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Floristic Study of *Anagyris foetida* L. Stand in Kermanshah Province (Iran)

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ABSTRACT

Western forests of Iran are considered the richest biological resources of Iran. The rangelands of forest provide the bulk of the forage needed for livestock of nomads and villagers in the region. Therefore, research on this forest vegetation is very necessary. In this research, the studied area is part of the middle-sized Zagros forest ecosystem located in the Kaseh-Garan of Gilan-e-Gharb area (Kermanshah province, Iran). This research aims to achieve the effect of the canopy cover of bean trefoil (*Anagyris foetida)* as a nursing plant in identifying accompanying species and also identifying the dominant flora of the region. For this purpose, 55 samples were taken based on a randomized pattern with 100 * 100 m network dimensions. By inserting 1 × 1 m microplates into each plot, the total number of plants per unit area was investigated. The results of land surveying in the forests of the region showed that *A. foetida* with 61.5% had the highest coverage. Also, all of the plant specimens of this area were collected and identified using botanical resources in the Razi University herbarium (RUHK). In the floristic study, a total number of 333 plant species were belong to 225 genera and 58 families. Among the plant families, Asteraceae had the highest number of plant species with about 19%. In terms of life forms, the highest percentage for both therophytes and hemicritophytes (41%) were found. In the chorological study, the highest frequency related to the Irano-Turanian elements (66%), Irano-Turanian, and Mediterranean areas (9%), Irano-Turanian, the Mediterranean, and Euro-Siberian (8%), Irano-Turanian and Euro-Siberian (7%), and remaining 10 percent related to species with other geographical distribution in the area. Although the Kaseh-Garan area is phytogeographically related to Irano-Turanian, elements from the Mediterranean and Sahara-Sindian have infiltrated this region. Therefore, the presence of bean trefoil stand (with 61.5% coverage), high floristic diversity, and special vegetation of Kaseh-Garan shows the importance of this region and the protection of vegetation in this area is necessary.

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Introduction

M By identifying and introducing the plants of an area, the potential and vegetative ability of the area can be determined. This vegetation area covers a large part of the Zagros Mountains, which is home to the country's semi-arid forests. This area covers 3.4% of the soil area of Iran and 69% of the flora of Iran is the element of this area (Safari, 2009). The canopy of trees and forest shrubs, especially in desert and arid areas, due to different effects on the environment, plays an important role in the establishment or non-establishment of associated species. Various researchers have described these effects in different ways. Tree coverings have a great impact on the environment, especially the microclimate. The effect of the presence of trees and their canopy on air flow, changes in

temperature and humidity, water regime and soil moisture as well as material exchange is known (Hosseinzadeh *et al.*, 2015). The density of forest cover is one of the most important quantitative characteristics that is considered in the planning and implementation of forestry projects and especially in the rehabilitation of degraded forests. Since the vegetation in the forests of Zagros is not able to produce wood that can be used in the relevant industries, so the volume of forest mass can not be used as a factor to study and measure (Mahdavi *et al*., 2014). Therefore, another characteristic such as canopy should be used to study the evolution of vegetation (Yeganeh *et al.,* 2012). The diversity of perennial species below and outside the crown of *Acacia tortilis* (Forssk.) Hayne was the same, but not for annuals. Various factors affect the diversity and number of species below and outside the canopy of tree and shrub species.

Types of tree and shrub species, exploitation status, age and height of the tree, freshness, and decay of plant organs under the canopy, climatic and habitat conditions, species competition, and other side effects are among these factors. Ecological effects of trees under canopies include reduced sunlight, temperature, evaporation from the soil surface, transpiration from the limbs of the species under the canopy, and reduced soil erosion at the canopy surface. While the soil moisture content under the canopy and its shelf life is higher, the soil volume density is higher and the soil organic matter and sometimes minerals are higher (Shabankareh, 2003). One of the unique habitats in the forests of Zagros belongs to the *Anagyris foetida* L. forest with 231 shrubs per hectare (Salimi *et al*., 2019). The specialized habitat of this plant in Iran with an area of 170 hectares is located 5 km from the city of West Gilan-Garb (Iran) and is rarely scattered in the neighboring region (Sabzi *et al.*, 2018). The dense foliage of the *A. foetida* dramatically prevents the intensity of rainfall on the ground, and the water slowly sinks to the ground at the foot of the shrub, which also makes it more permeable. Therefore, the presence of moisture at the foot of *A. foetida* causes the growth of many plants in its neighborhood (Walipur, 2015).

For accurately and scientifically recognizing the plants, classification knowledge is used. In this regard, due to the impact of the formation of new species, invasive migratory species in the flora of each area, and the sense of responsibility in the maintenance of plant species, the floristic study of each area has great importance, because it acts as a birth certificate for each area (Naghipour Borj *et al.* 2011). Safikhani *et al.* (2006) in the floristic study of the Khangormaz area in Hamadan province found that Hemicryptophyte and Therophyte biological forms had the highest percentage. Iranbakhsh *et al.* (2008) examined the flora, biological forms, and Chorotypes of the plants in Garmsar in the Semnan province and they concluded that 55.9 percent of these species belong to the Iranian-Turanian area and Therophyte sare the main biological form of Garmsar area. Dolatkhahi *et al.* (2010) in the floristic study of Parishan wetland and its surrounding identified 269 plant species and showed that among the plant families, Asteraceae is the family that has the greatest number of species and Therophytes had the highest percentage among biological forms. Also, in floristic research of one of the neighboring provinces of Kermanshah and Kermanshah province, they have been shown that among the plant families, Papilionaceae and Asteraceae families have the highest number of species (Jalilian *et al*, 2014; Nooraii *et al.*, 2014; Dehshiri, 2016; Dehshiri *et al,.* 2019;). The objective of this study is to provide basic floristic information to determine the plant species available in the area and to identify the potential of the areas and the possibility of creating proper management plans for preserving this habitat because, without information about vegetation and floristic studies as well as habitat resources of this area, principled solutions cannot be provided to protect plant genetic storages followed by careful deliberate planning to preserve, restore and expand it. Additionally, due to the importance of botany in various sciences, including biological sciences, agriculture and pharmacy, this study was conducted in the area.

Materials and Methods

Study area

The studied area is located in the vicinity of Kaseh-Garan village in East of Gilan-e Gharb

city of Kermanshah province in West of Iran. This area is one of the sub-areas of Gilan-e Gharb River with an area of 21403 hectares (Figs. 1 and 2).

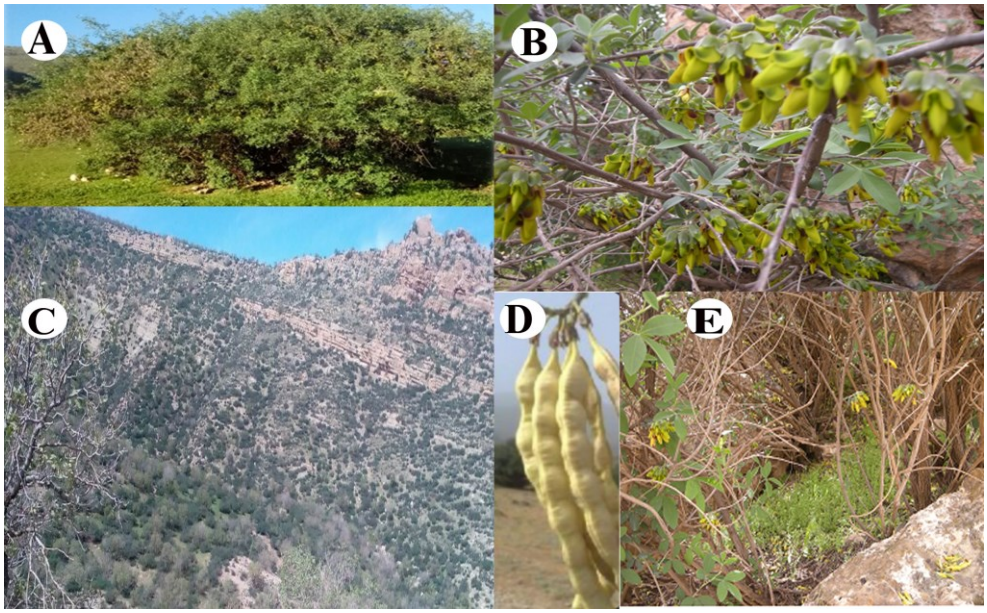

Fig. 1. The bean trefoil (*Anagyris foetida*) and its habitat in the Kaseh-Garan of Gilan-e-Gharb area (Kermanshah province, Iran: A) Bean trefoil shrub in the habitat; B) Flowering branches with compound leaves on them; C) A view of the ecosystem of Zagros forests dominated by oak, with a darker color BeanTrefoil plant in the lower and left corner of the image plants; D) Legume fruits in the bean trefoil; E) Trifolate leaves between the branches of the plant.

Its geographical coordinates included 34° 8′ to 34° 10′ in North latitude and 45 ° 9′ to 46° 1′ in East longitude. This area is limited to the Ilam Shirvan-Chardavol area from the East, Gilan-e Gharb from the west, Guaver and Kalkesh area from the north, and Zarneh and Gurtak from south. The average altitude of the study area is 1170 m above sea level, the minimum is 970 m along the Dolabi River and the maximum is 1420 m at the top of Sarkesh heights. The slope of habitat is 14% on average, which it reaches to over 50% in some points, and the mean temperature is annually between 12 °C and 18 °C, and the mean annual rainfall is between 400 mm and 500 mm (Hosseinzadeh *et al.,* 2015).

Methodology

Plant specimens were collected using field survey in the years 2015 and 2016. Along with full harvesting from each plant sample, some of the required information such as altitude and habitat characteristics was obtained. All of plant specimens were prepared in Razi University Herbarium of Kermanshah (RUHK) and using valid botanical sources, including Flora Iranica (Rechinger, 1963- 2015), Flora of Iran (Assadi, 1988-2016) and flora of Iran in natural colors (Ghahreman, 1975-2006), Iran herbs (Mobayen, 1975-1995), and plant species were identified. Geographical distribution and chorology of plant elements were determined based on classification of geographical areas and based on classification of Zohary floristic areas (Zohary, 1973).

The biological form of plant elements available in habitat was determined using the method of Raunkiaer classification of biological forms (Raunkiaer, 1934) and relevant graphs were plotted. In this system, based on position of life reinvent shoots, plants are divided into 5 categories including Phanerophytes, Chamaephytes, hemicryptophytes, Cryptophytes, and Therophytes (Figs. 3, 4). It is noteworthy that the authors' names were matched with (http://www.ipni.org (IPNI) system. List of plant species, life form and geographic distribution in Kasekaran area is in Table 2.

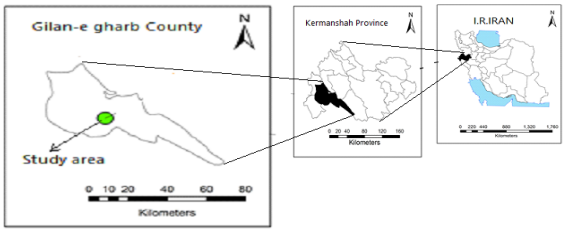

Fig. 2. Study area (Kaseh-Garan).

Results

In this study, as shown in Table 1, 5. *A. foetida* had the highest percentage of canopy cover with 61.5 and *Quercus*, *Crataegus*, *Astragalus* and wild cherry (*Cerasus microcarpa*), *Ficus* with 30.1, 6, 1.9, 0.3 and 0.2, respectively (Table 1).

Table 1. Canopy level and percentage of canopy cover of species protected by *Anagyris foetida* L. species in the mass

Species	Canopy level	Percentage canopy
A. foetida	810	61.5
Quercus	394	30.5
Crataegus	79	6
Astragalus	4	0.3
Cerasus microcarpa	3	0.3
Ficus	25	1.9
Mass	1310	100

In this study, 333 species from 58 family and 225 plant genera were identified, which the list of identified families and species in the studied area and their biological form has been shown in this study, out of 85 families, Asteraceae., Papilionaceae, and Brassicaceae with 65, 38, and 26 species had the highest percentage of species, respectively (Supplementary 1). The biological spectrum of the plants in the studied area represents the flora of the low-height mountainous areas with Mediterranean climate that results related to this biological spectrum showed that hemicryptophytes and therophytes (each with 41%) had the highest biological form of the area and Geophytes with 10%, phanerophytes with 5%, chamaephytes with 2%, and hydrophyte with 1% had the lowest biological form of the area (Figs. 3, 4).

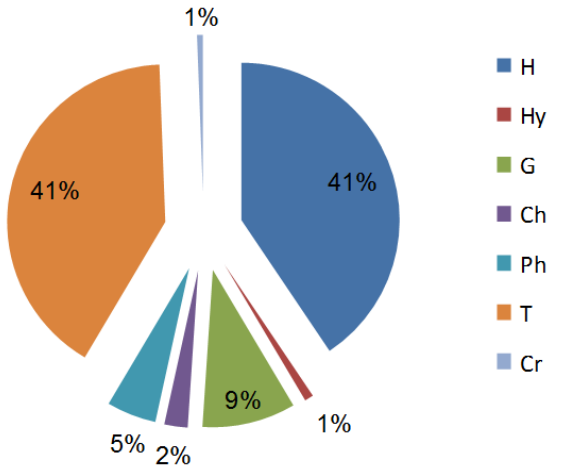

Fig. 3. Percentage of plant life forms (the Raunkiær system) in Kaseh-Garan area, Gilaneghaeb county: H) Hemicryptophyte; Hy) Hydrophyte; G) Geophyte; Ch) Chamaephyte; Ph) phanerophyte; T) Therophyte; Cr) Cryptophyte.

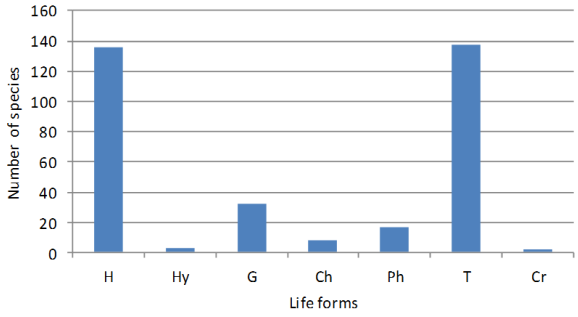

Fig. 4. Frequency of species of plant life forms in Kaseh-Garan area, Gilaneghaeb county: H) Hemicryptophyte; Hy) Hydrophyte; G) Geophyte; Ch) Chamaephyte; Ph) phanerophyte; T) Therophyte; Cr) Cryptophyte.

The presence of 10% of graphytes forms showed low degradation of vegetation in this area (Supplementary 1). Results related to geographical distribution of this area species reflect the species dominance of Irano-Turanian region. These species make up 66 percent of this area flora. Irano–Turanian and Mediterranean region (9%), Irano-Turanian, and Euro-Siberian region (7%) and remaining 10 percent related to species with other geographical distribution in the area (Fig. 5).

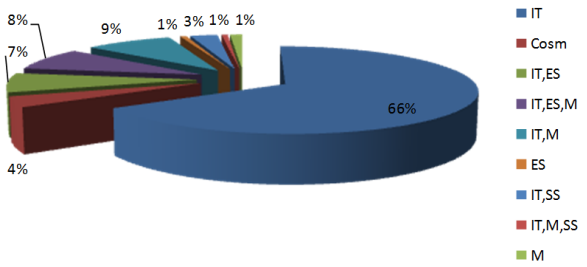

Fig. 5. Percentage of geographical distribution of plants growing regions in Kaseh-Garan area, Gilaneghaeb county: IT) Irano-Turanian; Es) Europe-Siberia; M) Mediterranean; SS) Sahara-Sandy; Cosm) Cosmopolitan.

Discussion

It has been shown that Shrub species, which are often found in arid and semi-arid lands of the world, are known as the main components of biodiversity in these areas. (Zhao *et al.*, 2017). In this study, *A. foetida* with a canopy cover of 61.5% is an important species in the diversity of its associated species (Table 1 and Supplementary 1). The presence of species facilitates the establishment and survival of other plants and plays a key role in positive relationships between species (Suzan-Azpiri & Sosa, 2006). In the Kaseh-Garan area, tree and shrubs species (*Amygdalus lycioides*, *A. foetida, Astragalus brachycalyx*, *Cerasus microcarpa*, *Crataegus azarolus*, *Paliurus spina- christii*, *Quercus brantii*) have taken on the role of nurses for other species under the canopy. Drezner's (2006) study also found that plants with smaller size and density had more positive effects on the growth and establishment of their dormant plants. The small floristic composition of a plant community is reflected in the effect of environmental factors on plants and the plants' response to adaptation to their ecological potential. The real floristic composition of a plant community is manifested as a result of the impact of environmental factors on plants and responses of plants to adapt to their ecological potentials (Drezner, 2006). It is very important compared to the researches done in other parts of Zagros mountains. In the studied area, 333 plant species of 58 families and 225 different genera grow that they have formed different communities appropriate with their ecological needs and management applied over the years (Tab. 2). The area of *A. foetida* station (Qar-e-Taj) is estimated from 170 to 520 hectares The area of *A. foetida* (Qar-e-Taj) stand is estimated from 170 to 520 hectares in Gilan-e-Gharb area (Sabzi *et al*., 2018; Hosseinzadeh *et al.*, 2015). Plants of Kase-Garan area show great diversity in comparison with other floristic researches in much larger area of Zagros Mountains. In the studied area, Asteraceae, Papilionceae respectively having 65 and 38 species had the most species, respectively, similar to other floristic studied conducted in Zagros Mountains (Dehshiri, 2016; Darvishnia *et al.*, 2012; Gurgin Karaji *et al*., 2014; Hejraneh & Keshavarzi, 2016; Naghipour Borj. *et al.,* 2011; Safikhani *et al.,* 2006). Also, the large number of species in Asteraceae, Papilionceae, and Brassicaceae were consistent with many studies conducted in Irano-Tueanian region of Iran (Ahvazi *et al.,* 2015: Dehshiri *et al*., 2019). One of the reasons for the diversity of these families is their adaptation to "insect pollination". The papilionaceous flower in Papilionaceae, Cruciform flower in Brassicaceae, and Ligulate or Tubular flowers of capitulum inflorescences in the Asteraceae family attract insects (Fedorov, 1981). It has been shown that the family Umbelliferae (Apiaceae) is the third family with high species diversity after Papilionaceae and Brassicaceae (Gurgin Karaji *et al.*, 2013). However, in the study area, due to the low altitude (1170 m above sea level), the number of different species of plants from the Apiaceae family is less.

Plant biological forms, regardless of showing their taxonomic characteristics, reflect the plant adaptation to environmental conditions. The most plant elements forming them are Cryptophyte and Therophyte vegetative form of them with the geographical distribution of Irano-Turanian. In addition, the climate of the area according to Emberger method is semi-arid cold. The vegetative form of area of the plant species arises from their adaptation to their environment is life. The result of this adaptability is a special form that hasa perfect harmony with vegetative conditions. The biological spectrum of plants is different in different climates. This means that ineach climate, the percentage of plant biological forms is different and the spectrum related to one area represents its environmental conditions (Salahi Kojour *et al.*, 2014). Dehshiri (2016) in studying the flora of Khargushan Mountains in Lorestan concluded that the highest species were

in family Fabaceae (12.79%) and Asteraceae (10.42%) and in terms of biological life form; Therophyte (36.49%) and hemicryptophyte (18.96%) had the highest percentage. Nooraii, *et al.*, (2014) in Flora study of Ghalaje area reported the hemicryptophytes as the most abundant biological form in mountainous regions of Zagros. (Sadeghi Rud *et al.*, 2014). In the flora, biological form, and Chorology of and cement watershed in Kermanshah province, concluded that hemicryptophytes with 36.28% had the highest frequency, followed by Therophytes with 32.74%, phanerophytes with 12.38%, Chamaephyte with 7.96% and Geophytes with 7.07%. In terms of chorology, the highest frequency related to Irano-Turanian region (59.29%). Ahmadi and Ahmadi (2016) in the flora biological form, and chorology study in Chagakdu ranch in Kermanshah province showed that hemicryptophytes with 35% had the highest frequency, followed by Therophytes with 33%. In terms of chorology, the highest frequency related to Irano-Turanian area and Irano-Turanian Iranian-Turanian and Mediterranean areas with 58 and 17%, respectively. In a study on protected area of Manesht and Qalarang in Ilam, hemicryptophytes with 42% and Therophytes with 32%were known as the most frequent biological form of the area. Jalilian *et al.*, (2014) in a floristic study in Bharab area in the Zagros Mountains found similar results. The presence of Therophytes can be attributed to destructions occurred in this area since overgrazing in this area and lack of observing the pasture season in the past have caused destruction and change in composition of the plant species. In addition, drought in recent years was also involved in this issue. Naghipour Borj *et al.* (2014) in a flora study of the plants in protected area of Meymand in the Shahrekord reported that the dominance of hemicryptophytes and therophytes biological forms in the area represents special flora of the central mountainous regions of Iran. On the other hand, Geophytes survive under soil in cold temperature conditions in the form of rhizomes and bulb and no member of them is seen in the winter season. According to the Archibold (1995), the frequency of hemicryptophytes in one area indicates cold and mountainous climate, since seedlings of hemicryptophytes is soil surface and among leaves in the winter. This characteristic causes that it shows soil high resistance to cold temperatures. Therefore, the frequency of the biological spectrum is affected by regional climate. In terms of chorology, the highest frequency related to elements of the Irano-Turanian area (218species), Irano-Turanian and Mediterranean areas (29 species), Irano-Turanian, Mediterranean, and European-Siberian areas (28 species) and Irano-Turanian and European-Siberian (24 species) and other species were placed in next ranks. Given 66% of area species related to vegetative elements of Irano-Turanian, it can be concluded that this area belongs to the Irano-Turanian area. It is reported that the vegetation of the Zagros region, from the standpoint of the flora, resembles the submediterranean vegetation (Mobayen & Tregubov, 1970. The presence of Mediterranean elements such as *Myrtus communis* L. located in the Gilan-e Gharb near the study area (approximately 15-20 kilometers) represents this impact. On the other hand, reducing the height of the Zagros forest area of Irano-Turanian and hot and arid climate of Sahara-Arabic have affected the vegetation of this area.

Conflict of Interest disclosure

The authors declare no competing interests.

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