

ALPINE AND SUB-ALPINE FLORISTIC STUDY OF DALAKHANI MOUNTAIN, WEST OF IRAN

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Abstract

Dalakhani Mountain, with an elevation ranging from 1800 to 3350 m a.s.l., is the third-highest massif in Kermanshah Province, following the Parrow and Shahu ranges. It represents an important montane system within the Zagros Mountains. This study aimed to document the vascular plants of Dalakhani Mountain across its alpine and subalpine elevational gradients. The results showed that Dalakhani Mountain has a rich flora with a high plant diversity. In total, 173 taxa of vascular plants, belonging to 110 genera and 35 families, were recorded. The richest families were Lamiaceae (33 species), Asteraceae (26), Fabaceae (19), Poaceae (18), and Caryophyllaceae (11). Hemicryptophytes (58.38%) and chamaephytes (16.76%) were the dominant life forms. Biogeographically, 67.05% of the species belong to the Irano-Turanian region. The flora includes 32 endemic species to Iran and 18 regional endemics shared with Iraq or Turkey. The most species-rich genera were *Astragalus* (14 species), *Phlomis* (6), *Stachys*, *Euphorbia*, and *Cousinia* (each with 5 species), and *Salvia* and *Thymus* (each with 4 species). Major environmental threats to the area include climate change and reduced precipitation, wildfires, land-use change, overgrazing, intensive trekking, and the collection of aromatic and medicinal plants. To preserve the biodiversity of Dalakhani Mountain, effective conservation actions, including the designation of protected areas and stricter regulation of human activities, are urgently required.

Keywords: Biodiversity; conservation; endemism; floristic study; Kermanshah

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بررسی فلورستیک نواحی آلبی و نیمه آلبی کوه دالاخانی در غرب ایران

نسترن جلیلیان: دانشیار پژوهش، بخش تحقیقات جنگلها و مراتع، مرکز تحقیقات و آموزش کشاورزی و منابع طبیعی استان کرمانشاه، سازمان تحقیقات، آموزش و ترویج کشاورزی، کرمانشاه، ایران.

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چکیده: کوه دالاخانی با ارتفاع ۱۸۰۰ تا ۳۳۵۰ متر از سطح دریا، سومین کوه مرتفع در استان کرمانشاه پس از رشته‌کوه‌های پرآو و شاهو محسوب می‌شود. این کوه یک سامانه کوهستانی مهم در زاگرس به‌شمار می‌رود. هدف از این مطالعه، بررسی فلور گیاهان آوندی این کوه در امتداد شیب ارتفاعی آلی و نیمه آلی بود. نتایج نشان داد که کوه دالاخانی دارای فلوری غنی با تنوع گیاهی بالاست. در مجموع تعداد ۱۷۳ آرایه از گیاهان آوندی متعلق به ۱۱۰ جنس و ۳۵ تیره در مناطق آلی و نیمه آلی جمع‌آوری و شناسایی شد. بزرگترین تیره‌های گیاهی از نظر تعداد گونه، تیره نعنا با ۳۳ گونه بود و تیره‌های کاسنی (۲۶ گونه)، باقلا (۱۹ گونه)، گندمیان (۱۸ گونه) و میخک (۱۱ گونه) در رتبه‌های بعدی قرار گرفتند. فراوانترین شکل زیستی همی‌کریپتوفیتها (۵۸/۳۸٪) و کامفیت‌ها (۱۶/۷۶٪) بودند. علاوه بر این، از نظر پراکنش جغرافیایی ۶۷/۰۵ درصد گونه‌های شناسایی شده متعلق به ناحیه ایران-تورانی هستند. در منطقه ۳۲ گونه انحصاری ایران و ۱۸ گونه انحصاری منطقه‌ای شناسایی شد که با عراق یا ترکیه مشترک می‌باشند. جنس‌های *Astragalus* (۱۴ گونه)، *Phlomis* (۶ گونه)، *Stachys*، *Euphorbia*، *Cousinia* هر کدام با ۵ گونه و *Salvia* و *Thymus* هر کدام با ۴ گونه دارای بیشترین گونه گیاهی ارتفاعات دالاخانی هستند. تغییرات اقلیمی و کاهش بارندگی، آتش‌سوزی‌ها، چرای بی‌رویه، کوهپیمایی شدید و جمع‌آوری گیاهان معطر و دارویی، تهدیدات مهمی برای تنوع زیستی این منطقه محسوب می‌شوند. اقدامات حفاظتی از جمله تعیین مناطق حفاظت شده و مدیریت فعالیت‌های انسانی، برای حفظ تنوع زیستی کوه دالاخانی ضروری است.

INTRODUCTION

Kermanshah Province covers an area of 24640 km² in western Iran. Phytogeographically, it spans two major regions: the Irano-Turanian Region/Kurdo-Zagrosian Province (Assadi 2025); or the Armeno-Iranian Province/Kurdo-Zagrosian Subprovince (Takhtajan 1986), which encompasses most of the territory; and the Saharo-Sindian Region, Nubo-Sindian Province (Assadi 2025) or the Sudano-Zambezian Region/South Iranian Province (Takhtajan 1986), in the southwestern districts. The province features 11 terrestrial habitat types, primarily shaped by the altitudinal gradient of the Zagros Mountains. These habitats support diverse vegetation, ranging from semi-arid steppes to temperate oak forests (Sagheb-Talebi & al., 2014). Bioclimatically, the region is characterized by Mediterranean Pluvioseasonal Continental and Mediterranean Xeric Continental regimes (Djamali & al. 2011). Altitudinal zonation is a key factor in plant species distribution in mountainous ecosystems, typically categorized into: lowland (sea level to 1,500 m), montane (1500 to 2800 m a.s.l.), alpine (approximately 2800 to 4400 m a.s.l.), and nival zones (above 4000 m a.s.l.) (Jafari & al. 2015). The alpine zone lies between the climatic tree line and the permanent snowline (Körner 2003), exhibits varying altitudinal limits globally due to latitudinal influences. In the Alborz and Zagros ranges of Iran, this zone shows significant geographical variability; for instance, the Alborz alpine belt is specifically delineated between 3000-4000 m a.s.l. (Noroozi & al. 2008). Despite the ecological importance of high-altitude mountain ecosystems, Research on floristic diversity in the Zagros Mountain range is scarce, with few studies

conducted (Pairanj & al. 2011; Dehshiri & al. 2016; Dehshiri & Mahdavar 2016; Noroozi & al. 2020; Akhavan Roofgar & al. 2024; Dinarvand & al. 2025). Over the past two decades, extensive floristic research has been conducted across the mountainous and semi-arid zones of the province. Key studies include a survey of the collection and identification of Kermanshah province flora (Nemati Peykani & al. 2009; Jalilian & Rahimi 2024 a,b), Bisotun protected area (Hamzehee 2016), floristic composition and plant diversity of the Baharāb and Novā Mountains (Jalilian & al. 2014; Dehshiri & al. 2017), and Qalageh protected area (Nemati Peykani & al. 2021). Logistical challenges and topographical constraints, such as rugged terrain and difficult access routes, hinder comprehensive exploration, resulting in fragmented data on plant diversity. Consequently, the plant diversity of these areas remains largely understudied or documented only through fragmented data. The objectives of this study are to assess the species diversity and identify endemic species within the region, analyze the factors contributing to their vulnerability, and propose strategies to protect and preserve biodiversity in the region.

MATERIALS AND METHODS

Study area

Dalakhani Mountain is located in the Zagros range, in northeastern Kermanshah Province, within Sonqor County, at elevations ranging from 1800 to 3350 m above sea level. This limestone massif forms a distinct high-altitude ecosystem characterized by cold, snowy winters and mild summers. It is the third-highest massif in the province, after the Parrow (3405 m) and Shahu

(3390 m) ranges, and represents an important montane environment within the Zagros. Etymologically, the name "Dalakhani" is derived from the Kurdish word Dal (eagle), meaning "nest of eagles." The massif includes several prominent peaks, such as Soheil, Dalakhani, Kal-Faraj, Gheyt-Ghaleh, Kamar-Zard, and Chalav. The twin peaks of Soheil and Dalakhani both

reach 3350 m a.s.l. and are centrally located at 34°41'25.14" N, 47°37'23.30" E and 34°41'22.06" N, 47°37'52.27" E, respectively (Fig. 1). The summit offers an outstanding topographic vantage point with a panoramic view of the northern mountain chains extending from Parrow to Bisotun.

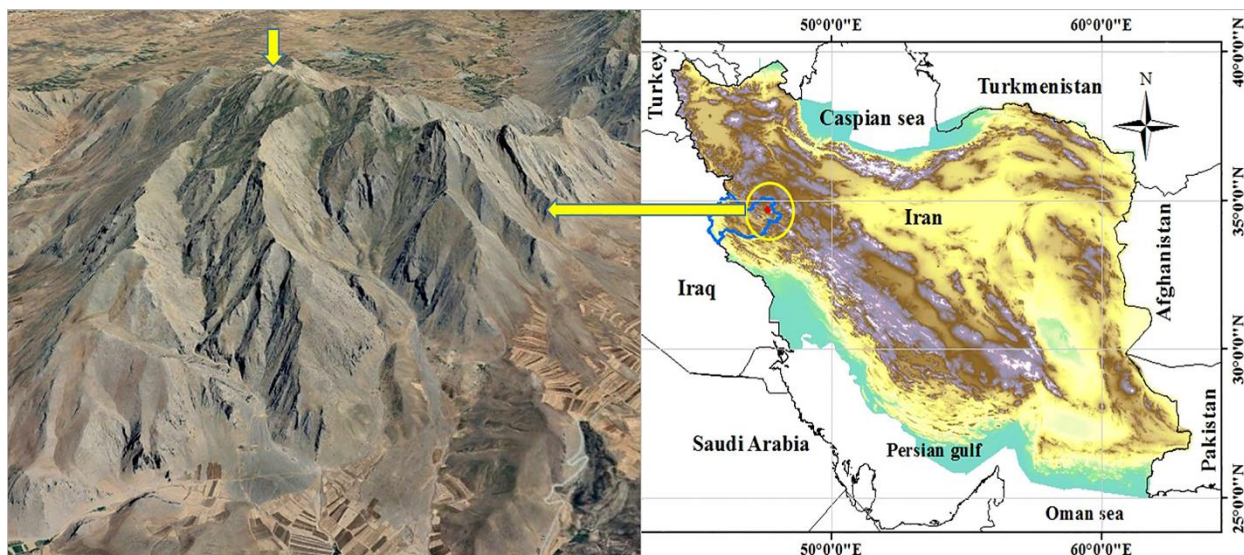


Fig. 1. Map of the study area showing its location in Iran and a view of the elevation zones on Dalakhani Mountain (1800–3350 m a.s.l.). Figure prepared by the authors.

Floristic survey

Field surveys were carried out over three years (2022–2024), and vascular plant specimens were collected from a range of elevations, slopes, and cliffs during the growing season. Plant material was sampled within three elevational belts, defined based on previous studies and local vegetation characteristics. Elevations above 2800 m a.s.l. were designated as subalpine and alpine zones, characterized by typical alpine flora, whereas elevations between 1800 and 2800 m a.s.l. were classified as montane zones. Collection routes encompassed the northern slopes (via Quri Chay and Hosseinabad villages) and the southern slopes (via Tinemo and Gavanban villages), extending toward the summit ridge. All specimens were collected, dried, mounted on herbarium sheets, and labeled with detailed information, including scientific name, family, herbarium number, altitude, coordinates, collector, and collection date. The voucher specimens are deposited in the RANK and TARI herbaria (acronyms according to Thiers 2025). Plant specimens were identified using standard floristic works, primarily Flora Iranica (Rechinger 1963–2015), Flora of Iran (Assadi & al. 1989–2024), Flora of Iraq (Townsend & Guest 1974–1985), and Flora of Turkey and the East Aegean Islands

(Davis & al. 1967–1982). Scientific names and author citations follow reliable taxonomic resources such as The Plant List (theplantlist.org) and Plants of the World Online (POWO, powo.science.kew.org). Phytogeographical elements, including Irano-Turanian (IT), Euro-Siberian (ES), and Saharo-Sindian (SS), were determined following the works of Zohary (1973), Takhtajan (1986), and Assadi & al. (1989–2024). Life forms were classified following Raunkiaer (1934) into chamaephytes (Ch), geophytes (Ge), hemicryptophytes (He), phanerophytes (Ph), and therophytes (Th).

Climate

The study area, located in Sonqor County, has a cold semi-arid climate. According to long-term meteorological data, the region experiences harsh, frigid winters with substantial snowfall and mild summers. Owing to the high-altitude terrain of Mount Dalakhani, snow cover persists on the peaks and northern cirques well into the late spring and summer months. This climatic regime is strongly shaped by the area's elevation and specific topographic features. For this study, ombrothermic diagrams were constructed using long-term data (2001–2021) from the Sonqor synoptic station to illustrate the seasonal distribution of temperature and precipitation (Fig. 2).

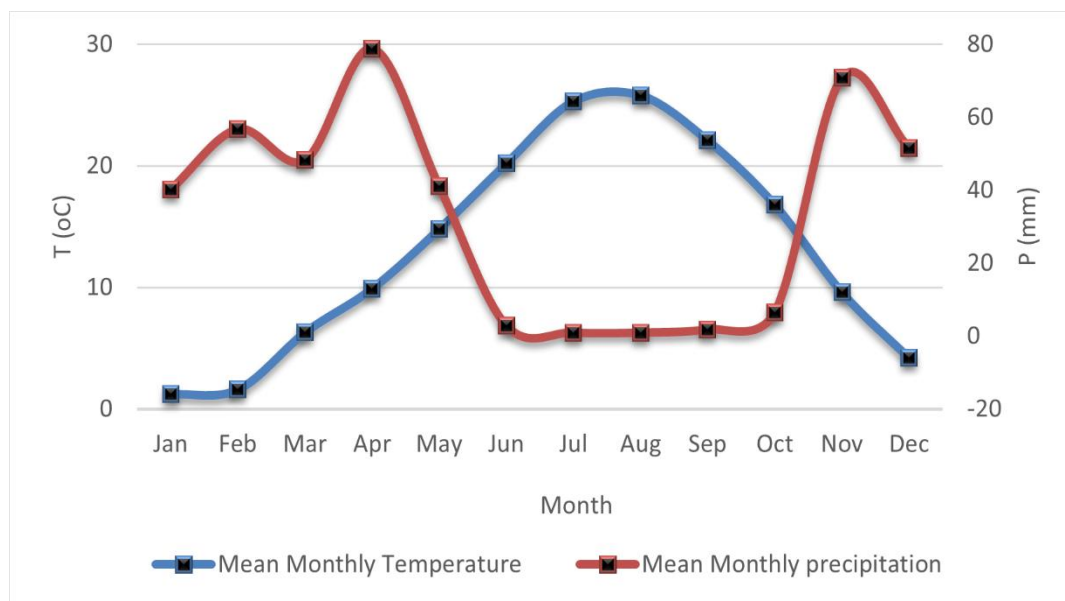


Fig 2. Ombrothermic diagram based on 2001–2021 data from the Sonqor synoptic station.

RESULTS

Species diversity

A total of 173 vascular plant species, belonging to 110 genera and 34 families, were recorded on Dalakhani Mountain. The most prevalent families were Lamiaceae (13 genera, 11.81%; 33 species, 19.07%), followed by Asteraceae (17 genera, 15.45%; 26 species, 15.02%), Fabaceae (4 genera, 3.63%; 19 species, 10.98%), Poaceae (14 genera, 12.72%; 18 species, 10.40%), Caryophyllaceae (6 genera, 5.45%; 11 species, 6.35%) and Brassicaceae (7 genera, 6.36%; 7 species, 4.04%). For comparative purposes, species richness in the study area was evaluated against the total flora of Kermanshah Province (Table 1). The most diverse genera in the alpine and subalpine zones were *Astragalus* L. (14 species, 8.09%), *Phlomis* L. (6 species, 3.46%), *Stachys* L., *Euphorbia* L., and *Cousinia* Cass. (each with 5 species, 2.89%), as well as

Salvia L. and *Thymus* L. (each with 4 species, 2.31%). The remaining genera each comprised fewer than four species. With respect to endemism, 50 species of conservation or regional significance were documented, including 32 endemics to Iran and 18 regional endemics shared with Iraq or Turkey. Furthermore, six taxa (*Astragalus aspadanus*, *A. patrius*, *Cerasus brachypetala* var. *bornmuelleri*, *Kochia prostrata* subsp. *alpina*, *Ranunculus dalechanensis*, and *Scrophularia nervosa* subsp. *boissieriana*) are known only from a single population in Kermanshah Province. Notably, *Ranunculus dalechanensis* Iranshahr & Rech. f., an alpine specialist, is a narrowly distributed local endemic restricted to this massif (Jalilian & al. 2023). A comprehensive checklist of the vascular plants recorded in the alpine and subalpine zones of Dalakhani Mountain is presented in Table 2.

Table 1. List of the most species-rich vascular plant families in alpine and subalpine zones.

Family	Species in Dalakhani Mt.	Species in Kermanshah Province
Lamiaceae	33	113
Asteraceae	26	144
Fabaceae	19	186
Poaceae	18	83
Caryophyllaceae	11	42
Brassicaceae	7	77

Life forms

The life form spectrum of Dalakhani Mountain reflects adaptation to the cold semi-arid, high-altitude conditions. Hemicryptophytes dominate with 101 species (58.38%), followed by chamaephytes (29 species, 16.76%), therophytes (24 species, 13.87%), geophytes (14 species, 8.09%), phanerophytes (4 species, 2.31%), and helophytes (1 species, 0.58%) (Fig. 3a).

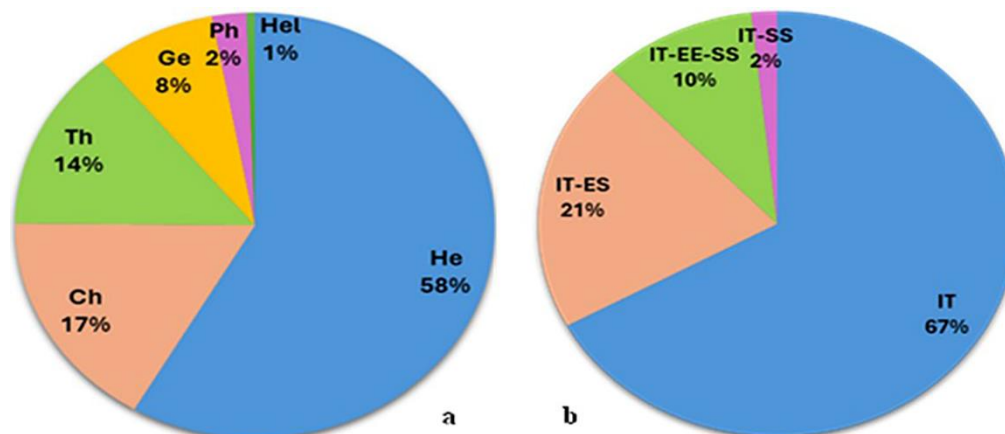


Fig. 3. Life forms (a) and chorological (b) spectra of Dalakhani Mountain (alpine and subalpine zones). Abbreviations: a, Th: Therophytes, He: Hemicryptophytes, Ph: Phanerophytes, Ch: Chamaephytes, Hel: helophytes, Ge: geophyte; b, IT: Irano-Turanian elements; ES: Euro-Siberian; SS: Saharo-Sindian elements.

Endemic and rare species

Thirty-two endemics to Iran and 18 regional endemics (shared with Iraq or Turkey) were recorded in the study area. The largest group of endemic species belonged to the genus *Astragalus*, with 6 species, making it the most significant genus in terms of endemism. Fabaceae, with 9 endemic species, and Lamiaceae, with 6 endemic and 5 regional endemic species, exhibited the highest levels of endemism, underscoring their importance in the local flora. Some notable endemics and rare species include *Acantholimon bromifolium* subsp. *platyphyllum*, *Allium keusgenii*, *Astragalus patrius*, *A. aspadanus*, *Cerasus brachypetala* var. *bornmuelleri*, *Kochia prostrata* subsp. *alpina*, *Thymus daenensis* subsp. *lancifolius*, *Ranunculus dalechanensis*, *Scilla persica* and *Scrophularia nervosa* subsp. *boissieriana*, highlighting the unique biodiversity of the region and emphasizing the need for focused conservation efforts (Fig. 4, 6) (Table 2).

Edible and medicinal plants

Wild harvesting of edible and medicinal plants by local people poses important threats to the flora of Dalakhani Mountain. The most commonly harvested species for their edible and medicinal uses include: *Allium keusgenii*, *Artemisia haussknechtii*, *Arum conophalloides*, *Ferulago carduchorum*, *Echinophora*

Chorotypes

Phytogeographically, the flora of Dalakhani Mountain is predominantly Irano-Turanian (IT), with 116 species (67.05%). Other chorological elements include IT/Euro-Siberian (36 species, 20.81%), IT/Euro-Siberian/Saharo-Sindian (18 species, 10.40%), and IT/Saharo-Sindian (3 species, 1.73%) (Fig. 3b).

platyloba, *Eryngium billardieri*, *Ixiolirion tataricum*, *Nasturtium officinale*, *Rheum ribes*, *Rosa elymaitica*, *Stachys lavandulifolia*, *Thymus* spp., *Tanacetum kotschyi*, and *Ziziphora clinopodioides* (Figs. 4, 6) (Table 2).

Vegetation and physiognomy

In the study area, species diversity is influenced by factors such as altitudinal gradients, geological variations, the presence of permanent glaciers, and anthropogenic disturbances. The plant species are distributed across distinct altitudinal zones. The Dalakhani karst massif is primarily drained by the permanent Gaznehleh spring, also known as Sarab-e Sonqor. Other significant water resources and high altitude springs, which are vital for mountaineers, wildlife, and local nomadic communities, include the Soheil and Pouneh springs. Soheil Spring is situated 100 meters north of the Dalakhani refuge at an elevation of 3000 m a.s.l., providing permanent, very cold, and high-quality potable water. Additionally, Pouneh spring, located at approximately 2700 m a.s.l. on the southern slope along the ascent route from Tinmu village, serves as a permanent water source. This spring flows abundantly during the spring season and is a primary water supply for local nomads, livestock, and regional apiculture activities. The

habitats of Dalakhani are predominantly rangelands, with the primary ecological niches consisting of rocky and scree formations (Fig. 5). Within the Dalakhani Mountain, the endemic species *Allium keusgenii* was recorded in scree areas at elevations ranging from 3100 to 3300 m a.s.l. on the southern and southwestern slopes. On steep and gentle slopes, characterized by deeper soil profiles and rocky outcrops with moisture supplied by snowmelt and perennial springs, several species are widely distributed across most aspects from 2800 m to the highest peaks. These include *Astragalus iranicus*, *A. aspadanus*, *A. patrius*, *Lotus corniculatus*, *Nasturtium officinale*, *Onobrychis cornuta*, and *Ranunculus dalechanensis*, as well as *Thymus eriocalyx*, *T. fallax*, and *T. kotschyanus*. Rocky habitats with varying gradients are prevalent in area within the altitudinal range of 2300 to 2800 m a.s.l. across most aspects. The dominant species in this zone include *Aethionema fimbriatum*, *Arum conophalloides*, *Asyneuma persicum*, *A. pulchellum*, *Chaerophyllum macropodium*, *Chenopodium foliosum*, *Ferulago carduchorum*, *Kochia prostrata* subsp. *alpina*, *Lagochilus aucheri*, *Lamium album* subsp. *crinitum*, *Nepeta humilis*, *Phlomis herba-ventii* subsp. *pungens*, *P. persica*, *Physoptychis gnaphalodes*, *Rheum ribes*, *Scilla persica*, *Scrophularia atropatana*, *Scutellaria pinnatifida* subsp. *pinnatifida*, and *Stipa arabica*. Furthermore, the eastern slopes of Dalakhani Mountain, from 2400 m up to the summit, are characterized by vertical rock walls and deep, impassable canyons. Navigating these areas is extremely challenging, requiring professional rock-climbing expertise and specialized technical equipment. Within the lower altitudinal range of 1800 to 2300 m, the following species are present across most aspects, many of which also extend into the 2300–2800 m range: *Astragalus rhodosemius*, *Centaurea pseudoscabiosa*, *Crucianella gillanica* subsp. *glauca*, *Colchicum kotschyi*, *C. persicum*, *Cousinia cylindracea*, *Dactylis glomerata*, *Echinophora platyloba*, *Eryngium billardiarei*, *Jurinea cordata*, *Rosa elymaitica*, *Salvia bracteata*, and *Tanacetum kotschyi*. This physiognomy exemplifies adaptation to cold semi-arid Zagros alpine conditions, underscoring the need for rocky habitat conservation to protect local endemics (Figs. 4-6).

Conservation status of endemic plants

The conservation status of endemic plant species at Dalakhani Mountain was assessed using IUCN criteria (IUCN 2024), including Area of Occupancy (AOO), Extent of Occurrence (EOO), and population size, relative to life form spectra (Fig. 7). Among hemicryptophytes, six species (including *Cousinia cylindracea*, *Echinophora platyloba*, *Helichrysum*

oligocephalum, *Scutellaria multicaulis* subsp. *multicaulis*, *Stachys benthamiana*, and *Veronica acrotheca*) are classified as Endangered (EN). Additionally, seven species, namely *Astragalus aspadanus*, *A. patrius*, *Cousinia lurorum*, *C. sanandajensis*, *Jurinea cordata*, *Trichodesma aucheri*, and *Ranunculus dalechanensis*, qualify as Critically Endangered (CR), while six species (*Astragalus avicennicus*, *Cousinia kirrindica*, *Ferulago carduchorum*, *Onobrychis lunata*, *Pimpinella dichotoma*, and *Phlomis persica*) are Vulnerable (VU). In the chamaephyte category, four species, including *Astragalus paralurges*, *Dianthus szowitsianus*, *Kochia prostrata* subsp. *alpina*, and *Lagochilus aucheri* subsp. *aucheri*, are recognized as Endangered (EN). Furthermore, three species (*Astragalus brachycalyx* subsp. *eriocalyx*, *Stachys pilifera*, and *Thymus daenensis* subsp. *lancifolius*) are identified as Critically Endangered (CR), and four species are categorized as Vulnerable (VU). Finally, regarding phanerophytes and geophytes, *Astragalus myriacanthus* is classified as CR and *Allium keusgenii* as EN, respectively (Table 2). The high proportion of threatened endemic species highlights the conservation significance of Dalakhani Mountain. Disturbance of perennial springs, habitat fragmentation, and degradation of high-altitude scree slopes could result in the irreversible loss of species that lack alternative refugia. Consequently, targeted conservation measures are urgently needed, including the designation of the area as a botanical conservation sanctuary, implementation of sustainable resource-management practices, and establishment of long-term monitoring programs. Such actions would help reconcile the region's traditional importance for nomadic livelihoods with the imperative to conserve its unique and irreplaceable botanical diversity in the face of ongoing environmental pressures.

DISCUSSION

Based on floristic classifications (Zohary 1973; Takhtajan 1986; Assadi 1989-2024), the study area lies within the Irano-Turanian (IT) region of the Zagros. According to the supplement to the Flora of Iran, 177 plant families, 1303 genera, and 7371 species (8520 taxa) are present in the country (Assadi & Heidarnia 2024). Dalakhani Mountain hosts 35 vascular plant families, 110 genera, and 173 taxa, representing 19.77%, 8.44%, and 2.03% of Iran's total plant diversity at each respective taxonomic level, highlighting the area's significant floristic value of Asteraceae, with 199 genera, and Fabaceae, with 1,232 species, are the largest plant families in Iran (Assadi & Heidarnia 2024).



Fig 4. Selected species of Dalakhani Mt. in their habitats: A, *Astragalus avicennicus*; B, *Astragalus iranicus*; C, *Astragalus tabrizianus*; D, *Astragalus paralurges*; E, *Astragalus myriacanthus*; F, *Astragalus rhodosemius*; G, *Tulipa systola*; H, *Asyneuma pulchellum*; I, *Cousinia lurorum* J, *Acantholimon olivieri*; K, *Allium keusgenii*; L, *Crucianella gillanica* subsp. *glauca* (Photos by authors).

In Dalakhani Mountain, the families with the highest number of genera were Asteraceae (15.45%), Poaceae (12.72%), Lamiaceae (11.81%), and Brassicaceae (6.36%). Regarding species richness, the flora was dominated by six families: Lamiaceae (19%), Asteraceae (15%), Fabaceae (11%), Poaceae (10.5%), Caryophyllaceae (6.35%), and Brassicaceae (4%). These families account for 65.85% of the plant species in this area. Each of the other families had fewer than 5 species. About one-third of all families were represented by a single species. Among the monotypic families of the area, Ixioliriaceae also has only one species in the area (Table 2). Lamiaceae was the third

and the largest family regarding genera and species, respectively. The dominance of the Lamiaceae family in the Dalakhani region is consistent with its status as a core element of the Irano-Turanian flora (Jamzad 2012). This high diversity is likely facilitated by the region's rugged topography along with the physiological adaptations of these species to the semi-arid, high-altitude conditions of the Zagros range (Zohary 1973). Members of the Asteraceae can spread easily, some of which have spines for protection against potential grazers; in addition, the family has a wide ecological tolerance (Archibold 1995).



Fig. 5. Representative vegetation and topographical features of Dalakhani Mountain: A, Alpine summit vegetation (3150-3350 m a.s.l.); B, Distant habitat view and close-up of *Allium keusgenii* (3100-3200 m a.s.l.); C, Habitat of *Ranunculus dalechanensis* (3050-3150 m a.s.l.); D, Habitat of *Onobrychis cornuta*, a spiny cushion-forming species (2800-3200 m a.s.l.) (Photos by authors).

Another major group in the study area was grasses. According to available information on the natural distribution of grasses, 50% of all species experience cold and freezing, suggesting that adaptations to these conditions are common and widespread in the Poaceae (Schubert & al. 2020). The members of this family were distributed in most parts of the study area and covered slopes of the heights. Also, perennial grasses such as *Bromus tomentellus*, *Dactylis glomerata*, *Festuca ovina*, *Hordeum bulbosum*, *Melica persica*, *Poa bulbosa*, and *Stipa hohenackeriana* were found in the high regions of the area. In the Dalakhani region, 31 endemic species were identified, 17 of which were observed in the alpine zone. Generally, the high representation of endemic species in Iran belongs to the Irano-Turanian region (Akhani 2006). The genera *Astragalus*, and *Stachys* have the highest number of endemic species in the Dalakhani region. Other studies indicate that *Astragalus* is a characteristic IT element (Manafzadeh & al. 2016). Due to *Astragalus* being included in the family Fabaceae, this family has

attained first place in terms of species number in Iran with 804-817 species (Maassoumi 2005; Assadi & Heidarnia 2024). Fabaceae is the third-largest family in terms of the number of species. Consisting of 14 species, *Astragalus* was the largest genus in area. Moreover, *Astragalus aspadanus*, and *A. patrius* were collected for the first time in this area in Kermanshah Province. In terms of life forms of endemic species, 56% is hemicryptophyte, 34% chamaephyte and phanerophytes, and geophytes each one 3.125% in the study area (Jalilian & al. 2025). Life forms of plant species indicated the possibility of adaptation to environmental factors, especially climatic conditions (Nafisi & Ghahremaninejad 2014). The number of therophytes often decreases with increasing elevation (Atashgahi & al. 2018). While therophytes adapt to drought and low rainfall by surviving the unfavorable season as seeds, hemicryptophytes employ strategies such as water storage, leaf abscission to reduce transpiration, and utilizing groundwater to overcome harsh environmental conditions (Jalilian 2014).



Fig 6. Selected species of Dalakhani in their habitats: A, *Dianthus szowitsianus*; B, *Ferulago carduchorum*; C, *Onobrychis cornuta*; D, *Onobrychis lunata*; E, *Ranunculus dalechanensis*; F, *Physoptychis gnaphalodes*; G, *Eremostachys macrophylla*; H, *Asyneuma persicum* (Photos by authors).

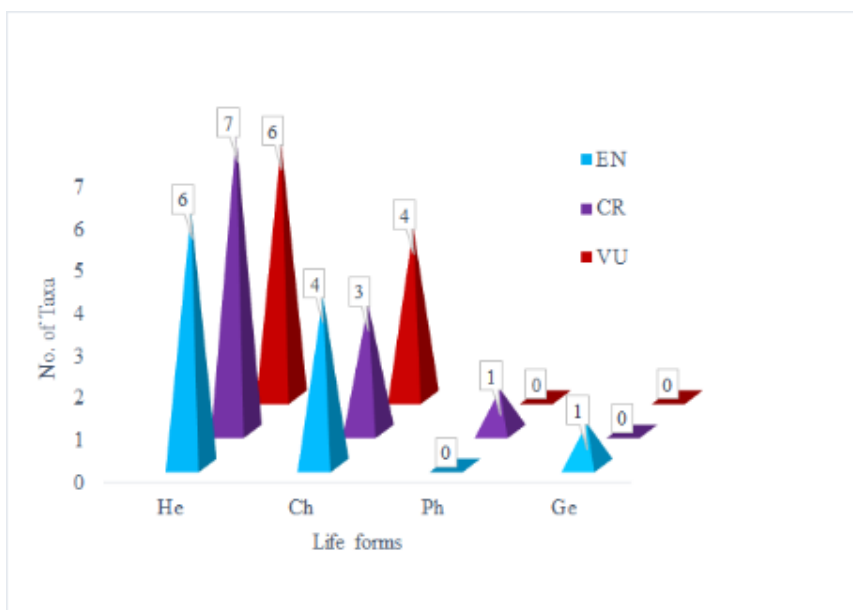


Fig.7. Relationship between life forms and conservation status of plant species in the Dalakhani Mountain region.

According to Mobayen (1981), the high frequency of hemicryptophytes is attributed to cold and temperate climates; thus, their dominance in the Dalakhani region reflects the adaptation of the flora to highland conditions. Additionally, chamaephytes play a significant role in the vegetation, forming suffrutescent and thorny cushion communities' characteristic of the Zagros range. Similar results were obtained in studies conducted in other alpine regions of the Zagros, such as Alvand (Dehshiri & al. 2016), Hashtad Mountain (Akhavan Roofigari & al. 2024), and Keyno Mountain (Dinarvand & al. 2025). Of all of them, the *Astragalus* genus was the largest, hemicryptophytes were the dominant life form, and most of the species belonged to the Irano-Turanian region. In conclusion, the floristic investigation of Dalakhani Mountain underscores its pivotal role as a significant refugium for plant biodiversity within the Zagros range, marked by the pronounced dominance of Irano-Turanian phytogeographical elements and the prevalence of hemicryptophytes, reflecting specialized evolutionary adaptations to the alpine environment and unique karst topography. Beyond this floristic richness, the mountain embodies a delicate equilibrium between perennial water sources and specialized rocky habitats, where the survival of critically endangered and endemic flora is inextricably linked to the preservation of its hydrological and geological integrity. The area's status as a floristic hotspot, characterized by proportions of narrow local specialists, is nevertheless highly vulnerable due to anthropogenic pressures,

including unsustainable harvesting of edible and medicinal plants.

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Table 2. Checklist of vascular plants of Dalakhani Mountain (alpine and sub-alpine). including life-forms: Ch (chamaephyte), Ge (geophyte), Hel (helophyte), He (hemicryptophyte), Ph (phanerophyte), Th (therophyte). Chorotypes: IT: Irano-Turanian, ES: Euro-Siberian, S: Saharo-Sindian. Voucher specimens in RANK herbarium. Iranian endemics are marked by a double asterisk (**) and regional endemics (shared with Iraq or Turkey) are marked by a single asterisk (*). Conservation status of endemic species in Kermanshah province (CS): EN (endangered), CR (critically endangered) and VU (vulnerable).

No	Families / Taxa	Life form	Chorotype	CS	Voucher specimens
Alliaceae					
1	<i>Allium keusgenii</i> R.M.Fritsch**	Ge	IT	EN	10371
2	<i>Allium paniculatum</i> L.	Ge	IT		10391
Apiaceae					
1	<i>Chaerophyllum macropodum</i> Boiss.	He	IT		9580
2	<i>Echinophora platyloba</i> DC.**	He	IT	EN	11121
3	<i>Eryngium billardieri</i> F.Delaroche	He	IT-ES		10759
4	<i>Ferulago carduchorum</i> Boiss. & Hausskn.**	He	IT	VU	10771
5	<i>Pimpinella dichotoma</i> (Boiss. & Hausskn.) H.Wolff*	He	IT	VU	10770
Araceae					
1	<i>Arum conophalloides</i> Kotschy ex Schott	Ge	IT		10996
Aristolochiaceae					
1	<i>Aristolochia bottae</i> Jaub. & Spach	He	IT		9614
Asteraceae					
1	<i>Achillea millefolium</i> L.	He	IT-ES		9421
2	<i>Artemisia aucheri</i> Boiss.	Ch	IT		10815
3	<i>Artemisia haussknechtii</i> Boiss.	He	IT		10783
4	<i>Carthamus lanatus</i> L.	Th	IT		10450
5	<i>Centaurea pseudoscabiosa</i> Boiss. & Buhse	He	IT		10802
6	<i>Centaurea virgata</i> Lam.	He	IT-ES		10781
7	<i>Cirsium vulgare</i> (Savi) Ten.	He	IT-ES		10819
8	<i>Cousinia cylindracea</i> Boiss.**	He	IT	EN	10397
9	<i>Cousinia inflata</i> Boiss. & Hausskn.	He	IT		10808
10	<i>Cousinia kirrindica</i> Bornm. & Rech.f.*	He	IT	VU	11125
11	<i>Cousinia lurorum</i> Bornm.**	He	IT	CR	10810
12	<i>Cousinia sanandajensis</i> Rech.f.*	He	IT	CR	10375
13	<i>Crupina crupinastrum</i> (Moris) Vis.	Th	IT		9606
14	<i>Echinops ritrodes</i> Bunge	He	IT		10760
15	<i>Echinops tenuisectus</i> Rech.f.*	He	IT-ES		10989
16	<i>Gundelia tournefortii</i> L.	He	IT		7818
17	<i>Helichrysum ologocephalum</i> DC.**	He	IT-ES	EN	10754
18	<i>Helichrysum plicatum</i> DC. subsp. <i>pseudoplicatum</i> (Nábělek) P.H.Davis & Kupicha	He	IT		10389
19	<i>Jurinea cordata</i> Boiss. & Hausskn.**	He	IT	CR	10818
20	<i>Lactuca aculeata</i> Boiss. & Kotschy ex Boiss.	He	IT		10780
21	<i>Picris strigosa</i> M. Bieb. subsp. <i>strigosa</i>	Th	IT-ES-S		10912
22	<i>Pulicaria dysenterica</i> (L.) Bernh.	Ge	IT-ES-S		8113
23	<i>Tanacetum kotschy</i> (Boiss.) Grierson	He	IT		10388
24	<i>Tanacetum polycephalum</i> Sch. Bip.	He	IT-S		10813
25	<i>Tragopogon longirostris</i> Bisch. ex Sch.Bip.	He	IT-ES		10514
26	<i>Urospermum picroides</i> (L.) Scop. ex F.W.Schmidt	Th	IT-ES-S		10614
Boraginaceae					
1	<i>Anchusa italica</i> Retz.	He	IT-ES-S		9615
2	<i>Echium italicum</i> L.	He	IT-ES-S		10598
3	<i>Onosma intertexta</i> Boiss.	He	IT		10376

No	Families / Taxa	Life form	Chorotype	CS	Voucher specimens
4	<i>Trichodesma aucheri</i> DC.**	He	IT	CR	10447
	Brassicaceae				
1	<i>Aethionema fimbriatum</i> Boiss.	Ch	IT		10384
2	<i>Fibigia suffruticosa</i> (Vent.) Sweet	He	IT-ES		10366
3	<i>Graellsia saxifragifolia</i> (DC.) Boiss. subsp. <i>longistyla</i> Poulter	He	IT-ES		10378
4	<i>Isatis cappadocica</i> Desv. subsp. <i>cappadocica</i>	He	IT-ES		10197
5	<i>Nasturtium officinale</i> W.T.Aiton	Hel	IT-ES		10757
6	<i>Physoptychis gnaphalodes</i> (DC.) Boiss.	Ch	IT		10788
7	<i>Sameraria stylophora</i> Boiss.	Th	IT		9877
	Campanulaceae				
1	<i>Asyneuma persicum</i> (A.DC.) Bornm.	He	IT		10756
2	<i>Asyneuma pulchellum</i> (Fisch. & C.A.Mey.) Bornm.	He	IT-ES		10881
3	<i>Michauxia laevigata</i> Vent.	He	IT-ES		11126
	Caryophyllaceae				
1	<i>Acanthophyllum caespitosum</i> Boiss.*	Ch	IT		1109
2	<i>Acanthophyllum crassifolium</i> Boiss.	Ch	IT		10747
3	<i>Acanthophyllum mucronatum</i> C.A.Mey.	Ch	IT		10900
4	<i>Cerastium brachypetalum</i> Desp. ex Pers.	Th	IT-ES-S		10742
5	<i>Dianthus orientalis</i> Adams	Ch	IT		9675
6	<i>Dianthus szowitsianus</i> Boiss.**	Ch	IT	EN	10821
7	<i>Mesostemma kotschyanum</i> (Fenzl ex Boiss.) Vved.	He	IT		1085
8	<i>Minuartia hamata</i> (Hausskn. & Bornm.) Mattf	He	IT-ES		11006
9	<i>Silene ampullata</i> Boiss.	He	IT		10497
10	<i>Silene aucheriana</i> Boiss.	He	IT		10803
11	<i>Silene montbretiana</i> Boiss.	He	IT		10377
	Chenopodiaceae				
1	<i>Chenopodium foliosum</i> Asch.	Th	IT-ES		10782
2	<i>Kochia prostrata</i> (L.) Schrad subsp. <i>alpina</i> Bornm.**	Ch	IT	EN	10773
	Colchicaceae				
1	<i>Colchicum kotschyi</i> Boiss.	Ge	IT		5764
2	<i>Colchicum persicum</i> Baker	Ge	IT-ES		5750
	Crassulaceae				
1	<i>Rosularia sempervivum</i> (M.Bieb.) A. Berger subsp. <i>sempervivum</i> (M.Bieb.) Berger	He	IT		11071
2	<i>Umbilicus intermedius</i> Boiss.	He	IT-ES-S		8729
	Dipsacaceae				
1	<i>Cephalaria hirsuta</i> Stapf	He	IT		10392
2	<i>Pteroccephalus canus</i> Coult. ex DC.	He	IT		8315
	Euphorbiaceae				
1	<i>Euphorbia boissieriana</i> (Woronow) Prokh.	He	IT		10784
2	<i>Euphorbia cheiradenia</i> Boiss. & Hohen	He	IT		10785
3	<i>Euphorbia dentata</i> Michx.	He	IT		10814
4	<i>Euphorbia macrocarpa</i> Boiss. & Buhse	He	IT		10758
5	<i>Euphorbia szovitsii</i> Fisch. & C.A.Mey.	Th	IT		10822
	Fabaceae				
1	<i>Astragalus amblolapis</i> Fisch	Ch	IT		10037
2	<i>Astragalus aspadanus</i> Bunge**	He	IT	CR	10823
3	<i>Astragalus avicennicus</i> A. Parsa**	He	IT	VU	10365

No	Families /Taxa	Life form	Chorotype	CS	Voucher specimens
4	<i>Astragalus brachycalyx</i> Phil. subsp. <i>eriosstylus</i> (Boiss. & Hausskn.) Zarre**	Ch	IT	CR	10740
5	<i>Astragalus echinops</i> Aucher ex Boiss.	He	IT		10999
6	<i>Astragalus gossypinus</i> Fisch.	Ch	IT-ES		8298
7	<i>Astragalus iranicus</i> Bunge	He	IT		10573
8	<i>Astragalus microcephalus</i> Willd.	Ch	IT		10811
9	<i>Astragalus myriacanthus</i> Boiss.**	Ph	IT	CR	10702
10	<i>Astragalus paralurges</i> Bunge**	Ch	IT	EN	11130
11	<i>Astragalus patrius</i> A. A. Ramak Maassoumi**	He	IT-ES	CR	10386
12	<i>Astragalus rhodosemius</i> Boiss. & Hausskn.**	Ch	IT	VU	10633
13	<i>Astragalus tabrizianus</i> Fisch.**	Ch	IT	VU	10794
14	<i>Astragalus verus</i> Olivier	Ch	IT		10380
15	<i>Lotus corniculatus</i> L.	He	IT-ES-S		10763
16	<i>Onobrychis lunata</i> Boiss.**	He	IT	VU	10995
17	<i>Onobrychis cornuta</i> (L.) Desv.	Ch	IT		10379
18	<i>Vicia sativa</i> L.	Th	IT-ES-S		10800
19	<i>Vicia variabilis</i> Freyn & Sint.	He	IT		9353
Geraniaceae					
1	<i>Geranium tuberosum</i> L.	Ge	IT		9635
Hyacinthaceae					
1	<i>Ornithogalum orthophyllum</i> Ten.	Ge	IT-ES		10370
2	<i>Scilla persica</i> Hausskn.	Ge	IT		10390
Hypericaceae					
1	<i>Hypericum asperulum</i> Jaub. & Spach*	He	IT		9604
Iridaceae					
1	<i>Crocus pallasii</i> subsp. <i>haussknechtii</i> (Boiss. & Reut. ex Maw) B.Mathew	Ge	IT		9284
Ixioliriaceae					
1	<i>Ixiolirion tataricum</i> (Pall.) Schult. & Schult.f.	Ge	IT		11127
Lamiaceae					
1	<i>Acinos graveolens</i> (M.Bieb.) Link	Th	IT-ES		9593
2	<i>Eremostachys macrophylla</i> Montbret & Aucher ex Benth.	He	IT-ES		11001
3	<i>Lagochilus aucheri</i> Boiss. Subsp. <i>Aucheri</i> var. <i>aucheri</i> **	Ch	IT-ES	EN	10906
4	<i>Lamium album</i> L. subsp. <i>crinitum</i> (Montbr. & Auch. Ex Benth.) Mennema	He	IT		10368
5	<i>Marrubium astracanicum</i> Jacq.	He	IT		10749
6	<i>Nepeta humilis</i> Benth.*	Th	IT		9584
7	<i>Nepeta macrosiphon</i> Boiss.	He	IT		10751
8	<i>Phlomis anisodonta</i> Boiss. subsp. <i>occidentalis</i> Jamzad*	He	IT		10374
9	<i>Phlomis bruguieri</i> Desf.	He	IT-S		10992
10	<i>Phlomis herba-ventii</i> subsp. <i>pungens</i> (Willd.) Maire ex DeFilipps	He	IT-ES		10769
11	<i>Phlomis olivieri</i> Benth.	He	IT-ES		10765
12	<i>Phlomis persica</i> Boiss.**	He	IT	VU	11131
13	<i>Phlomis rigida</i> Labill.	He	IT		11135
14	<i>Salvia bracteata</i> Banks & Sol.	He	IT		11128
15	<i>Salvia macrosiphon</i> Boiss.	He	IT-S		10993
16	<i>Salvia multicaulis</i> Vahl	He	IT-ES		9415
17	<i>Salvia spinosa</i> L.	He	IT		10994

No	Families /Taxa	Life form	Chorotype	CS	Voucher specimens
18	<i>Scutellaria multicaulis</i> Boiss. subsp. <i>multicaulis</i> **	He	IT	EN	10789
19	<i>Scutellaria pinnatifida</i> A.Ham. Subsp. <i>pinnatifida</i> *	He	IT-ES		11000
20	<i>Stachys ballotiformis</i> Vatke	He	IT		10807
21	<i>Stachys benthamiana</i> Boiss.**	He	IT	EN	10880
22	<i>Stachys inflata</i> Benth	He	IT-ES-S		10792
23	<i>Stachys lavandulifolia</i> Vahl	Ch	IT-ES		10990
24	<i>Stachys pilifera</i> Benth.**	Ch	IT	CR	10820
25	<i>Teucrium orientale</i> L.	He	IT-ES		10991
26	<i>Teucrium polium</i> L.	He	IT-ES-S		10998
27	<i>Thymus daenensis</i> Celak. subsp. <i>lancifolius</i> (Čelak.) J alas**	Ch	IT	CR	10383
28	<i>Thymus eriocalyx</i> (Ronniger) J alas*	Ch	IT		10381
29	<i>Thymus fallax</i> Fisch. & C.A.Mey.*	Ch	IT		10382
30	<i>Thymus kotschyanus</i> Boiss. & Hohen var. <i>kotschyanus</i>	Ch	IT		10791
31	<i>Ziziphora capitata</i> L. subsp. <i>orientalis</i> Rech.f.	Th	IT-ES		9609
32	<i>Ziziphora clinopodioides</i> Lam.	He	IT-ES		10787
Liliaceae					
1	<i>Fritillaria imperialis</i> L.	Ge	IT		9308
2	<i>Tulipa systola</i> Stapf	Ge	IT-ES		9311
Malvaceae					
1	<i>Alcea kurdica</i> (Schltdl.) Alef. var. <i>kurdica</i>	He	IT		11132
Papaveraceae					
1	<i>Papaver persicum</i> Lindl. subsp. <i>microcarpum</i> (Boiss.) Kadereit*	He	IT		10752
Plumbaginaceae					
1	<i>Acantholimon bromifolium</i> Boiss. Subsp. <i>platyphyllum</i> Bornm**	Ch	IT	VU	10790
2	<i>Acantholimon oliveri</i> (Jaub. & Spach) Boiss.**	Ch	IT	VU	10997
Poaceae					
1	<i>Aegilops triuncialis</i> L.	Th	IT		9073
2	<i>Avena sterilis</i> L.	Th	IT		9556
3	<i>Bromus danthoniae</i> Trin. var. <i>danthoniae</i>	Th	IT		11004
4	<i>Bromus sterilis</i> L.	Th	IT-ES-S		10801
5	<i>Bromus tomentellus</i> Boiss.	He	IT-ES		9578
6	<i>Dactylis glomerata</i> L. subsp. <i>glomerata</i>	He	IT-ES-S		7501
7	<i>Echinaria capitata</i> (L.) Desf.	Th	IT		9518
8	<i>Festuca ovina</i> L.	He	IT		10812
9	<i>Heteranthelium piliferum</i> (Sol.) Hochst. ex Jaub. & Spach	Th	IT		11003
10	<i>Hordeum bulbosum</i> L.	He	IT-ES		11002
11	<i>Hordeum murinum</i> subsp. <i>leporinum</i> (Link) Arcang.	Th	IT-ES-S		8163
12	<i>Lolium persicum</i> Boiss. & Hohen.	Th	IT-ES		11129
13	<i>Melica persica</i> Kunth	He	IT		10793
14	<i>Poa bulbosa</i> L.	Ge	IT-ES-S		11005
15	<i>Stipa arabica</i> Trin. & Rupr.	He	IT		10776
16	<i>Stipa hohenackeriana</i> Trin. & Rupr.	He	IT		10809
17	<i>Taeniatherum caput-medusae</i> subsp. <i>crinitum</i> (Schreb.) Melderis	Th	IT-ES-S		9613
18	<i>Vulpia hirtiglumis</i> Boiss. & Hausskn.	Th	IT-ES-S		8735
Polygonaceae					

No	Families /Taxa	Life form	Chorotype	CS	Voucher specimens
1	<i>Atraphaxis spinosa</i> L.	Ch	IT		10798
2	<i>Rheum ribes</i> L.	He	IT		9390
	Ranunculaceae				
1	<i>Nigella oxypetala</i> Boiss.	Th	IT		7934
2	<i>Ranunculus dalechanensis</i> Iranshahr & Rech. f.**	He	IT	CR	10372
	Rosaceae				
1	<i>Cerasus brachypetala</i> Boiss. var. <i>bornmuelleri</i> (C.K.Schneid.) Browicz*	Ph	IT		10797
2	<i>Rosa elymaitica</i> Boiss. & Hausskn.	Ph	IT		10891
	Rubiaceae				
1	<i>Asperula glomerata</i> (M.Bieb.) Griseb.	He	IT		9568
2	<i>Crucianella gillanica</i> Trin subsp. <i>glauca</i> (A.Rich. ex DC.) Ehrend.	He	IT		10660
3	<i>Cruciata taurica</i> (Pall. ex Willd.) Ehrend. subsp. <i>taurica</i>	He	IT-ES		9582
4	<i>Galium setaceum</i> Lam. subsp. <i>decaisnei</i> (Boiss.) Ehrend.	Th	IT-ES		10753
	Santalaceae				
1	<i>Thesium kotschyanum</i> Boiss.	He	IT		10385
	Scrophulariaceae				
1	<i>Linaria fastigiata</i> Chav.	He	IT		10762
2	<i>Scrophularia amplexicaulis</i> Benth.	He	IT		10741
3	<i>Scrophularia atropatana</i> Grossh.	He	IT		10879
4	<i>Scrophularia nervosa</i> Benth. subsp. <i>boissieriana</i> (Jaub. & Spach) Grau*	He	IT		10373
5	<i>Veronica acrotheca</i> Bornm. & Gauba**	He	IT	EN	10387
	Thymeleaceae				
1	<i>Daphne mucronata</i> Royle	Ph	IT		10764
	Urticaceae				
1	<i>Parietaria judaica</i> L.	He	IT-ES-S		7421
	Violaceae				
1	<i>Viola modesta</i> Fenzl	Th	IT		9300