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Plant Species Diversity in Jokhaneh Plain and Southern Slope of the Nil Mt. in Kohgilouyeh va Boyerahmad Province (Central Zagros Region of Iran)

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Abstract

Plant species diversity in Jokhaneh plain and the southern slope of Nil Mt. is investigated in order to determine the flora and life forms and chorotypes of plants in this area. The studied area is located in Kohgilouyeh va Boyerahmad province, covers 22'475 hectares and its average elevation is 2'315 m above sea level. In spite of a few studies in this region, broad knowledge of the flora of this area does not exist. In this study, plants were collected randomly along the growing seasons during 2015-2016. Vegetation of the studied area comprised of 157 species and 124 genera belonging to 42 families. Asteraceae, Lamiaceae and Poaceae were the most species-rich families. The most species-rich genera were *Astragalus*, *Salvia, Scorzonera, Ranunculus, Galium* and *Bromus*. Hemicryptophytes and therophytes were dominant life forms in this area. Endemic elements constitute 61% (92 species) of this flora, of which, 23 species were endemic to Irano-Turanian region. Species list of this area was both compared and combined with those of 27 more local floras in order to perform multivariate floristic analysis based on presence/absence data of 2039 plant species × 28 floras. Results showed that the set of local floras could be divided into four distinct clusters, showing geographical distribution of floristic diversity along NS, WE and center of the Zagros run. This study highlights the importance of the study area by introducing eleven species not previously collected from the region consisting 27 local floras, and also the importance of multivariate analyses in comparative floristic studies.

Key words: Endemics; Flora; Geographic distribution; Species richness; Zagros

Introduction

The central Zagros Mts. contain globally-significant biodiversity. Climatic conditions of this region have led to different habitats and diverse ecosystems; a home for many plant and animal species, including more than 2000 species of vascular plants comprising of many endemics (Noroozi *et al.*, 2016). Rainfall diet in Zagros region of Iran is Mediterranean, which implies occurrence of much of the rainfall during December to April, and a dry period in the summer (Soltani and Modarres, 2006). During the last glaciation period, this region has been a mountain steppe of *Cousinia* and *Tulipa* spp. (Djamali *et al.*, 2009; Djamali *et al.*, 2011) and the species richness has been increased due to changes in species ranges in the post-glacial period (Normand *et al.*, 2011). Topography and soil diversity in this region support hight richness, while, exploitation and overgrazing are two major factors that have negative effect of species richness. Several floristic studies (Table 1) in the region, have shed lights on the status of diversity in this region (Parishani, 2004; Yousofi *et al*., 2011; Khajeddini and Yeganeh, 2010; Dolatkhahi and Yousofi, 2009; Pourrezaei *et al*., 2010; Basiri *et al*., 2011; Taghipour *et al*., 2011; Esmaeili *et al*, 2007; Shahrokhi, 2005; Mataji *et al*., 2013; Aghaei *et al*., 2013; Shirmardi *et al*., 2014a; Shirmardi *et al*., 2014b; Dinarvand *et al.,* 2015; Dehghani *et al*., 2015; Farhang *et al*., unpublished; Jalali *et al*., 2016; Gahanbakhsh-Ganje and Ebadi, 2015; Asadi-Boroujeni and Ebrahimi, 2009; Shirmardi *et al*., 2011; Jafari and Zarifian, 2015; Parvizi, 2017; Naghipour-Borj *et al*., 2014; Jafari and Janipour, 2014; Jafari and Yazdanparast, 2014).

The number of species in a given area; species richness (Magurran, 2013) along with a list of their scientific names presented under a system of classification is usually achieved through a floristic study. Species richness is the prominent factor of productivity and stability (Cristofoli, 2010) and is predominantly controlled by local factors. Studying the plant species diversity or species richness in a region is required for further understanding the relationships between ecological factors, and for improved management (Marini *et al.*, 2007). One of the most important local floras studied so far, is the flora of Savers (Jafari and Zarifian, 2015), with 8000 ha area (1700-3189 m a.s.l.) and 295 plant species in 202 genera and 62 families.

This study concerns plant species diversity in Jokhaneh plain and the associated vegetation in southern slope of the Nil Mountain in Kohgilouyeh va Boyerahmad province. Results of this study are considered as contribution to the flora of central Zagros region of Iran.

Material and Methods

Study area

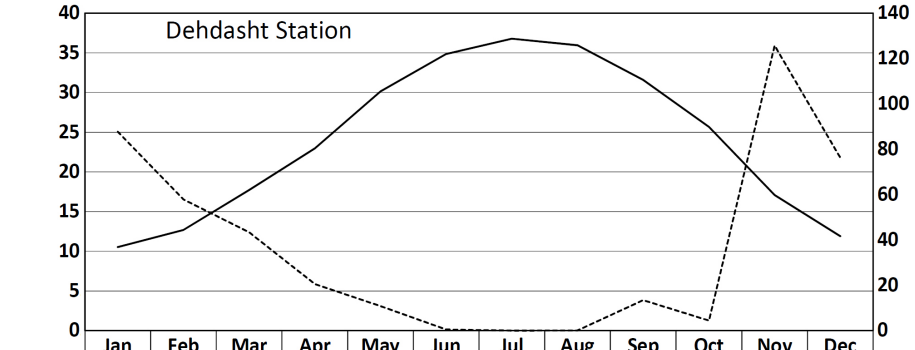
Jokhaneh plain is located 35 km north of Choram city, with more than 2500 ha area and is a continuation of Nil (Nir) Mt. in Zagros chain. This plain, along with southern slope of Nil Mt. (2150-3300 m a.s.l.) covers an area of about 22475 ha (30.944 - 30.76 N and 50.747 - 50.975 E), that its floristic diversity has not been studied yet. The study area is circumscribed between Vahrisadaat and Darrehsard and Chaatbarik in north, Aabhayat and Pahnaleili in south, Aabhayat and Nil Mt. in west, and Moorvik in east. Preliminary observations and known nearby local floras, confirm that this area might have a rich flora and high plant species diversity.

The study area has a wet climate according to De Martonne's classification, similar to the climate type in Dehdasht and Gachsaran. Meteorology data (2006-2014) show that drought period in the study area spans from March to October (Fig. 1), and 75 percent of precipitation is in form of rain, most of which (391 mm; 89%) falls during November to March. Average annual rainfall is 582 mm (monthly max is 125.68 mm in Nov.), and average annual temperature is 11 ºC (monthly min is 10.53 ºC in Jan., and monthly max is 36.79 ºC in July). Average annual minimum and maximum temperature are 2.6 and 27.1, respectively. Vegetation of the study area comprises of grasses, annual and perennial herbs and a number of woody forms (*Quercus* L. spp., *Crataegus* L. spp., *Pyrus* L. spp. and *Acer* L. spp.). There are vineyards and walnut gardens in north and northeast, a small phosphate mine in northwest, and animal husbandry in south of the study area. The boundaries of the studied area (E 50.747, N 30.944 - E 50.975, N 30.76) were determined using satellite maps in the Google Earth software package (Google ink., 2013).

Collection and identification of plant specimens

Plant specimens were collected from April 2015 to July 2016, determined and deposited in the herbarium of Faculty of Science (University of Shahrekord), and the Herbarium of Faculty of Science (University of Yasouj). Determinations were based on related identification keys in Flora Iranica (Rechinger, 1963-2012), Flora of Iran (Assadi *et al*., 2010), Flora of Iraq (Townsend *et al.*, 1985), Flora of Turkey (Davis, 1965-1985), Flora Palaestina (Zohary, 1966) and Flora of Kuwait (Al-Rawi, 1987).

The list of scientific names was checked for spelling and authority using the 'CheckName' software (Sharifi-Tehrani, 2014), and the chorotype and life-form of each species were determined using the information in relevant literature (Rechinger, 1963-2012; Ghahreman and Attar, 1998).



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
—Temp	10.53	12.67	17.70	22.99	30.14	34.84	36.79	35.94	31.60	25.68	17.09	11.90
---Perc	87.69	57.81	43.41	20.50	10.80	0.43	0.00	0.04	13.44	4.40	125.68	76.29

Fig. 1. Ombrothermic plot of precipitation and temperature data. Meteorology data of 8-years (2006-2014) retrieved from Dehdasht Meteorology station.

Data analysis

In this study, we used terms 'area' and 'region' are repectively used for the studied area, and for the overall area comprising nearby local floras mentioned in Table 1. Floristic lists of nearby local floras (Table 1) were summarized into a new dataset and checked for spelling, then compared to the checklist of studied area (Appendix 1) using 'iHerbs' floristic database (Sharifi-Tehrani and Rahiminejad-Ranjbar, 2013). Species exclusively found in this study, floristic analysis (FlorAn), pie plots, and the cumulative data matrix of species occurrence in the 28 local floras in the region were retrieved from iHerbs database. The raw matrix was then analyzed by neighbor net clustering method (Median network) which requires binary data (Huson and Bryant, 2006).

Results and discussion

Floristic diversity of Jokhaneh and southern slope of Mt. Nil

The floristic list of the studied area (Appendix 1) showed that this area comprised of 42 families (35 dicots and 7 monocots), 124 genera and 157 species. *Asteraceae* (20 species, 12.7%), *Lamiaceae* (16 species, 10.1%) and *Poaceae* (12 species, 7.6%) were the most species-rich families (Fig. 3a). Ten most important families regarding the number of genera are presented in Fig. 3b. The largest genera were *Astragalus* L. (6 species, 3.8%), *Salvia* L., *Scorzonera* L., *Ranunculus* L., *Galium* L. and *Bromus* L. (3 species, 1.9% each) (Fig. 3c).

As figure 4 shows, 92 species (61%) were native to Irano-Turanian region, 17 species (11%) pluriregional, and 38 species (25%) were elements distributed in both IT and neighboring (Euro-Siberian or Mediterranean) regions. Determination of Raunkiaer life-forms showed that 41% of the species (65 species) belonged to Hemicryptophytes, 33% (52 species) to Therophytes, 11% (17 species) to Cryptophytes, 11% (17 species) to Phanerophytes, and 4% (6 species) to Chamaephites (Fig. 5a). 23 species (15%) were endemics to Flora of Iran (Fig. 5b). The studied area comprised of 53 (34%) medicinal plant species, 10 of which (6% of the flora) are endemics (Table 1). Higher percentage of therophytes and hemicryptophytes is attributed to the adaptations to the Mediterranean climate conditions in Irano Turanian region (Zohary, 1973), and may be related also to the intense grazing. Thorny and spiny forms like *Astragalus* spp., and aromatic secondary product-rich species like *Salvia* spp. can better survive grazing and hence are among abundant and diverse taxa in this region. Non-endemic plant species constitute up to 85 percent of the flora (134 species), showing floristic affinities between the neighboring regions.

Table 1. Local floras nearby Jokhaneh and Nil Mt. Left column (ID) matching to numbers on Fig. 2B. Numbers in parentheses are average values, ranges denote: max, min. α-diversity= total number of species found in the studied area.

ID	Flora	Coordinates (Lat., Long.)	Temp. (ºC)	Prec. (mm)	Alt. (m)	Area (ha)	α-diversity**	Year publ.
106	Ysj_Dena	30.886, 51.202	na *	Na	900-4400	80000	212	2011
107	Ysj_DenaDezh	30.808, 50.319	na	470	max 1657	7318	188	2011
178	Ysj_Vezg	30.510, 51.665	na	Na	na	356	122	2013
249	Ysj_Meyntgn	30.948, 51.401	(+15)	800	1900, 2700	1000	165	2015
303	Ysj_Svrz	30.715, 51.118	na	826	1700, 3189	8000	295	2015
306	**Ysj_Jokhnh**	**30.944, 50.747**	**+2.6, +27.1**	**582**	**(2315)**	**22475**	**157**	**2017**
311	Ysj_Mymnd2	31.133, 51.333	(15.2)	694	1806, 2730	3200	279	2014
312	Ysj_Ardkn	30.389, 51.944	na	Na	550, 4400	1501593	928	2013
313	Ysj_PhnMt	30.741, 50.981	na	Na	1000, 3000	5000	275	2014
317	Ysj_Lendeh	30.982, 50.426	na	Na	na	na	145	2017
228	4MB_MtSheet	32.375, 50.874	-0.03, +25.16	349	2120, 2660	1070	212	2015
229	4MB_Sheida	32.576, 50.656	(+10.8)	435	2100, 3165	22164	316	2015
232	4MB_Jhnbn	32.174, 50.758	-0.8, +22.8	324	2150, 3300	12187	260	2016
254	4MB_Sabzkouh	31.781, 51.018	na	na	1140, 3900	54010	433	2009
259	4MB_Karsnk3	32.508, 50.462	na	450	2250, 3100	576	276	2011
183	4MB_Gheysar	32.162, 50.336	na	na	na	Na	487	2014
194	4MB_HelenPA	31.666, 50.533	na	na	na	40231	392	2014
149	4MB_Kallar	31.824, 50.957	na	na	max: 3700	na	514	2005
227	Khz_Shimbr	32.133, 49.483	+6, +34	412	400, 3400	53000	189	2015
50	Khz_Ban	30.659, 50.224	(+24.5)	350	540, 1701	2125	202	2010
91	Khz_Behbahan	30.648, 50.160	(+24.5)	350	250, 300	75	82	2011
97	Khz_Alaa	31.117, 49.667	na	na	339, 3597	229903	382	2011
174	Khz_Dehdez	31.793, 50.067	(+19.1)	596	1950, 2204	238	240	2013
2	Isf_Vanak	31.473, 51.274	-19, +38	398	1650, 4034	40000	614	2004
7	Isf_Chadegan	32.805, 50.657	+1.65, +17.9	324.3	1950, 3915	10000	339	2011
9	Isf_Hanna	31.05, 51.666	+3.6, +20.02	382.5	2389, 3050	20452	307	2010
44	Frs_ParishanLake	29.510, 51.770	(+22.2)	434.4	(820)	4187	54	2009
145	Frs_Ghadamgah	30.25, 52.4170	na	na	1660	na	47	2007

* na: not available. ** α-diversity is refered to here as the mean species diversity in each site as was introduced by Whittaker (1972). 106: Yasouj, Dena; 107: Yasouj, Dena (Dezh Mt. & Three Peaks); 178: Yasouj, SW Forests of Iran- Vezg; 249: Meyantangan Mt. Refuge, E-Dena; 303: Saverz Mt; 306: Yasouj, Jokhaneh plain; 311: Yasouj, Meymand PA; 312: Yasouj region, Ardakan; 313: Yasouj, Pahn Mt. and Eshgar; 317: Flora of Lendeh; 228: Flora Mt. Sheet; 229: Flora of Sheida PA; 232: Flora of Mt. Jahanbin; 254: Flora of Sabzkouh Mt.; 259: Flora of Karsanak; 183: Flora of Gheysari rangelands; 194: Flora of Helen PA; 149: Flora of Kallar Mt.; 227: Flora of Shimbar PA; 50: Khuzestan, Behbahan, Tang-e Ban; 91: Khuzestan, Behbahan, River Forest; 97: Khuzestan, Alaa and Rood-Zard; 174: Flora of burned forest areas in Dehdez; 2: Isfahan, Semirom,Vanak; 7: Isfahan, Chadegan; 9: Isfahan, Semirom, Hanna; 44: Fars, Parishan lake; 145: Fars, Ghadamgah spring. PA: Protected area.

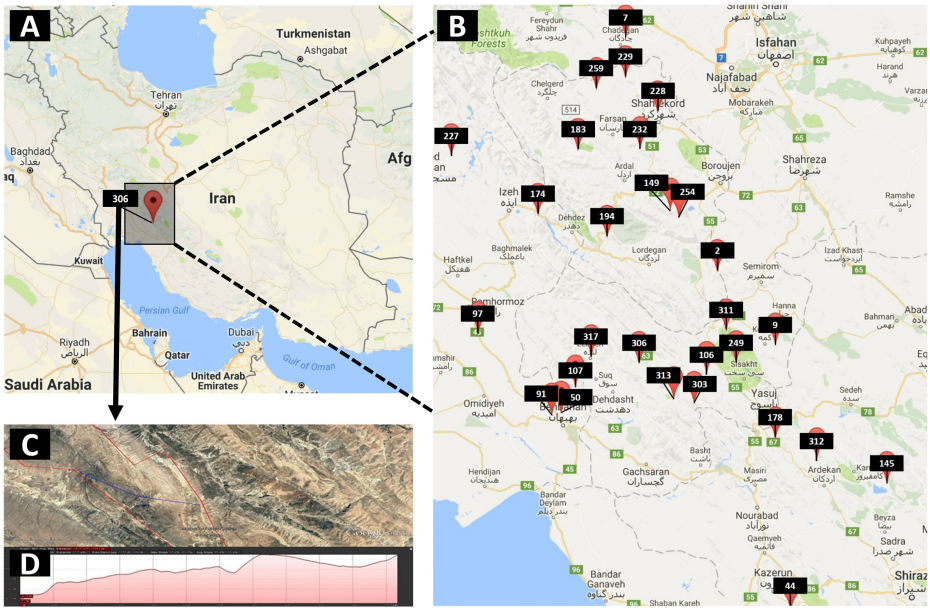


Fig. 2. Study area in the map of Iran: (A), and among nearby local floras (B). Satellite view (C), and the elevation profile (D) retrieved from Google Earth software package.

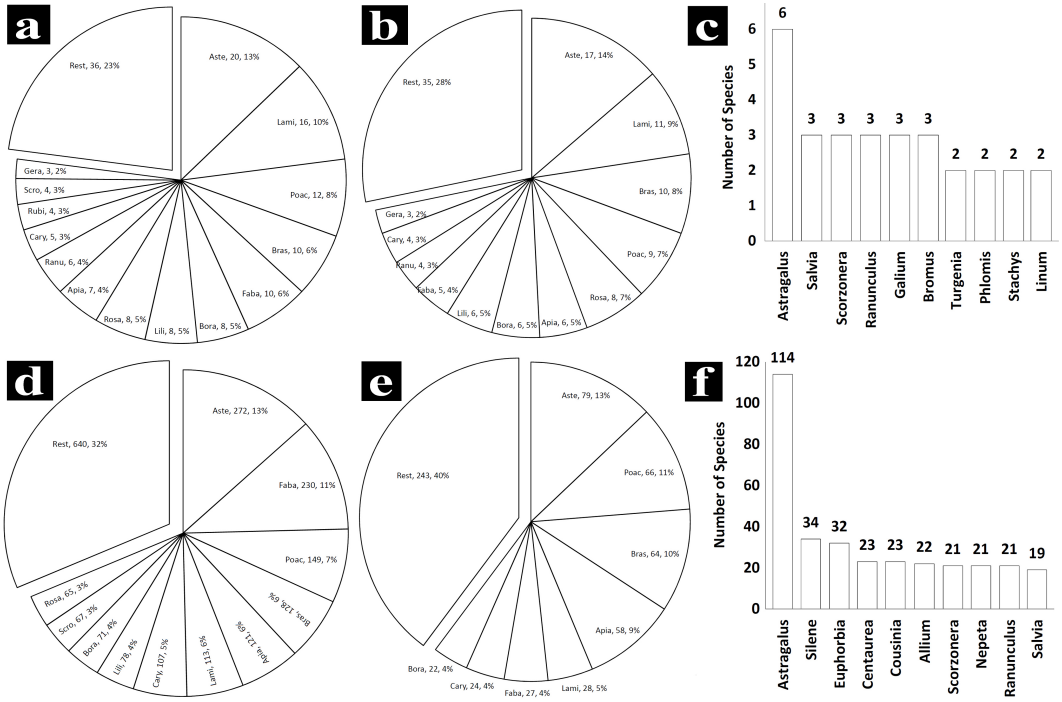


Fig. 3. Important families and genera in the studied area and region. **a**: number and percentage of species in the most species-rich families. **b**: number of genera in the most genus-rich families. **c**: number of species in the 10 most species-rich genera. **d**: number and percent of species in the most species-rich families in the region. e: number of genera in the most genus-rich families in the region. **f**: number of species in the 10 most species-rich genera in the region. Poac: *Poaceae*, Faba: *Fabaceae*, Bras: *Brassicaceae*, Lami: *Lamiaceae*, Cary: *Caryophyllaceae*, Apia: *Apiaceae*, Lili: *Liliaceae*, Rubi: *Rubiaceae*, Bora: *Boraginaceae*, Ranu: *Ranunculaceae*, Euph: *Euphorbiaceae*, Poly: *Polygonaceae*.

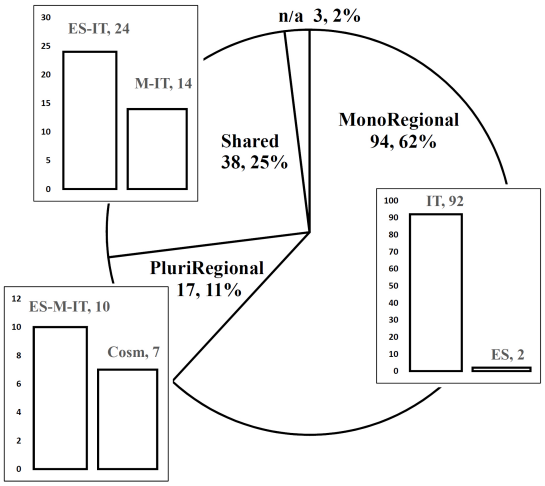


Fig. 4. Percentage and number of plants belonging to each chorotype in the studies area. ES: Euro-Siberian, M: Mediterranean, IT: IranoTuranian, SS: SaharoSindian.

Floristic diversity of the region

Our finding showed that there were 140 shared taxa between the studied area and the region which the most observed shared taxa were of the families Asteraceae and Lamiaceae (16 taxa each); Brassicaceae (10 taxa); Fabaceae (9 taxa); Poaceae and Rosaceae (8 taxa each) and Liliaceae (7 taxa). Our results demonstrated 11 species in Jokhaneh plain and Mt. Nil were new records (asterisks in Appendix 1) in local floristic studies, in this region. Total number of species present in the region consisting of 28 floras, was 2040 (consisting of 309 monocots, 1714 dicots, 7 angiosperms and 10 pterophytes). Flora of Jokhaneh plain and Mt. Nil was the 23rd species rich flora among 28 local floras (8th in the province). Flora of Ardakan (ID 312), Mt. Savers (ID 303), and Meymand (ID 311) were three most species rich floras in the province (see Table 1). Flora of the region consisted of 100 families and 611 genera. Species to family, species to genera and genera to family ratios were 20.41, 3.34

and 6.11, respectively. Low average sp/gen ratio, appears to be related to Zagros region being a refugium during the last glacial maximum (LGM) (Mashkour *et al.*, 2009), where, many species did not survive. Species to family, species to genera and genera to family ratios in this region were comparable to those for another study in northern part of central Zagros region, with 24 local floras mainly located in Lorestan, Hamedan, Kermanshah and Khuzestan provinces (Veiskarami and Sharifi-Tehrani, 2017). γ-diversity value which is defined by Whittaker (1972) as the total species diversity in the region, in our dataset comprising 28 local floras showed that about 27% of the known species in flora of Iran exists in this region. β-diversity between all pairs of local floras (Appendix 2) ranges from 27 (between floras of Savers; ID: 303, and flora of Mt. Pahn, ID: 313) to max 926 (between floras of Parishan Lake; ID: 44, and flora of Ardakan, ID: 312). Values demonstrated high floristic variations between 28 local floras.

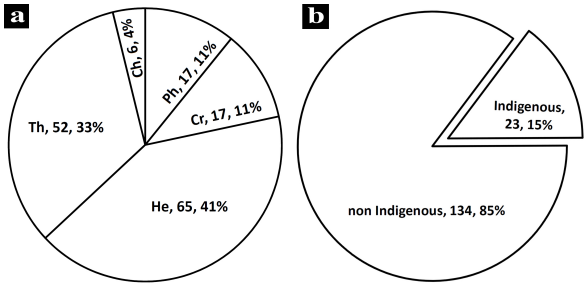


Fig. 5. Determination of Raunkiaer life-forms: (**a**): Life forms, Ph: Phanerophytes, He: Hemicryptophytes, Th: Therophytes, Ch: Chamaephytes, Cr: Cryptophytes. (**b**): Endemics (indigenous plants).

Five most species-rich families are Asteraceae, Fabaceae, Poaceae, Brassicaceae and Apiaceae. The richest genera are *Astragalus* (114), *Silene* (34), *Euphorbia* (32), *Centaurea* (23), *Cousinia* (23) and *Allium* (22).

New reports of Jokhaneh plain and southern slope of Mt.Nil

Eleven species found in Jokhaneh plain and Mt. Nil were not previously collected from the region consisting 27 local floras (denoted by asterisks in Appendix 1). These include the endemic species *Astragalus spachianus* Boiss. & Buhse (in the southern bound of its distribution in Iran), and the rare medicinal plant species *Malva verticillata* L. which was reported just once since 1989, in a recent floristic study in the Hamun Lake basin (Keshavarzi *et al.*, 2017). These new collections, denote the importance of the studied area for conservation programs and also show the need for more intense collections in the region for more possible populations of these rare species. There may be morphological variations between populations of these species and their more distant populations in other parts of Iran, which merit attention.

Multivariate analysis

Usefulness of cluster analyses using UPGMA and the NMDS methods in identifying transition zones and for grouping of areas and regions are demonstrated by Kreft and Jetz (2010). To investigate the floristic similarities between the local floras in the central Zagros region, 10 local floras (including Jokhaneh plain and Mt. Nil) in Kohgiluyeh va Boyerahmad province, eight local floras in Chaharmahal va Bakhtiari province, five local floras in Khuzestan province, three local floras in Isfahan province, and two in Fars province (Table 1) are considered in the construction of the data matrix. Among them, local floras in the Khuzestan plain which are connected to the Zagros oak forests through western foothills of Zagros chain (Akhani, 2004) are less investigated than other parts. The 28 nearby local floras (Table 1) in the central Zagros region are clustered into four groups by using 'net clustering' of occurrence data (Fig. 6). Flora of Jokhaneh plain and Mt. Nil is grouped in a cluster (cluster IV in Fig. 6) consisting of eight floras (six other local floras in Kohgiluyeh va Boyerahmad province; IDs: 106, 107, 249, 303, 313, 317) and one local flora in south of Isfahan province (flora of Hanna, ID=9). Cluster I consists of seven local floras, located in southern part of Bakhtiary province and also consist of two floras in Kohgiluyeh va Boyerahmad province and one in Isfahan. Flora of Ardakan area in this cluster is not geographically located near to other members of this cluster, however, floristic

similarities based on occurrence of shared species, groups it within cluster I. Cluster II consists of five local floras mainly located in northern Bakhtiary province. It constitutes of two sub clusters, one of which encompasses 3 near local foras in Chadegan, Sheida and Karsanak areas, and the other embraces floras of Mt. Sheet and Mt. Jahanbin, both located around the Shahrekord city. Cluster III embraces the rest of datasets, mainly from Khuzestan and Fars provinces in the southern part of central Zagros region. Resultant groupings which is shown in Fig. 7 demonstrates that the plant species diversity is distributed according to geographical location of the sites. Topography, elevation, latitude and slopes of the Zagros chain have shaped the pattern. Phytogeographical regionalization is important for answering certain questions in the fields of phytogeography, evolution and conservation. Application and usefulness of multivariate technics are recently shown in analysis of species occurrence data for classification of local floras in Iran (Veiskarami and Sharifi-Tehrani, 2017; Jalali *et al.*, 2016). This study evaluated biogeographical borders between 28 local floras in the central Zagros region of Iran.

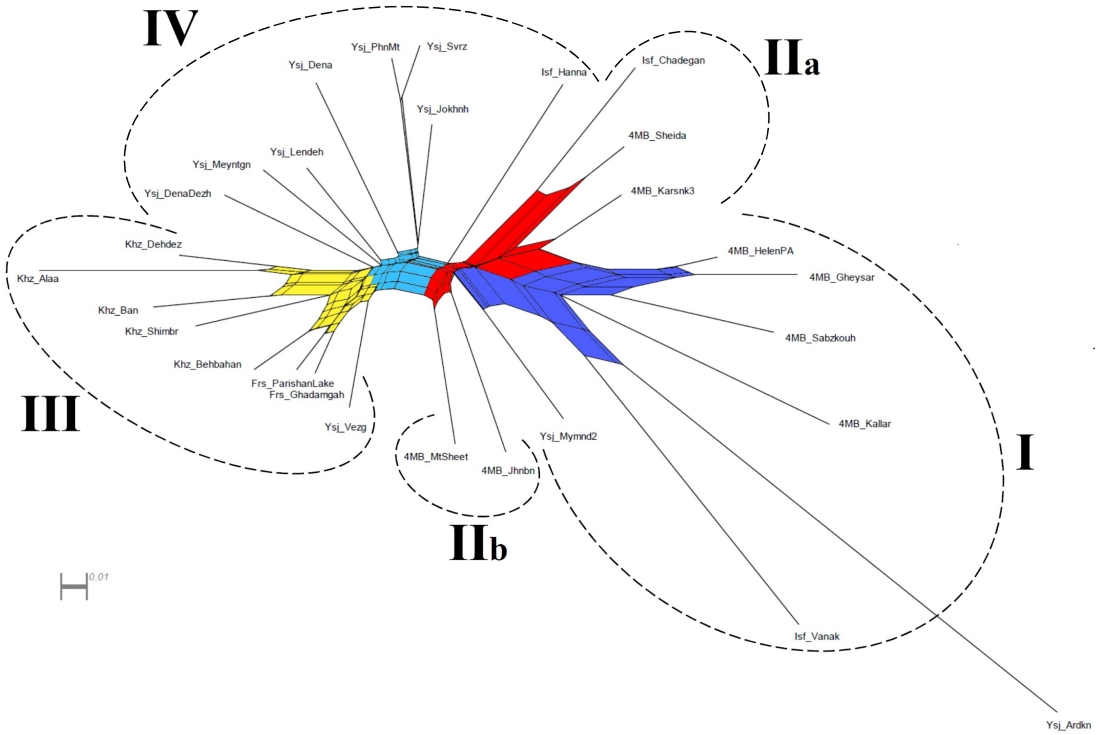


Fig. 6. Multivariate analysis of presence/absence of species in the studied area and its nearby local floras. Analysis of data matrix using a Neighbor Net Clustering Method. Abbreviations are similar to Table 1

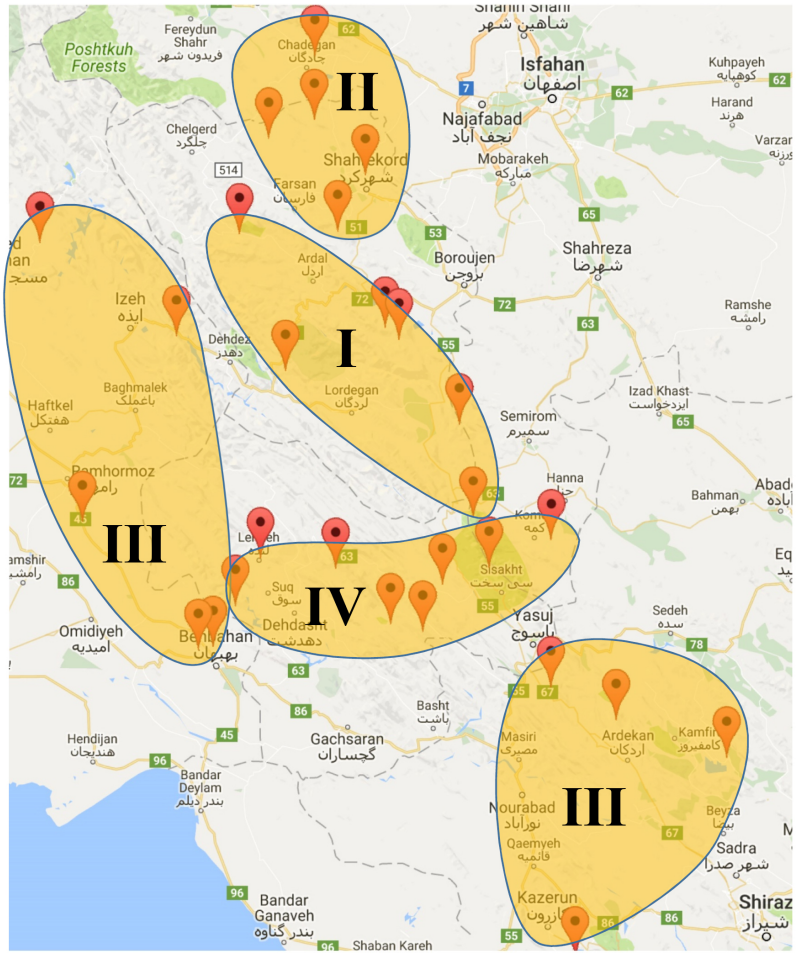


Fig. 7. Map of the region showing four groups in cluster analysis. For names of each local flora, refer to Table 1 and Fig. 2.

Conclusion

Management policies are needed to protect plant species diversity of Jokhaneh plain and Mt. Nil. Diversity of plant species in this local flora is relatively high. Although different impacts (such as exploiting by human, livestock grazing, mining, farming and promenading and being surrounded by cities) exists, management strategies may help to maintain its valuable diversity. Overgrazing is considered as the main impact here, as in all other parts of the Zagros chain (Veiskarami and Sharifi-Tehrani, 2017; Jalali *et al.*, 2016; Dehghani *et al.*, 2015; Shirmardi *et al.*, 2011; Abrari-Vajari *et al.*, 2014; Abrari and Veiskarami, 2005; Pilehvar *et al.*, 2010), althouth this requires a detailed study to be approved. Monitoring changes in diversity at species level, is a prerequisite for researchers to identify factors impacting ecosystems, and to design proper management strategies. Therefore, more intense floristic studies must be conducted in this floristic rich region.

Acknowledgments

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Appendix

Floristic list of Jokhaneh Plain and southern slope of Nil Mt; and so Beta diversity values for each pair of local floras bring in the Appendix 1 and 2, respectively.

Appendix 1. Floristic list of Jokhaneh Plain and southern slope of Nil Mt., with classification, Chorotype (CT), Life Form (LF), Endemism (End) and Medicinal plants (Med) 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, Med: Medicinal plant, *: New report from the region (refer to text).

Class/Family	Species name	LF	CT	End/Med
Liliopsida				
Amaryllidaceae	*Ixiolirion tataricum* (Pall.) Herb. & Traub	Ge	IT	
Araceae	*Arum giganteum* Ghahr.	Ge	IT	End
Liliaceae	*Bellevalia* sp.	Ge	IT	
	Colchicum robustum Stef.	Ge	IT	
	Fritillaria imperialis L.	Ge	IT	Med
	Fritillaria persica L.	Ge	IT	
	Gagea gageoides (Zucc.) Vved.	Ge	IT	
	Gagea sp.	Ge	IT	
	Muscari neglectum Guss. ex Ten.	Ge	PL	
	Ornithogalum umbellatum L.	Ge	IT	
Poaceae	*Alopecurus arundinaceus* Poir.	Hem	IT-ES-M	
	Bromus danthoniae Trin. ex C.A.Mey.	Th	IT	
	Bromus squarrosus L.	Th	Cosm	
	Bromus tectorum L.	Th	IT-ES	
	Catabrosella humilis (M.Bieb.) Tzvelev ssp. *calvertii*	Hem	IT-M	*
	Elymus longearistatus (Boiss.) Tzvelev	Hem	PL	*
	Eragrostis curvula (Schrad.) Nees	Th	IT	*
	Heteranthelium piliferum Hochst. ex Jaub. & Spach	Hem	IT-ES-M	
	Hordeum brevisubulatum (Trin.) Link ssp. *iranicum*	Hem	IT	End
	Hordeum bulbosum L.	Ge	IT	
	Poa bulbosa L.	Th	IT	
	Secale strictum C.Presl var. *strictum*	Hem	PL	*
Magnoliopsida				
Aceraceae	*Acer monspessulanum* L.	Ph	IT	End
Anacardiaceae	*Pistacia atlantica* Desf. ssp. *mutica*	Ph	IT	Med
	Rhus coriaria L.	Ph	IT-M	Med
Apiaceae	*Chaerophyllum macropodum* Boiss.	Hem	IT	
	Eryngium billardierei Heldr. ex Boiss.	Hem	IT	Med
	Prangos ferulacea Lindl.	Hem	IT	
	Scandix aucheri Boiss.	Th	IT	*
	Smyrnium cordifolium Boiss.	Hem	IT	Med
	Turgenia latifolia Hoffm.	Th	IT	
	Turgenia lisaeoides C.C.Towns.	Th	IT-ES	
Asteraceae	*Achillea wilhelmsii* K.Koch	Hem	IT-ES	Med
	Anthemis odontostephana Boiss.	Th	na	Med
	Centaurea sp.	Hem	IT	
	Centaurea virgata Lam.	Hem	IT	
	Cousinia bachtiarica Boiss. & Hausskn.	Hem	IT	End
	Crepis sancta (L.) Babc.	Th	IT-M	
	Crupina crupinastrum Vis.	Th	IT-M	
	Echinops ritrodes Bunge	Hem	IT	End, Med
	Gundelia tournefortii L.	Hem	IT-M	Med
	Onopordum berardioides (Boiss.) Sch.Bip.	Hem	IT	*
	Picnomon acarna (L.) Cass.	Hem	IT-M	
	Scariola orientalis (Boiss.) Soják	Hem	IT	
	Scorzonera lanata Schrank	Ge	IT	*
	Scorzonera papposa DC.	Ge	IT	*
	Scorzonera sp.	Ge	IT	
	Serratula bachtiarica Boiss. & Hausskn. ex Boiss.	Hem	IT	End
	Sonchus asper (L.) Hill	Th	IT-M	
	Tanacetum polycephalum Sch.Bip.	Hem	IT-ES	Med
	Taraxacum sp.	Hem	IT	
	Tragopogon graminifolius DC.	Hem	IT	
Boraginaceae	*Arnebia decumbens* Coss. & Kralik	Th	PL	End
	Myosotis sp.	Th	na	
	Onosma microcarpa DC.	Hem	IT	
	Onosma platyphylla Riedl	Hem	IT	End
	Rindera lanata Bunge	Hem	IT-ES	
	Rindera sp.	Hem	na	
	Rochelia disperma (L.) Wettst.	Th	IT	
	Solenanthus circinatus Ledeb.	Hem	IT-ES	
Brassicaceae	*Alyssum* sp.	Th	IT	
	Arabis nova Vill.	Th	IT-ES	
	Capsella bursa-pastoris (L.) Medik.	Th	IT	Med
	Cardaria draba (L.) Desv.	Th	Cosm	
	Erysimum repandum L.	Th	Cosm	
	Neslia apiculata Fisch., C.A.Mey. & Avé-Lall.	Th	IT	
	Raphanus raphanistrum L.	Th	IT-ES	
	Sinapis arvensis L.	Th	IT-M	
	Sisymbrium irio L.	Th	IT-ES	
	Thlaspi arvense L.	Th	IT-ES	
Campanulaceae	*Campanula cecilii* Chitt.	Th	IT	
Caprifoliaceae	*Lonicera* sp.	Ph	IT	Med
Caryophyllaceae	*Cerastium dichotomum* L.	Th	PL	
	Paronychia sp.	Hem	IT	
	Silene chlorifolia Sm.	Hem	IT	
	Silene conoidea L.	Th	IT-M	
	Vaccaria grandiflora Jaub. & Spach	Th	IT	
Chenopodiaceae	*Chenopodium album* L.	Th	IT-ES	Med
	Chenopodium foliosum Asch.	Th	IT-ES	
Convolvulaceae	*Convolvulus arvensis* L.	Hem	IT- ES	Med
Dipsacaceae	*Pterocephalus canus* Coult. ex DC.	Hem	IT	
Euphorbiaceae	*Euphorbia descipiens* Boiss. & Buhse	Hem	IT	End, Med

Class/Family	Species name	LF	CT	End/Med
Fabaceae	*Astragalus aegobromus* Boiss. & Hohen.	Ch	IT	
	Astragalus fasciculifolius Boiss.	Ch	IT	End
	Astragalus grammecalyx Boiss. & Hohen.	Ch	IT	
	Astragalus kirrindicus Boiss.	Hem	IT	End
	Astragalus spachianus Boiss. & Buhse	Ph	IT	End, *
	Astragalus susianus Boiss.	Hem	IT	End
	Lotus corniculatus L.	Hem	IT-ES-M	End
	Medicago sativa L.	Hem	Cosm	
	Melilotus officinalis (L.) Lam.	Th	PL	Med
	Ononis spinosa L.	Hem	IT	
Fagaceae	*Quercus brantii* Lindl.	Ph	IT	Med
Gentianaceae	*Gentiana olivieri* Griseb.	Th	IT	Med
Geraniaceae	*Biebersteinia multifida* DC.	Ge	IT	
	Erodium cicutarium (L.) L'Hér.	Th	IT-ES-M	
	Geranium tuberosum L.	Ge	IT	Med
Juglandaceae	*Juglans regia* L.	Ph	IT	Med
Lamiaceae	*Acinos graveolens* Link	Th	IT-ES-M	Med
	Ballota aucheri Boiss.	Hem	IT	
	Eremostachys macrophylla Montbret & Aucher	Hem	IT	
	Lamium amplexicaule L. var. *amplexicaul*	Th	IT-ES	
	Marrubium vulgare L.	Hem	IT-ES	Med
	Mentha longifolia (L.) L. var. *chlorodictya*	Hem	IT	End, Med
	Nepeta glomerulosa Boiss.	Hem	IT	End, Med
	Phlomis elliptica Benth.	Hem	IT-ES	End, Med
	Phlomis olivieri Benth.	Th	IT	Med
	Salvia hydrangea DC. ex Benth.	Hem	IT-M	Med
	Salvia sclarea L.	Hem	IT-ES	Med
	Salvia virgata Ortega.	Hem	IT	Med
	Stachys lavandulifolia Vahl	Hem	IT	Med
	Stachys pilifera Benth.	Hem	IT	End, Med
	Ziziphora capitata L. ssp. capitata	Th	IT	Med
	Ziziphora tenuior L.	Th	IT	Med
Linaceae	*Linum album* Kotschy ex Boiss.	Th	IT-M	End, Med
	Linum usitatissimum L.	Hem	IT	End, Med
Malvaceae	*Malva neglecta* Wallr	Th	IT-ES-M	Med
	Malva verticillata L.	Th	IT-ES-M	Med, *
Moraceae	*Morus nigra* L.	Ph	IT-ES-M	Med
Morinaceae	*Morina persica* L.	Hem	IT-ES	
Orobanchaceae	*Orobanche* sp.	Hem	IT-M	
Papaveraceae	*Papaver dubium* L.	Hem	IT	End, Med
	Papaver rhoeas L.	Th	PL	Med
Plantaginaceae	*Plantago lanceolata* L.	Hem	IT- ES	Med
Plumbaginaceae	*Acantholimon melananthum* Boiss.	Ch	IT	
Polygonaceae	*Polygonum aviculare* L.	Ch	IT	
	Rumex acetosa L.	Hem	IT	Med
Ranunculaceae	*Adonis aestivalis* L.	Th	IT-ES-M	
	Ceratocephala falcata (L.) Pers.	Th	IT-ES	
	Ficaria kochii (Ledeb.) Iranshahr & Rech.f.	Hem	IT	
	Ranunculus arvensis L.	Ge	IT-M	
	Ranunculus grandiflorus L.	Th	IT	
	Ranunculus macrocarpus Pritz.	Hem	IT	*
Rosaceae	*Amygdalus lycioides* Spach	Ph	IT	End, Med
	Cerasus pseudoprostrata Pojark.	Ch	IT	
	Cotoneaster luristanicus G.Klotz	Ph	IT	Med
	Crataegus pontica K.Koch	Ph	IT	Med
	Malus orientalis Uglitzk. ex Juz.	Ph	Hyre	Med
	Pyrus glabra Boiss.	Ph	IT	End
	Rosa beggeriana Schrenk	Ph	IT	Med
	Sanguisorba minor Bertol. ssp. *minor*	Hem	IT-ES-M	
Rubiaceae	*Callipeltis cucullaris* (L.) DC.	Th	IT	
	Galium aparine L.	Th	IT	
	Galium mite Boiss. & Hohen.	Hem	IT	
	Galium verum L.	Hem	IT	
Salicaceae	*Populus euphratica* Oliv.	Ph	IT	
Scrophulariaceae	*Linaria elymaitica* (Boiss.) Kuprian.	Hem	IT	
	Linaria fastigiata Chav.	Hem	IT	
	Veronica arvensis L.	Hem	IT-M	
	Veronica orientalis Mill.	Th	IT-ES	
Solanaceae	*Hyoscyamus reticulatus* L.	Hem	IT-ES	Med
	Solanum nigrum L.	Hem	Cosm	Med
Thymelaeaceae	*Daphne mucronata* Royle	Ph	IT	Med
Valerianaceae	*Valerianella discoidea* (Willd.) Loisel.	Th	IT	Med
Violaceae	*Viola odorata* L.	Th	IT-ES	Med
	Viola tricolor L.	Th	ES	Med
Vitaceae	*Vitis vinifera* L.	Ph	IT-ES	

Appendix 2. Beta diversity values for each pair of local floras. ID number of local floras same as IDs in Table 1. Gamma diversity value is: 2040.

	2	**7**	**9**	**44**	**50**	**91**	**97**	**106**	**107**	**145**	**149**	**174**	**178**	**183**	**194**	**227**	**228**	**229**	**232**	**249**	**254**	**259**	**303**	**306**	**311**	**312**	**313**
7	612																										
9	580	410																									
44	625	367	335																								
50	685	493	453	244																							
91	655	415	375	122	204																						
97	738	590	550	403	335	369																					
106	635	423	393	262	368	288	503																				
107	613	411	377	212	306	242	427	344																			
145	624	358	332	83	245	127	414	253	219																		
149	651	555	481	542	626	572	657	510	564	519																	
174	633	459	407	272	246	260	277	364	312	273	570																
178	601	373	353	168	288	196	429	278	272	167	524	296															
183	556	486	442	511	589	549	594	489	505	500	411	511	497														
194	541	435	383	420	494	458	517	420	412	411	416	430	426	135													
227	648	446	402	217	273	229	394	335	303	220	565	305	281	528	429												
228	558	398	340	263	371	279	514	339	333	254	485	375	277	438	375	348											
229	553	215	327	336	444	384	529	408	368	341	490	396	350	379	332	401	325										
232	540	410	374	315	411	341	502	375	365	306	467	377	309	420	375	382	270	347									
249	600	390	356	209	323	237	448	325	273	202	515	323	247	480	401	288	316	357	358								
254	582	516	446	455	505	481	554	471	463	442	445	473	463	296	257	450	440	437	414	444							
259	541	367	355	308	416	348	503	380	346	299	450	382	318	281	246	375	277	224	291	341	391						
303	571	437	417	332	420	366	523	340	378	315	496	398	330	461	404	381	363	402	361	361	449	370					
306	582	376	356	199	303	229	440	273	267	194	479	307	219	460	379	288	284	341	306	254	426	303	265				
311	545	361	371	312	396	340	495	372	348	317	508	362	308	443	378	373	309	280	355	321	441	314	386	309			
312	809	835	803	**926**	896	912	839	886	904	923	824	840	894	727	736	895	845	780	833	851	793	796	814	883	694		
313	573	427	399	310	400	344	511	330	368	295	496	384	304	469	404	361	347	392	353	333	449	354	**78**	253	362	824	
317	588	380	336	183	307	217	426	277	243	180	493	303	215	450	371	264	292	333	330	230	410	309	315	222	305	885	295

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