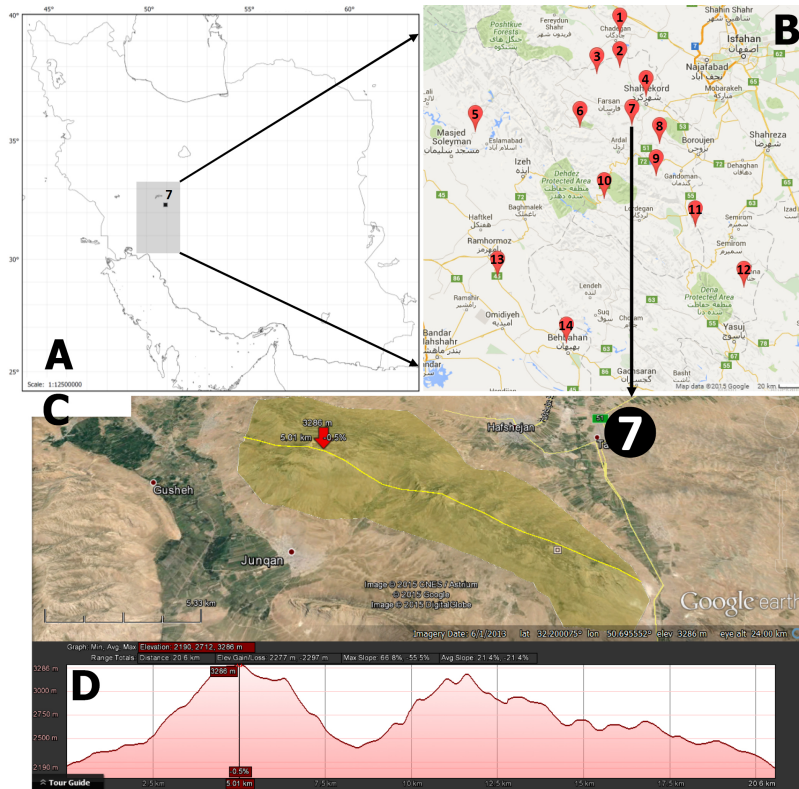


Fig. 1. Location of Mt. Jahanbin in the map of Iran (A) and among related floristic works in the central Zagros region (B). Satellite view of the Mt. Jahanbin (C), pointing the summit (3286 m), and the elevation profile of the Mt. Jahanbin (D) retrieves from Google Earth software package.

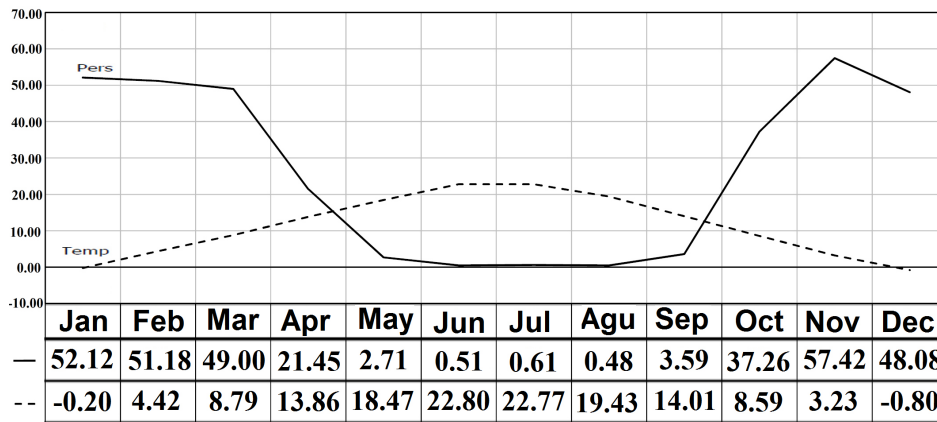


Fig. 2. Ambrothermic graph for Shahrekord station. Meteorology data of 12-years (1981-2014) retrieved from Shahrekord Meteorology station.

Results and Discussion

Flora of Mt. Jahanbin

Meteorology data (1981-2014) shows that the drought period in the study area spans from April to September (Fig. 2), and most of the rain (258 mm; 80%) falls in November to March. Frigid days occur from September to April most of them (27 days) occurring in December. Averaged maximum speed of wind

reach 15 km/h (Feb. and April), the average relative humidity in the study area reach 65 percent in December, and the average temperature reach maximum (22.8 C) in August, minimum (-0.8 C) in December. Flora of Mt. Jahanbin comprises of 42 families (35 dicots and 7 monocots), 189 genera and 273 species. Asteraceae (37 species, 13.5%), Poaceae (31 species, 11.3%) and Fabaceae (25 species, 9.1%) were the most important families regarding the number of species (Fig.

3A, C). Top ten large families regarding the number of genera are presented in Fig. 3B, E. The largest genera were *Astragalus* L. (9 species), *Euphorbia* L. (8 species), *Silene* L., *Hordeum* L., *Ranunculus* L., *Salvia* L. (5 species each) and *Galium* L., *Centaurea* L., *Scorzonera* L., *Bunium* L. (4 species each) (Fig. 3D). Determination of Raunkair life-forms showed that 42% of the species (115 species) were Hemicryptophytes, 33% (89 species) were Therophytes, 19% (51 species) were Cryptophytes, 4% (10 species) were Chamaephytes, and 2% (5 species) were phanerophytes (Fig. 5A). 149 species (55%) were native to Irano-Turanian region (Fig. 4A), 77 species (28%) were pluri-regional (Fig. 4A, B), 41 species (15%) were shared elements between IT and neighboring regions (Euro-Siberian, Mediterranean, or Sahar-Sindian), and 4 species (2%) were elements of neighboring regions that penetrated to IT region (Fig. 4A, D). 20 species (7%) were endemics to Flora of Iran (Fig. 5B), 17 species (6%) were of Low-Risk category and 3 (1%) of Vulnerable category (Fig. 5C). The studied flora comprised of 43% range plants, 35% medicinal and 22% weeds (117, 97 and 60 species respectively, as denoted in Table 1, Fig. 5-D). A higher percentage of therophytes and hemicryptophytes among other life forms could be attributed to the adaptations to the Mediterranean climate conditions in the Irano Turanian region (Zohary, 1973), and also be related to the intense grazing. Thorny and spiny forms like *Astragalus* spp., and poisonous species like *Euphorbia* spp. can better survive grazing and hence are among most abundant and diverse taxa in this region. Non-indigenous plant species constitute up to 45 percent of the flora, showing affinities between neighboring regions and flora.

Flora of the region

Thirteen inventories of adjacent local flora in the central Zagros region (Table 1) were cumulated and compared with the floristic inventory of Mt. Jahanbin (Table 2). Results revealed that there were 241 shared species between these 14 floras and that 28 species in Mt. Jahanbin were new in the overall region (denoted in Table 2 by asterisks). Total number of species present in the overall region consisting of 14 floras, was 1541, in which, flora of Mt. Jahanbin was the ninth richest flora. Flora of Vanak, Mt. Kallar, and Gheysari

were three top and most rich floras (Table 1). The overall region consisted of 95 families and 527 genera. Average species to family, species to genera and genera to family ratios were 16.22, 2.92 and 5.54, respectively. Low average species to genus ratio, is an indicative of Zagros region as being a refugium during last glaciation maximum (Mashkour et al., 2009), in which not all species of many genera and families survived in the central Zagros. However, the number of species reported for some genera (*Astragalus*; 78, *Euphorbia*; 26, and *Silene*; 26) is significantly higher in this region.

Top ten most rich families regarding the number of species are Asteraceae, Fabaceae, Poaceae, Brassicaceae, Apiaceae, Lamiaceae, Liliaceae, Scrophulariaceae and Rosaceae. Top ten most rich Genera are *Astragalus*, *Euphorbia*, *Silene*, *Centaurea* (19 spp), *Cousinia* (18), *Salvia* (17), *Trifolium* (16), *Scrophularia* (15), *Polygonum* (15) and *Nepeta* (15).

New reports for flora Mt. Jahanbin

Twenty-eight species (asterisks in Table 2) of species identified from flora Mt. Jahanbin, were not previously reported from the overall region consisting 13 floras. These include Iranian endemic species, *Fritillaria zagrica* Stapf., *Taraxacum roseum* Bornm., *Minuartia aucheriana* Bornm. and *Astragalus ecbatanus* Bunge, and the most notable species is *T. roseum*; a medicinal plant in 'vulnerable' category of the red list, which was previously only collected from two local floras; Mouteh and Savadkouh, since 1989 (Asri, 2008; Fallah et al., 2009). *Minuartia aucheriana* and *A. ecbatanus* were also notable new reports from Mt. Jahanbin, that are in the "low risk" category. *A. ecbatanus* was previously only known from seven local floras in Ilam and Lorestan provinces. *Minuartia aucheriana*, *Colpodium humile* Griseb., *Cousinia ardalensis* Attar & Djavadi, *Vicia tenuifolia* Roth. and *Asperula rechingeri* Ehrend. & Schönb.-Tem. are rare species had not previously reported by floristic studies in Iran. *Trigonella hamosa* L. is another rare species which has been reported just once from Qeshm Island in Persian Gulf (Attar et al., 2004). Collection of *Rumex sanguineus* L. a species with Euro-Siberian distribution, and *Ranunculus bulbosus* L. which were previously reported only from several local floras in

Hyrceanian region, also was interesting. Collection of these rare species from Mt. Jahanbin showed that flora of Central Zagros region merits more intense collections and there might be more biodiversity held there. An unfortunate phenomenon in this region is vast overgrazing of mountain pastures by

sheep and goats, even in areas under management.

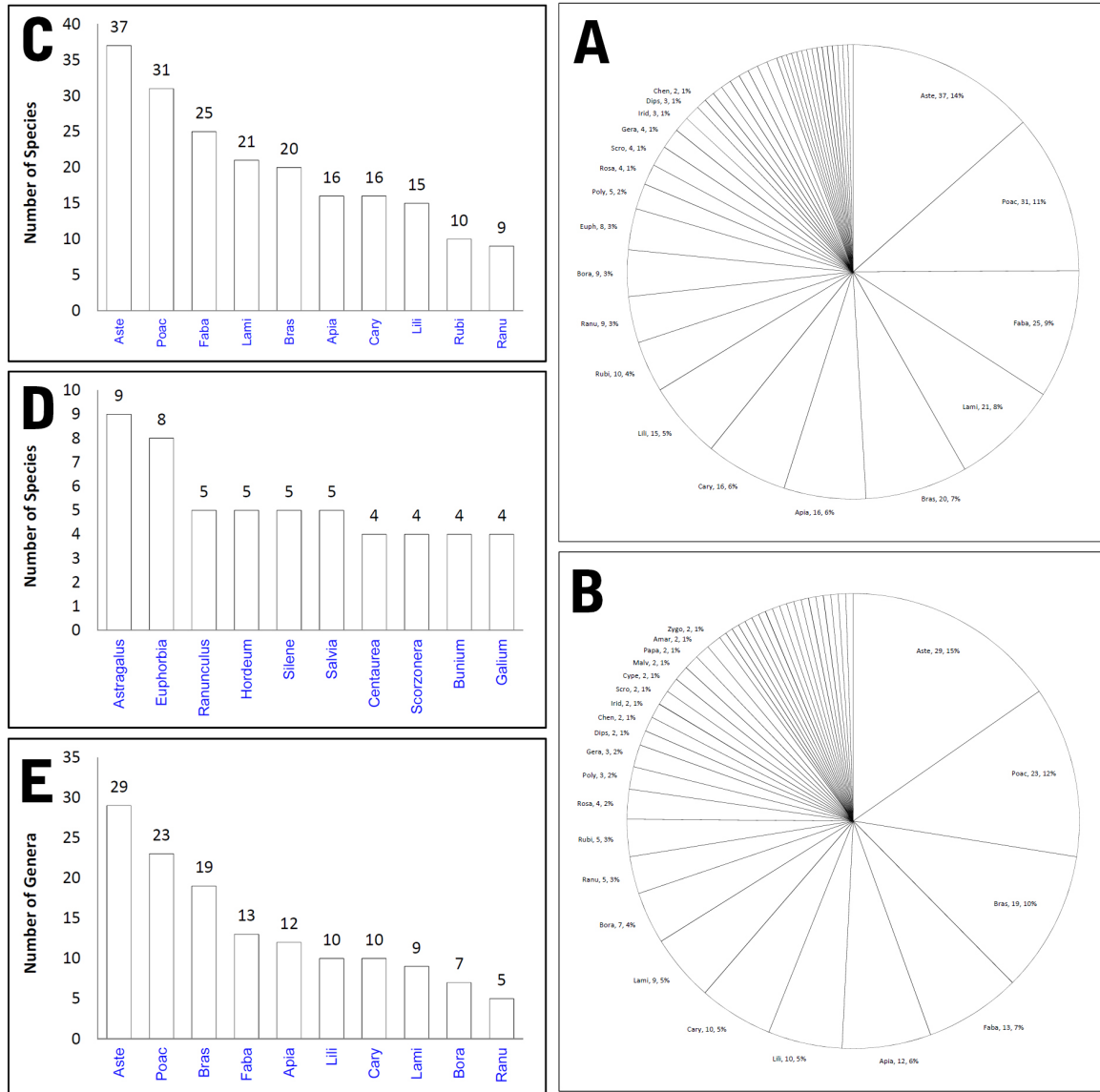


Fig. 3. Most important families and genera in flora of Mt. Jahanbin. A: number and percent of species in each Family. Poac: Poaceae, Faba: Fabaceae, Bras: Brassicaceae, Lami: Lamiaceae, Cary: Caryophyllaceae, Apia: Apiaceae, Lili: Liliaceae, Rubi: Rubiaceae, Bora: Boraginaceae, Ranu: Ranunculaceae, Euph: Euphorbiaceae, Poly: Polygonaceae. B: Number of species in each of ten most rich genera.

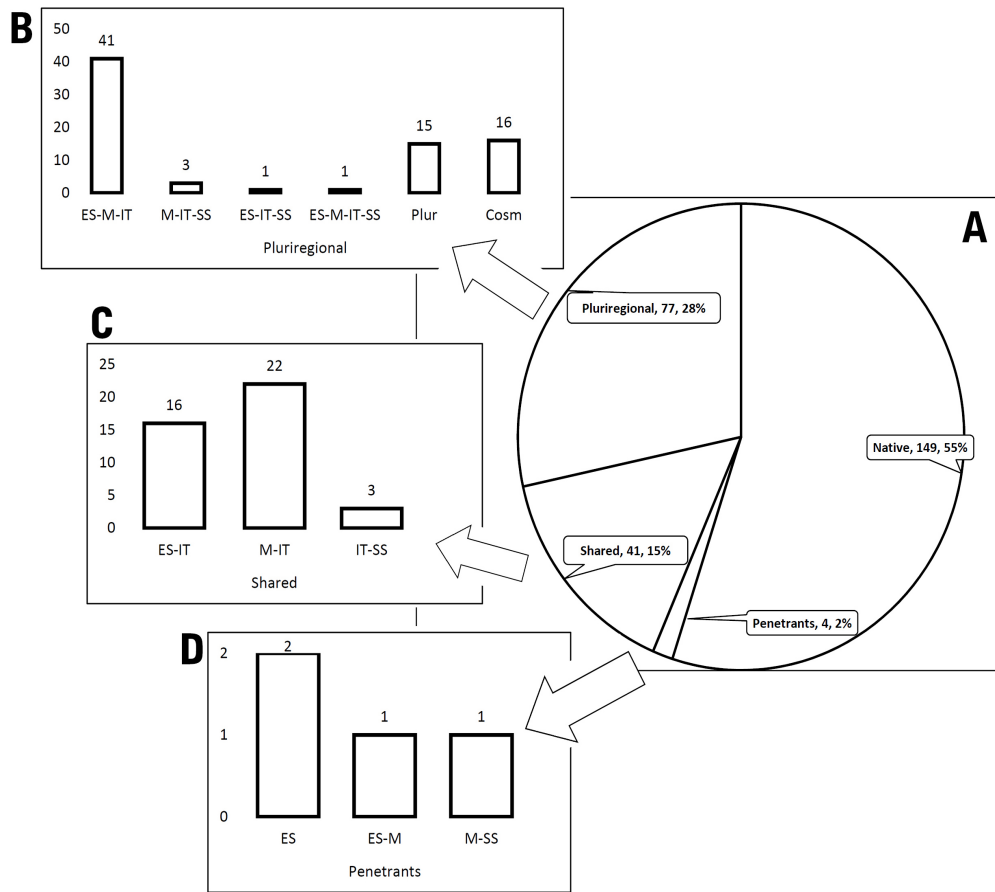


Fig. 4. Chorotypes. ES: Euro Siberian, M: Mediterranean, IT: IranoTuranian, SS: SaharoSindian.

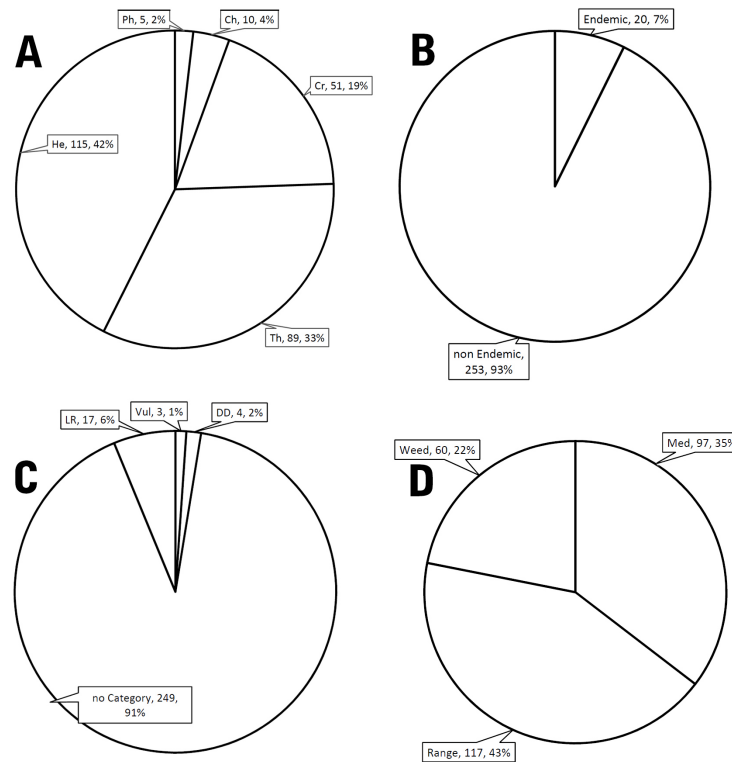


Fig. 5. A: Life forms, Ph: Phanerophytes, He: Hemicryptophytes, Th: Therophytes, Ge: Geophytes, Ch: Chamaephytes, Cr: Cryptophytes. B: Endemics. C: Conservation status categories. D: Usage importance, Med: medicinal plants.

Table 2. Floristic inventory of Mt. Jahanbin, with classification, Chorotype (CT), Life Form (LF), Conservation status (Cons), Endemism (Endem) and importance (imp) of each species. ES: EuroSiberian, M: Mediterranean, IT: IranoTuranian, SS: SaharoSindian, Ph: Phanerophyte, He: Hemicriptophyte, Th: Therophyte, Ge: Geophyte, Ch: Chamaephyte, Cr: Cryptophyte, End: Endemic to flora of Iran, Vu: Vulnerable, LR: LowRisk, DD: DataDeficit, Med: Medicinal plant, W: Weed, R: Range, *: New report from region (refer to text).

Family	Binominal authority	CT	LF	Cons	Endem	imp
Liliopsida						
Amaryllidaceae	<i>Ixiolirion tataricum</i> (Pall.) Herb. & Traub	ES-IT-SS	Cr	-		Med
	<i>Sternbergia clusiana</i> Ker Gawl. ex Schult.	IT	Th	-		Med, *
Araceae	<i>Arum conopthalloides</i> Kotschy ex Schott	IT	Cr	-		Med
Cyperaceae	<i>Carex stenophylla</i> Wahlenb.	IT	He	-		Range
	<i>Scirpoides holoschoenus</i> (L.) Sojak	Plur	Cr	-		Range
Iridaceae	<i>Gladiolus atrovioleaceus</i> Boiss.	IT	Cr	-		Med
	<i>Iris songarica</i> Schrenk	IT	Cr	-		Med
	<i>Iris spuria</i> L.	ES-M-IT	Cr	-		Med
Juncaceae	<i>Juncus inflexus</i> L.	Cosm	Cr	-		Range
Liliaceae	<i>Allium atrovioleaceum</i> Boiss.	IT	Cr	-		Med
	<i>Allium austroiranicum</i> R.M.Fritsch	IT	Cr	-		Med
	<i>Allium iranicum</i> (Wendelbo) Wendelbo	IT	Cr	-		Med
	<i>Bellevallia glauca</i> Kunth	IT	Cr	-		Range
	<i>Colchicum speciosum</i> Steven	ES	Cr	-		Med
	<i>Colchicum wendelboi</i> K.Perss.	IT	Cr	-		Med
	<i>Eremurus persicus</i> Boiss.	IT	Cr	-		Med
	<i>Fritillaria imperialis</i> L.	IT	Cr	-		Med
	<i>Fritillaria zagrica</i> Stapf.	IT	Cr	-	End	Weed, *
	<i>Gagea gageoides</i> (Zucc.) Vved.	IT	Cr	-		Range
	<i>Muscari neglectum</i> Guss. ex Ten.	ES-M-IT	Cr	-		Range
	<i>Ornithogalum pycnanthum</i> Wendelbo	IT	Cr	LR	End	Range
	<i>Scilla persica</i> Hausskn.	IT	Cr	-		Range, *
	<i>Tulipa biflora</i> Pall.	IT	Cr	-		Med
	<i>Tulipa stylosa</i> Fisch. ex Fisch. & C.A.Mey.	IT	Cr	-		Med
	Poaceae (Gramineae)	<i>Aegilops triuncialis</i> L.	M-IT	Th	-	
<i>Agropyron tauri</i> Boiss. & Balansa		IT	He	-		Range
<i>Alopecurus apiatus</i> Ovcz.		ES-M-IT	He	-		Range
<i>Alopecurus myosuroides</i> Huds.		ES, Med,	Th	-		Range
		IT				
<i>Arrhenatherum kotschyi</i> Boiss.		IT	Cr	-		Range
<i>Boissiera squarrosa</i> (Banks & Sol.) Eig		IT	Th	-		Range
<i>Bromus danthoniae</i> Trin. ex C.A.Mey.		IT	Th	-		Weed
<i>Bromus tectorum</i> L.		Cosm	Th	-		Weed
<i>Bromus tomentellus</i> Boiss.		IT	He	LR		Range
<i>Catabrosa aquatica</i> (L.) P.Beauv.		Plur	Cr	-		Range
<i>Colpodium humile</i> Griseb.		-	-	-		Range, *
<i>Dactylis glomerata</i> L.		ES, Med,	He	-		Range
		IT				
<i>Festuca arundinacea</i> Schreb.		ES-IT	He	-		Range
<i>Festuca ovina</i> L.		Plur	He	-		Range
<i>Phragmites australis</i> (Cav.) Trin. ex Steud.		Cosm	Cr	-		Range
<i>Heterantherium piliferum</i> Hochst. ex Jaub. & Spach		IT	Th	-		Weed
<i>Hordeum bulbosum</i> L.		M-IT	Cr	-		Range
<i>Hordeum glaucum</i> Steud.		ES-M-IT	Th	-		Weed
<i>Hordeum spontaneum</i> K.Koch		M-IT	Th	-		Weed
<i>Hordeum violaceum</i> Boiss. & Hohen.		ES-M-IT	He	-		Range
<i>Hordeum vulgare</i> L.		Cosm	Th	-		Cultivated
<i>Lolium perenne</i> L.	Cosm	He	-		Range	
<i>Melica persica</i> Kunth	IT	He	-		Range	
<i>Oryzopsis holciformis</i> Hack.	IT	Cr	-		Range	
<i>Panicum</i> sp.	ES, Med,	Th	-		Range	
	IT, SS					
<i>Poa bulbosa</i> L.	ES-M-IT	Cr	-		Range	
<i>Psathyrostachys fragilis</i> (Boiss.) Nevski	IT	Cr	-		Range	
<i>Sorghum halepense</i> Pers.	Cosm	Cr	-		Weed	
<i>Stipa hohenackeriana</i> Trin. & Rupr.	IT	He	-		Range	
<i>Taeniatherum crinitum</i> (Schreb.) Nevski	ES-M-IT	Th	-		Weed	
<i>Triticum</i> sp.	Cosm	Th	-		Cultivated	
Magnoliopsida						
Amaranthaceae	<i>Amaranthus albus</i> L.	Cosm	Th	-		Weed
Apiaceae (Umbelliferae)	<i>Bunium caroides</i> Hausskn. ex Bornm.	IT	Cr	-		Med
	<i>Bunium cylindricum</i> Drude	IT	Cr	-		Med
	<i>Bunium paucifolium</i> DC.	IT	Cr	-		Med

Family	Binominal authority	CT	LF	Cons	Endem	imp
Aristolochiaceae Asteraceae (Compositae)	<i>Bunium</i> sp.	IT	Cr	-		-
	<i>Bupleurum exaltatum</i> M.Bieb.	IT	He	-		Range
	<i>Chaerophyllum macropodum</i> Boiss.	IT	He	-		Med
	<i>Grammosciadium scabridum</i> Boiss.	IT	He	-		Range
	<i>Lisaea heterocarpa</i> Boiss.	ES-M-IT	He	-		Range, *
	<i>Malabaila sekakul</i> Boiss.	IT	He	-		Range
	<i>Prangos uloptera</i> DC.	IT	He	-		Med
	<i>Scandix pecten-veneris</i> L.	ES-M-IT	Th	-		Weed
	<i>Scandix stellata</i> Banks & Sol.	ES-M-IT	Th	-		Weed
	<i>Smyrniopsis aucheri</i> Boiss.	IT	He	-		Med
	<i>Torilis leptophylla</i> Rchb.f.	ES-M-IT	Th	-		Weed
	<i>Turgenia latifolia</i> Hoffm.	ES-M-IT	Th	-		Weed
	<i>Aristolochia bottae</i> Jaub. & Spach	IT	He	-		Med
	<i>Achillea wilhelmsii</i> K.Koch	ES-IT	He	-		Med
	<i>Acroptilon repens</i> (L.) DC.	IT	He	-		Med
	<i>Anthemis odontostephana</i> Boiss.	IT	Th	-		Med
	<i>Carduus pycnocephalus</i> L.	M-IT	Th	-		Weed
	<i>Carthamus oxyacantha</i> M.Bieb.	M-IT-SS	Th	-		Med
	<i>Centaurea depressa</i> M.Bieb.	IT	Th	-		Med
	<i>Centaurea iberica</i> Trevir. ex Spreng.	ES-M-IT	He	-		Weed
	<i>Centaurea solstitialis</i> L.	IT	Th	-		Weed
	<i>Centaurea virgata</i> Lam.	IT	He	-		Weed
	<i>Cephalorrhynchus microcephalus</i> (DC.) Schchian	IT	Cr	-		Range
	<i>Chardinia orientalis</i> Britten	IT	Th	-		Weed
	<i>Cichorium intybus</i> L.	Plur	He	-		Med
	<i>Cirsium libanoticum</i> DC.	ES-IT	Cr	-		Range, *
	<i>Cousinia ardalensis</i> Attar & Djavadi	IT	He	-		Range, *
	<i>Crepis sancta</i> (L.) Babc.	M-IT-SS	Th	-		Weed
	<i>Crupina crupinastrum</i> Vis.	M-IT	Th	-		Weed
	<i>Echinops kotschyi</i> Boiss.	IT	He	-		Range
	<i>Erigeron uniflorus</i> L.	ES-M-IT	Th	-		Range
	<i>Garhadiolus angulosus</i> Jaub. & Spach	IT	Th	-		Weed
	<i>Gundelia tournefortii</i> L.	IT	He	-		Range
	<i>Helichrysum oligocephalum</i> DC.	IT	He	LR	End	Med
	<i>Hertia angustifolia</i> Kuntze	IT	Ch	LR	End	Med
	<i>Lactuca serriola</i> L.	ES-M-IT	He	-		Weed
	<i>Lasiopogon muscoides</i> DC.	ES-IT	Th	-		Weed
	<i>Onopordum leptolepis</i> DC.	IT	He	-		Med
	<i>Picnomon acarna</i> (L.) Cass.	M-IT	Th	-		Weed
	<i>Scariola orientalis</i> (Boiss.) Soják	IT	He	-		Range
	<i>Scorzonera calyculata</i> Boiss.	IT	He	-		Range
	<i>Scorzonera leptophylla</i> (DC.) Krasch. & Lipsch.	IT	He	-		Range
	<i>Scorzonera mucida</i> Rech. f., Aell. & Esfand.	IT	Cr	-		Range, *
	<i>Scorzonera phaeopappa</i> Boiss.	IT	Cr	-		Range
	<i>Tanacetum polycephalum</i> Sch.Bip.	IT	Ph	DD	End	Med
<i>Taraxacum roseum</i> Bornm.	IT	He	VU	End	Med, *	
<i>Taraxacum syriacum</i> Boiss.	M-IT	He	-		Med	
<i>Tragopogon graminifolius</i> DC.	IT	He	-		Med	
<i>Tragopogon longirostris</i> Bischoff ex Sch.Bip.	M-IT-SS	He	-		Med	
<i>Xeranthemum longepapposum</i> Fisch. & C.A.Mey.	IT	Th	-		Weed	
Boraginaceae	<i>Asperugo procumbens</i> L.	ES-M-IT	Th	-		Weed
	<i>Lappula microcarpa</i> Gürke	Plur	Th	-		Range
	<i>Lithospermum arvense</i> L.	ES-IT	He	-		Weed
	<i>Nonea caspica</i> G.Don	IT	Th	-		Med
	<i>Onosma microcarpa</i> DC.	IT	He	-		Med
	<i>Onosma sericea</i> Willd.	IT	He	-		Med
	<i>Rochelia disperma</i> (L.) Wettst.	IT	Th	-		Weed
	<i>Trichodesma aucheri</i> DC.	IT	He	-		Range
	<i>Trichodesma incanum</i> Bunge	IT	He	-		Range
	<i>Trichodesma incanum</i> Bunge	IT	He	-		Range
Brassicaceae (Cruciferae)	<i>Alyssum linifolium</i> Stephan ex Willd.	Plur	Th	-		Med
	<i>Alyssum marginatum</i> Steud.	IT	Th	-		Med
	<i>Arabis caucasica</i> Willd.	ES-M-IT	He	-		Range
	<i>Aubrieta parviflora</i> Boiss.	IT	He	-		Range
	<i>Capsella bursa-pastoris</i> (L.) Medik.	Cosm	Th	-		Weed
	<i>Cardaria draba</i> (L.) Desv.	Cosm	He	-		Med
	<i>Clypeola lappacea</i> Boiss.	M-IT	Th	-		Weed
	<i>Conringia perfoliata</i> (C.A.Mey.) N.Busch	IT	Th	-		Range
	<i>Descurainia sophia</i> (L.) Webb ex Prantl	Cosm	Th	-		Med
	<i>Dielsiocharis kotschyi</i> O.E.Schulz	IT	He	-		Range
	<i>Draba aucheri</i> Boiss.	IT	He	-		Range
	<i>Drabopsis verna</i> K.Koch	IT	Th	-		Range

Family	Binominal authority	CT	LF	Cons	Endem	imp
	<i>Erysimum repandum</i> L.	IT	Th	-		Weed
	<i>Fibigia umbellata</i> (Boiss.) Boiss.	IT	He	-		Range
	<i>Graellsia saxifragifolia</i> Boiss.	IT	He	-		Range
	<i>Moriera spinosa</i> Boiss.	IT	Ch	-		Range
	<i>Myagrum perfoliatum</i> L.	ES-IT	Th	-		Weed, *
	<i>Robeschia schimperi</i> O.E.Schulz	IT	Th	-		Weed
	<i>Sisymbrium irio</i> L.	ES-M-IT	Th	-		Med
	<i>Thlaspi perfoliatum</i> L.	ES-M-IT	Th	-		Weed
Caryophyllaceae	<i>Acanthophyllum kurdicum</i> Boiss. & Hausskn. ex Boiss.	IT	Ch	-		Range, *
	<i>Arenaria leptoclados</i> Boiss.	ES-M-IT	Th	-		Weed
	<i>Cerastium dichotomum</i> L.	M-IT	Th	-		Weed
	<i>Cerastium inflatum</i> Link ex Sweet	IT	Th	-		Weed
	<i>Dianthus orientalis</i> Adams	IT	He	-		Med
	<i>Gypsophila polyclada</i> Fenzl ex Boiss.	IT	He	DD	End	Range
	<i>Holosteum umbellatum</i> L.	Cosm	Th	-		Weed
	<i>Minuartia aucheriana</i> Bornm.	IT	Th	LR	End	Range, *
	<i>Minuartia meyeri</i> Bornm.	IT	Th	-		Weed
	<i>Scleranthus orientalis</i> Rössler	IT	Th	-		Weed
	<i>Silene caesarea</i> Boiss. & Balansa	ES-M-IT	He	-		Range
	<i>Silene chlorifolia</i> Sm.	IT	He	-		Range
	<i>Silene conoidea</i> L.	Cosm	Th	-		Weed
	<i>Silene gynodioica</i> Ghaz.	IT	He	DD	End	Range
	<i>Silene spergulifolia</i> Rchb. ex Nyman	IT	He	-		Range
Chenopodiaceae	<i>Vaccaria grandiflora</i> Jaub. & Spach	IT	Th	-		Weed
	<i>Noaea mucronata</i> Asch. & Schweinf.	IT	Th	-		Range
	<i>Salsola kali</i> L.	Plur	Th	-		Med
	<i>Convolvulus arvensis</i> L.	Cosm	Cr	-		Weed
	<i>Convolvulus lineatus</i> L.	M-IT	He	-		Range
Crassulaceae	<i>Rosularia elymaitica</i> A.Berger	IT	He	LR	End	Range
	<i>Rosularia persica</i> A.Berger	IT	Cr	-		Range
Dipsacaceae	<i>Cephalaria persica</i> A.Berger	IT	Cr	-		Range
	<i>Cephalaria syriaca</i> Schrad.	IT	Th	-		Weed
	<i>Pteroccephalus canus</i> Coult. ex DC.	IT	He	-		Range
Euphorbiaceae	<i>Euphorbia aleppica</i> L.	M-IT	Th	-		Range, *
	<i>Euphorbia aserbajdzhanica</i> Bordz.	IT	Th	-		Range
	<i>Euphorbia aucheri</i> Boiss.	IT	He	-		Range
	<i>Euphorbia cheiradenia</i> Boiss. & Hohen.	IT	He	-		Range
	<i>Euphorbia myrsinites</i> L.	M-IT	He	-		Range, *
	<i>Euphorbia osyridea</i> Boiss.	IT-SS	He	-		Range, *
	<i>Euphorbia peplus</i> L.	ES-M-IT	Th	-		Weed
	<i>Euphorbia sororia</i> Schrenk	IT	Th	-		Range
Fabaceae (Leguminosae)	<i>Astragalus brachycalyx</i> Fisch. ex Boiss.	IT	Cr	LR		Range
	<i>Astragalus cephalanthus</i> DC.	IT	Ch	LR	End	Range
	<i>Astragalus ecbatanus</i> Bunge	IT	He	LR	End	Range, *
	<i>Astragalus effusus</i> Bunge	IT	He	LR	End	Range
	<i>Astragalus macropelmatus</i> Bunge	IT	He	-		Range
	<i>Astragalus mercklinii</i> Boiss. & Buhse	IT	He	-		Range, *
	<i>Astragalus ovinus</i> Boiss.	IT	He	-		Range
	<i>Astragalus ptychophyllus</i> Boiss.	IT	Ch	LR	End	Range
	<i>Astragalus rhodosemius</i> Boiss. & Hausskn.	IT	Ch	-		Range
	<i>Astrodaucus orientalis</i> Drude	IT	Cr	-		Med
	<i>Cicer oxydodu</i> Boiss. & Hohen.	IT-SS	He	-		Med
	<i>Coronilla varia</i> L.	ES, Med, IT	He	-		Med
	<i>Glycyrrhiza glabra</i> L.	IT	He	-		Med
	<i>Lathyrus inconspicuus</i> L.	ES-IT	Th	LR		Med
	<i>Lens orientalis</i> Popow	M-IT	Th	-		Med, *
	<i>Lotus corniculatus</i> L.	Plur	He	-		Med
	<i>Medicago lupulina</i> L.	Plur	He	-		Range
	<i>Medicago sativa</i> L.	ES-M-IT	He	-		Med
	<i>Melilotus officinalis</i> (L.) Lam.	ES-M-IT	He	-		Med
	<i>Onobrychis sativa</i> Lam.	IT	Ch	-		Range, *
	<i>Trifolium pratense</i> L.	ES-M-IT	He	-		Range
	<i>Trigonella disperma</i> Bornm.	IT	Th	-		Med
	<i>Trigonella hamosa</i> L.	M-SS	Th	-		Med, *
	<i>Trigonella uncinata</i> Banks & Sol.	M-IT	Th	-		Med, *
	<i>Vicia hybrida</i> L.	Plur	He	-		Med, *
	<i>Vicia tenuifolia</i> Roth.	Plur	He	-		Weed, *
Geraniaceae	<i>Biebersteinia multifida</i> DC.	IT	Cr	-		Range
	<i>Erodium cicutarium</i> (L.) L'Hér.	ES-M-IT	Th	-		Weed
	<i>Geranium lucidum</i> L.	ES-M	Th	-		Range
	<i>Geranium tuberosum</i> L.	ES-M-IT	Cr	-		Range
Hypericaceae	<i>Hypericum helianthemoides</i> (Spach) Boiss.	IT	He	-		Med
	<i>Hypericum scabrum</i> L.	IT	He	-		Med

Family	Binominal authority	CT	LF	Cons	Endem	imp	
Lamiaceae (Labiatae)	<i>Acinos graveolens</i> Link	ES-IT	Th	-		Range	
	<i>Marrubium cuneatum</i> Banks & Sol.	IT	He	-		Med	
	<i>Marrubium vulgare</i> L.	M-IT	He	-		Med	
	<i>Mentha longifolia</i> (L.) L.	Plur	Cr	-		Med	
	<i>Nepeta kotschy</i> Boiss.	M-IT	He	LR	End	Med	
	<i>Nepeta oxyodonta</i> Boiss.	IT	He	LR	End	Med	
	<i>Nepeta persica</i> Boiss.	IT	He	-		Med	
	<i>Phlomis aucheri</i> Boiss.	IT	He	LR	End	Med	
	<i>Phlomis olivieri</i> Benth.	IT	He	-		Med	
	<i>Phlomis persica</i> Boiss.	IT	He	-		Med	
	<i>Salvia multicaulis</i> Vahl	ES-IT	He	-		Med	
	<i>Salvia nemorosa</i> L.	ES, IT	He	-		Med	
	<i>Salvia sclarea</i> L.	ES-IT	He	-		Med	
	<i>Salvia virgata</i> Ortega.	ES-IT	He	-		Med	
	<i>Salvia xanthocheila</i> Boiss. Ex Benth.	IT	He	-		Med, *	
	<i>Stachys lavandulifolia</i> Vahl	IT	He	-		Med	
	<i>Stachys pilifera</i> Benth.	IT	He	-		Med	
	<i>Teucrium orientale</i> L.	ES-IT	He	-		Med	
	<i>Teucrium polium</i> L.	M-IT	Ch	-		Med	
	<i>Ziziphora capitata</i> L.	IT	Th	-		Med	
<i>Ziziphora clinopodioides</i> Lam.	IT	Ch	VU		Med		
Linaceae	<i>Linum album</i> Kotschy ex Boiss.	IT	He	LR	End	Med	
Malvaceae	<i>Alcea koelzii</i> I.Riedl	IT	He	DD	End	Med	
	<i>Malva neglecta</i> Wallr	ES-M-IT	He	-		Weed	
Morinaceae	<i>Morina persica</i> L.	IT	He	-		Range	
Orobanchaceae	<i>Orobanche</i> sp.	M-IT	Cr	-		Par	
Papaveraceae	<i>Hypecoum pendulum</i> L.	M-IT	Th	-		Weed	
	<i>Papaver dubium</i> L.	Plur	Th	-		Med	
Plantaginaceae	<i>Plantago lanceolata</i> L.	ES-M-IT	He	-		Weed	
Podophyllaceae	<i>Bongardia chrysogonum</i> Boiss.	ES-M-IT	Cr	-		Weed	
Polygonaceae	<i>Polygonum aridum</i> Boiss. & Hausskn. Ex Boiss.	IT	He	-		Range	
	<i>Polygonum aviculare</i> L.	Cosm	Th	-		Weed	
	<i>Rheum ribes</i> L.	IT	Cr	-		Med	
	<i>Rumex ponticus</i> E.H.L.Krause	IT	He	-		Med	
	<i>Rumex sanguineus</i> L.	ES	He	-		Med, *	
	Ranunculaceae	<i>Adonis aestivalis</i> L.	ES-M-IT	Th	-		Weed
		<i>Anemone biflora</i> DC.	IT	Cr	-		Weed
		<i>Ceratocephala falcata</i> (L.) Pers.	ES, Med, IT	Th	-		Weed
		<i>Ranunculus arvensis</i> L.	ES-M-IT	Th	-		Weed
	<i>Ranunculus bulbosus</i> L.	ES-M-IT	Th	-		Range, *	
<i>Ranunculus falcatus</i> L.	-	-	-		Range, *		
<i>Ranunculus kotschy</i> Boiss.	IT	He	LR	End	Range		
<i>Ranunculus oxyspermus</i> Willd.	ES-IT	Cr	-		Range		
<i>Thalictrum isopyroides</i> C.A. Mey.	IT	Cr	-		Range		
Rhamnaceae	<i>Rhamnus kurdica</i> Boiss. & Hohen.	ES-IT	Ph	-		Med	
Rosaceae	<i>Cerasus brachypetala</i> Boiss.	IT	Ph	-		Med	
	<i>Potentilla reptans</i> L.	ES-IT	Cr	-		Range	
	<i>Rosa elymaitica</i> Boiss. & Hausskn. ex Boiss.	IT	Ph	-		Med	
	<i>Sanguisorba minor</i> Bertol.	ES-M-IT	He	-		Range	
Rubiaceae	<i>Asperula molluginoides</i> Rchb.	IT	He	-		Range	
	<i>Asperula rechingeri</i> Ehrend. & Schönb.-Tem.	IT	-	-		Range, *	
	<i>Asperula setosa</i> Jaub. & Spach	IT	Th	-		Range	
	<i>Callipeltis cucullaris</i> (L.) DC.	IT-SS	Th	-		Range	
	<i>Crucianella gilanic</i> Trin.	IT	He	-		Range	
	<i>Cruciata taurica</i> (Pall.) Ehrend.	IT	He	-		Range	
	<i>Galium aparine</i> L.	ES-M-IT	Th	-		Weed	
	<i>Galium setaceum</i> Lam.	M-IT	Th	-		Weed	
	<i>Galium spurium</i> L.	ES-M-IT	Th	-		Weed	
	<i>Galium verum</i> L.	Plur	He	-		Med	
	Rutaceae	<i>Haplophyllum perforatum</i> Kar. & Kir.	IT	He	-		Range
	Salicaceae	<i>Salix acmophylla</i> Boiss.	M-IT	Ph	-		Range
Scrophulariaceae	<i>Scrophularia</i> sp.	IT	He	-		Range	
	<i>Scrophularia striata</i> Boiss.	IT	He	-		Med	
	<i>Scrophularia variegata</i> M.Bieb.	IT	Ch	-		Range	
	<i>Veronica</i> sp.	IT	Th	-		Range	
Urticaceae	<i>Parietaria judaica</i> L.	ES-M-IT	He	-		Range	
Valerianaceae	<i>Valerianella samolifolia</i> A.Gray	IT	Th	-		Med	
Violaceae	<i>Viola modesta</i> Fenzl	M-IT	Th	-		Med	
Zygophyllaceae	<i>Peganum harmala</i> L.	Plur	He	-		Med	
	<i>Tribulus terrestris</i> L.	Cosm	Th	VU		Med	

Multivariate analysis

Zagros oak forests are connected the Khuzestan plain through western foothills of Zagros Mountains in Khuzestan province, SW Iran (Akhani, 2004). This important area has been poorly investigated compared to other parts of Iran, during the Iran-Iraq war. In this study, three studied local floras in Khuzestan could be classified into seven groups, as the internal similarity and external similarity criteria are maximized and minimized (Table 3) for the groupings achieved for k=7. The first division (k=2) separated three floras; Shimbar, Alaa and Ban (All located in Khuzestan province, in west hillsides of central Zagros region) from other 11 floras. In the second division (k=3) Dice and SMC coefficients grouped 14 flora in three main clusters which separated the floras based on their location in western and eastern hillsides of Zagros, and the climatic differences in northern and southern parts of the province, in the eastern hillside. From k=5 forward, flora of Shimbar in northern Khuzestan is separated from the two related southern floras (Alaa and Ban). In eastern hillsides, with k=7, five groups could be determined (Table 3): 2: flora Chadegan

province (Table 1) are added to the data matrix, to investigate the relationships and floristic connections between the flora in western and eastern foothills of the central Zagros region. Clustering of the 14 adjacent local flora in the central Zagros region (Table 1) into groups of similar entities was performed by k-means clustering of occurrence data (Fig. 6). Results showed that the 14 floras and Sheida, in northern; 3: Mt. Jahanbin and Mt. Sheet; 5: Karsanak and Tange Sayad in middle, and 4: Gheysari, Helen and Mt. Kallar at southern parts of Bakhtiari province, and 6: Hana and Vanak flora in southern Isfahan province. Grouping of these 14 floras in the overall region was interesting as it marks different parts of the region according to their floristic similarities. Matrix visualization of the k-clustering (Fig. 6,III) shows the membership of each flora in the k=7 groups based on a divisive method. Further analyses of the raw data-matrix in this study consisted of an ordination and a net clustering method which were agglomerative in nature. Results (Fig. 7) were consistent to those obtained from k-clustering method, with minor differences.

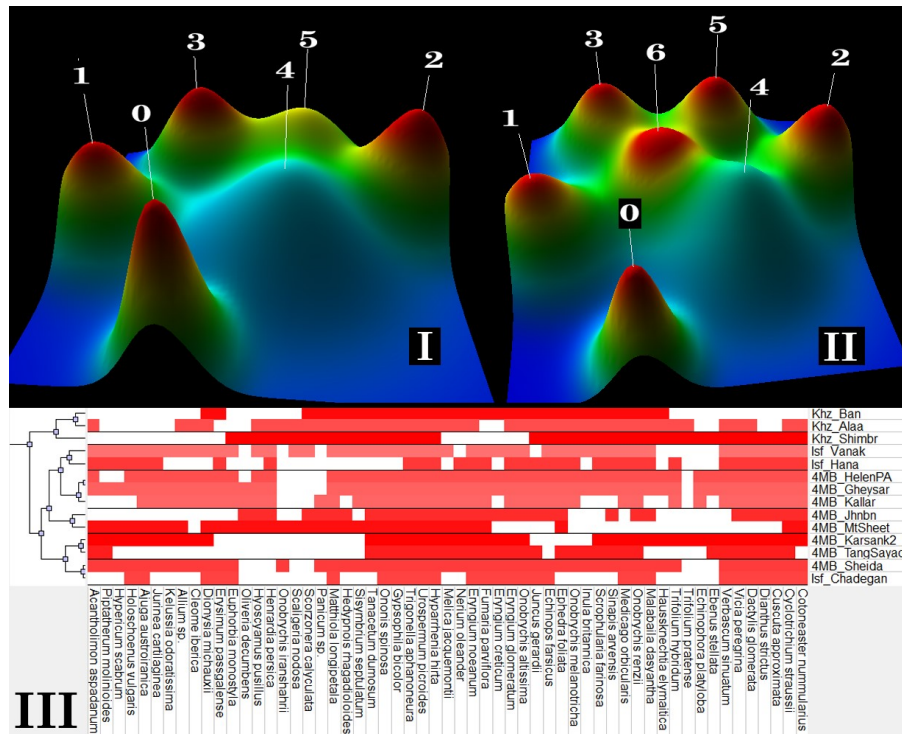


Fig. 6. Mountain visualization of NMDS-Kmeans clustering of species occurrence data from Mt. Jahanbin (this study) and 13 related floras in central Zagros region of Iran. I: results retrieved for k=6, II: k=6, III: matrix visualization for k=7 showing membership of each flora in k=7 groups. Names of each Flora if preceded by an acronym denoting the province: Khz: Khuzestan, Isf: Isfahan, 4MB: Chaharmahal and Bakhtiari.

Results of net clustering method were consistent with k=6 but two floras of Vanak and Hana, did not group together. Flora of Vanak was grouped with its adjacent flora in southern Bakhtiari province, while flora of Hana was appeared as an outlying entity, between the two groups in north of Bakhtiari province (Fig. 7, B). Ordination analysis (PCO) showed similar pattern, again, with western hillsides flora in Khuzestan province in one group, southern Bakhtiari flora in another group, and the rest in the third group. In this analysis, flora of Vanak is an intermediate between the last two groups. Flora of Vanak and Hana in the south of Isfahan province, therefore, could be considered as a separate less supported group, intermediate between nine floras in Bakhtiari province. Flora of Vanak shares 397 species with a cumulated list of these nine floras,

while flora of Hana shares 242 species. These two floras (Vanak and Hana) share 165 species which is high respecting the total number of species in each flora (Table 1).

Application of numerical methods for phytogeographic data to classify the floristic regions is an interesting field and has been of interesting to researches (Kreft and Jetz, 2010). Phytogeographical regionalizations, like kingdoms, regions, provinces, and other phytochoria are central to many questions in phytogeography, evolution, and of great value for conservation. Availability of species distribution data, along with multivariate techniques and improved computation analysis, enable new quantitative accounts of regionalization. In this study, we conducted quantitative analyses at the species-level to illustrate biogeographical borders between 14 local floras in the central Zagros Region.

Table 3. Statistics of K-means clustering of species occurrence data. Isim: Internal similarity, Esim: External similarity measures of defined groups (k=2 to k=7). Membership of each flora in each cluster are presented

Partitions	Cluster	N	Members*	Isim	Isdev	Esim	ESdev
K=2	0	3	a - c	0.570	0.027	0.185	0.050
	1	11	d - n	0.488	0.045	0.185	0.044
K=3	0	3	a - c	0.570	0.027	0.185	0.050
	1	5	k - m	0.568	0.040	0.329	0.029
	2	6	f - j, n	0.560	0.055	0.334	0.052
K=4	0	2	f, g	0.723	0.000	0.327	0.029
	1	3	a - c	0.570	0.027	0.185	0.050
	2	4	h - j, n	0.670	0.068	0.368	0.041
	3	5	d, e, k - m	0.568	0.040	0.329	0.029
K=5	0	1	A	1.000	0.000	0.210	0.000
	1	2	b, c	0.724	0.000	0.192	0.066
	2	2	f, g	0.723	0.000	0.327	0.029
	3	4	h - j, n	0.670	0.066	0.368	0.041
	4	5	d, e, k - m	0.568	0.040	0.329	0.029
K=6	0	1	A	1.000	0.000	0.210	0.000
	1	2	b, c	0.724	0.000	0.192	0.066
	2	2	d, e	0.835	0.000	0.355	0.066
	3	2	f, g	0.723	0.000	0.327	0.029
	4	4	h - j, n	0.670	0.066	0.368	0.041
	5	3	k - m	0.622	0.019	0.349	0.010
K=7	0	1	A	1.000	0.000	0.210	0.000
	1	2	b, c	0.724	0.000	0.192	0.066
	2	2	d, e	0.835	0.000	0.355	0.066
	3	2	f, g	0.723	0.000	0.327	0.029
	4	3	h - j	0.774	0.056	0.387	0.041
	5	2	k, l	0.737	0.000	0.359	0.003
	6	2	m, n	0.692	0.000	0.355	0.009

*a: Shimbar, b: Alaa, c: Ban, d: Chadegan, e: Sheida, f: Mt.Jahanbin, g: Mt.Sheet, h: Gheysari, i: HelenPA, j: Mt.Kallar, k: Karsanak, l: Tang-e Sayad, m: Hana, n: Vanak.

Kreft and Jetz (2010) explored the relative usefulness of ordination and clustering methods at different taxonomic levels and showed that non-metric multidimensional scaling (NMDS) was most valuable in identifying transition zones. They also showed that UPGMA as an agglomerative hierarchical clustering consistently had the best performance among other technics. Kreft and Jetz (2010) showed that the new quantitative regions exhibit

similarities to and differences from the classic divisions of the world's biota and provided evidence that the Sahara, northern Africa, the Arabian Peninsula and parts of the Middle East should be regarded as part of the AfroTropics. These technics may also be useful in refining or redefining borders of phytochoria at lower levels. Emerging floristic database of Iran, which was used to construct the data matrix for this study, may help such analyses in future.

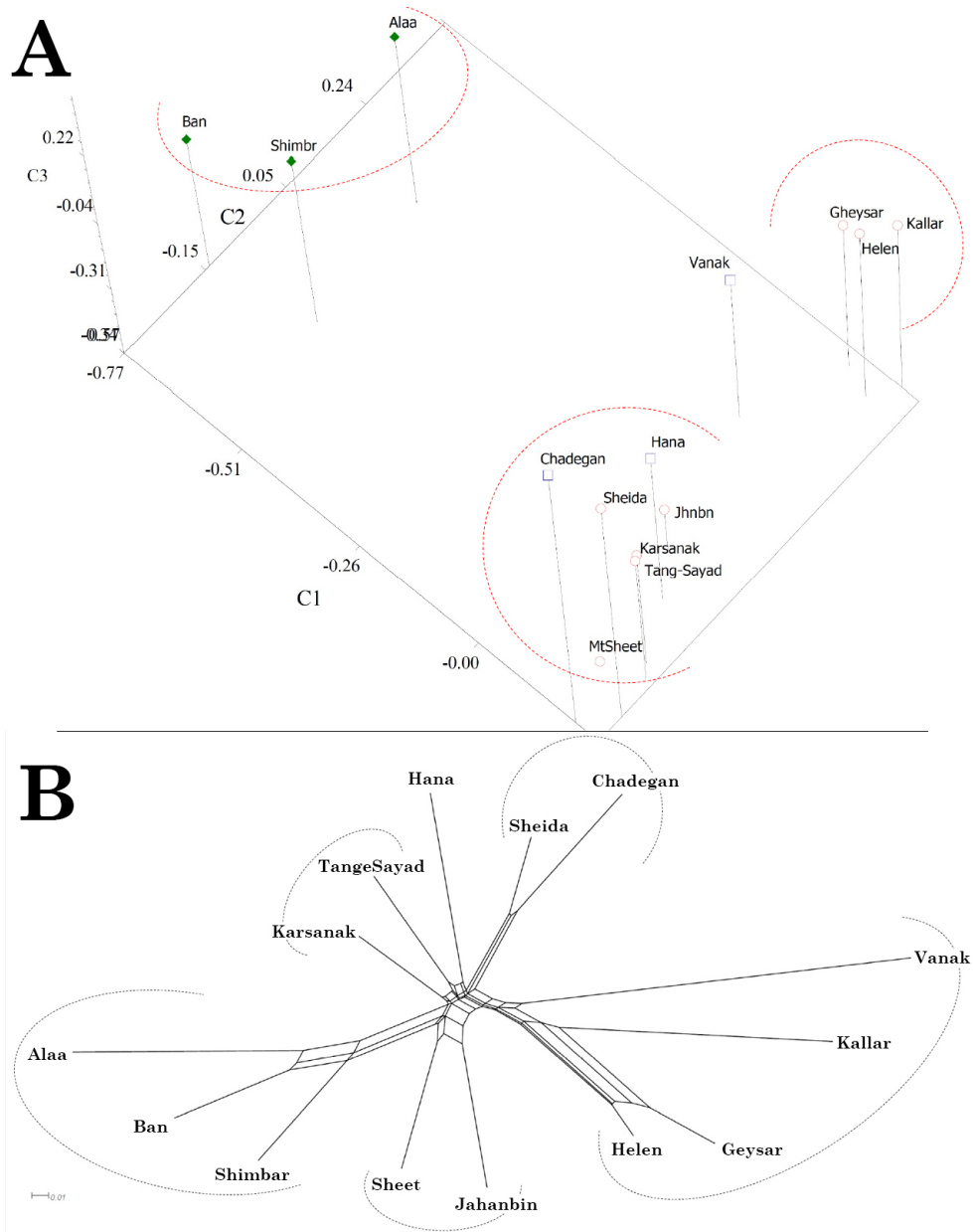


Fig. 7. Multivariate analysis of presence/absence of species in Mt. Jahanbin and adjacent floras. A: Analysis of data matrix using a Neighbor Net Clustering Method, B: Cluster analysis using Simple Matching Coefficient in NTSYS-pc. Abbreviation concordant to table 1

Conclusion

Flora of Mt. Jahanbin showed that this area merits more attention and could be considered for diversity management and protection. Plant species diversity in this flora is high although this area is surrounded by small cities and exploited by human for livestock grazing, mining farming and promenading. Overgrazing has been considered as the major factor, threatening the biodiversity in the central Zagros region. Change in species distributions have been considered as signs and impacts of gradual climatic change. As a result, borders of lower phytochoria consequently changing. Invasive species are the first penetrating groups into neighboring flora. For monitoring the changes of biodiversity, researchers are required to access well designed and comprehensive floristic databases enable to make necessary comparisons between adjacent floras. To fulfill this requisite, we have recently started working on a database for the flora of Iran which may help us for a better understanding of this flora.

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