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Study of flora, life form and chorology of plants in HameKasi mining area, Hamadan province, Iran

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Introduction: Plant vegetation represents the floristic capacity, biodiversity, and ecological conditions of each habitat. (Rosas et al., 2021). Iran is a large country characterized by diverse climates and unique topographic conditions (Noroozi et al., 2008). Iran harbors more than 8200 plant taxa, of which 2597 are (sub) endemic (Noroozi et al., 2019a; Noroozi et al., 2019b). Based on Noroozi et al. (2019b) most of Iranian endemics belong to the Irano-Turanian region.

Hamekasi mining area located in Hamedan province. Several projects have been involved in study of flora in the various parts of Hamadan province (Yavari & Shahgolzari, 2010; Dehshiri et al., 2016; Jafari et al., 2016; Fattahi et al., 2021). However, Hamekasi has special vegetation due to unique environmental conditions caused by existence of heavy metals in the soil. There is not any floristic study in Hamekasi mining area. Therefore, this study is carried out for the first time to 1. Identify the floristic composition, plants life forms, chorology, and their conservation status, and 2. Identify the endemic plants in the Hamekasi mining area.

Materials & Methods:

An extensive floristic study was conducted in Hamekasi mining site at different seasons. Hamekasi mining area is located on the northern slope of Almagolagh mountain, 35 km northwest of Hamedan, 2164 meters above sea level. The location of the mine was determined using topographic maps and GPS apparatus at latitude 34° 57′ N and longitude 48° 8′E, with 10 km^2 area (Barati, 1382). According to the data obtained from Hamadan meteorological station for the years 1992 to 2021, and following the Amberjeh climate profiling method, Hamekasi is classified under the category of cold and dry/semi-arid regions. Based on the data, the average annual rainfall was 359.32 mm, and the average annual temperature was obtained 11.3 °C. February was determined as the coldest month of the year with a minimum temperature of -11.88 °C, while the hottest month was August with a maximum temperature of 21.15 °C. Plant species were collected from March 2015 for one year. The identification of specimens was carried out using Flora Iranica (Rechinger, 2010-1963) and Flora of Iran (Assadi et al., 2018-1988). The classification of flowering plants and the name of the taxon's authors were based on APGIV (2016) and IPNI (2022), respectively. The life form of the species was determined based on Raunkiaer's classification system (Raunkiaer, 1934) and the geographical distribution of plants was determined based on Zohary's classification system for vegetation zones (Zohary, 1973). The conservation status of the studied species has been indicated according to IUCN threatened categories listed in the Red Data Book of Iran (Jalili & Jamzad, 1999). Determination of heavy metals (copper, iron, manganese, zinc) of control and

contaminated soil and plant samples was carried out using a Shimadzo AA-670 atomic absorption spectrometer at Hamedan Azad University.

Results & Discussion

In this study, a total of 79 plant species belonging to 68 genera and 26 families were identified. Eudicots with 21 families, 56 genera and 64 species were the richest group and monocots had five families, 12 genera and 15 species. The families in this study are as followings: Asteraceae (16 species), Poaceae (11 species), Lamiaceae (nine species), Brassicaceae and Caryophyllaceae (five species each), Ranunculaceae (four species), Boraginaceae, Euphorbiaceae and Fabaceae with three species each, Papaveraceae, Asparagaceae and Rosaceae with two species as well as 14 families with only one species. The genera with the highest species richness were *Bromus* with four species and *Euphorbia* with three species. Five families were represented by two species, while 61 genera were represented by only a single species. The highest number of genera were identified in Asteraceae (15 genera), Poaceae (eight genera) followed by Lamiaceae (seven genera), respectively, which is consistent with the results of Eshghi Malayeri et al, 2013. The results reveal that Asteraceae is well established in the site. The frequency of Asteraceae family is an indication of destruction in the area (Archibold, 1995; Vakili Shahrebabaki et al., 2001, Ghorbanli et al., 2009, Yavari & Shahgolzari, 2010, Fattahi et al., 2021).

The first step to evaluate the conservation status of a biogeographical area is determination of the number of endemic species (Noroozi et al., 2019). In the current study, the endemic taxa comprised nine families, 10 genera and 10 species, including about 13% of all studied species in the area. Nine medicinal species (11% of studied specimen) including *Achillea santolinoides* subsp. *wilhelmsii* (K. Koch) Greuter, *Carthamus oxyacanthus* M. Bieb., *Centaurea virgata* Lam. subsp. *squarrosa* (Willd.) Gugler, *Echinops pungens* Trautv., *Gundelia tournefortii* Ledeb. ex Trautv., *Alyssum lanigerum* DC., *Anchusa azurea* Mill., *Verbascum speciosum* Schrader, *Euphorbia macroclada* Boiss. are considered important from the therapeutic point of view (Zargari, 1991). The whole area was dominated by various hyper-accumulators including *Acanthophylum caespitosum* Boiss. *Astragalus verus* Olivier, *Centaurea virgata* Lam. subsp. *squarrosa* (Willd.) Gugler, *Cirsium leucocephalum* subsp. *penicillatum* (C. Koch) Greuter, *Cousinia bijarensis* Rech. Stapf., *Gypsophylla palli*, *Melica persica* Kunth, *Lactuca orientalis* (Boiss.) *Sojak* subsp. *orientalis*, Desf. *Stipa barbata*, *Tanacetum polycephalum* Schultz Bip and *Verbascum speciosum* Schrader.

In the assessment of the life form spectrum, the dominant life form belonged to hemicryptophytes (52%). However, therophytes, geophytes and chamaephytes contained 25%, 14% and 9% of total plant species, respectively. Regarding the above-mentioned data, hemicryptophytes and therophytes accustomed to the mentioned climate with interesting strategies (Archibold, 1995, Barbour et al., 1987; Asri, 2003). Therophytes occur abundantly in the areas with intense human intervention and short growing seasons (Archibold, 1995, Arya et al., 2011; Ghahremaninejad et al., 2012; Eshghi Malayeri et al., 2013, Gurgin Karaji et al., 2013; Rafay et al., 2013).

The geographical distribution of plants is related to the climate condition (Mobayen, 1991). Like previous studies (Yavari & Shahgolzari, 2010; Jafari et al., 2016), Irano-Turanian elements constitute the large proportion of the studied species (40%) including 31 species from a phytogeographical point of view, while there are 18% European-Siberian/Iranian-Turanian, 17% European-Siberian/Mediterranean/Iranian-Turanian, 5% European-Siberian/Saharan-Sindian/Iranian-Turanian, 2.6% Mediterranean/Iranian-Turanian, 18% multi-regional elements, Mediterranean/Euro-Siberian, cosmopolitan and semi-cosmopolitan species each 1.3%. The other characteristics of the area was the presence of 10 plant species at low risk (LR) including *Ranunculus elbursensis* Boiss., *Bromus tomentellus* Boiss., *Acantholimon olivieri* (Jaub. & Spach) Boiss., *Hymenocrater incanus* Bunge, *Astragalus verus* Olivier, *Astragalus gossypinus* Fischer, *Colchicum varians* (Freyn & Bornm.) Czernjak., *Bufonia capsularis* Boiss. & Hausskn., *Onosma kotschyi* Boiss., *Tanacetum polycephalum*.

Conclusion:

Mining activities have greatly affected the vegetation structure and decreased the plant biodiversity. The current study provides crucial data about successful resistant specimens surviving in a contaminated area that may serve as special

vegetation to cover similar areas. In addition, identification of resistant plants growing in harsh environments may help the eco-restoration of dry lands which are barren of vegetation, to develop a sustainable ecosystem. Finally, avoiding erosional events and over-harvesting the plants, conservation policies upon the area should be applied seriously to protect species richness and decrease the destructive effects of human activities.

Keywords: *Endemic, Hemicryptophyte, Irano-Turanian region, Therophyte.*

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Declaration of conflict of interest:

The authors declare that there is no conflict of interest.