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ENDEMIC PLANT SPECIES OF IRAQ: FROM FLORISTIC DIVERSITY TO CRITICAL ANALYSIS REVIEW

SAMI **Y**OUSSEF[*&**]

[*]Dept. of Recreation and Ecotourism, College of Agricultural Engineering Sciences, University of Duhok, Kurdistan Region-Iraq.

[**]Associate researcher at AMAP (Botany and Modelling of Plant Architecture and Vegetation), University of Montpellier/CIRAD/CNRS/INRA/IRD–AMAP, CIRAD TA A51/PS2, Montpellier, France.

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ABSTRACT

The endemic flora is the heart of our understanding of the current biodiversity hotspots, and plays a critical role to conceive successful management strategies for global biodiversity conservation. In Iraq territory context, despite its high plant diversity value, the endemicity is still largely under-investigated and there is no updated database of the Iraqi endemic flora. Therefore, this study sets out to present an updated list of the endemic plant species in Iraq, including a quantitative analysis of their floristic analysis, biological life forms, and geographical distribution. This first Iraqi endemic list can be seen as the first step towards better understanding of the floristic diversity, and can play an important role for future conservation priorities. This endemic list was based initially on the classical flora of Iraq and it has been completed and refining according to the floras of the neighbouring countries. To establish an updated list, it has been added all the Iraqi endemic taxa newly described by retrieving it from the botanical papers and taxonomical websites. For each endemic taxa researcher has provided the following floristic baseline: scientific name, family, phytogeographical distribution, elevation range, biological life forms, and IUCN assessment. The results of this floristic investigation present for the first time an updated endemic list of Iraqi plant species which contains a total of 174 endemic taxa(153 species, 11 subspecies, 10 varieties) in 27 families and 75 genera. They represent an endemicity rate of 5.3% of the total estimated flora of Iraq, which constitutes a low level compared to those of neighboring Irano-Anatolian countries. The family *Asteraceae*, *Papilionaceae*, *Boraginaceae* and *Apiaceae* are the richest flowering families. The life biological forms indicate that a major part of endemic taxa are chamaephytes (44%) and perennial hemicryptophytes (32%) as an adaptation indicator to the dry-harsh environmental conditions of the Irano-Anatolian mountainous areas. These floristic quantitative analysis support the idea that the species richness and endemicity are not uniformly distributed within the altitudinal gradient and phytogeographical districts of Iraq. For instance, a significant part of the Iraqi endemic taxa concentrate on the Zagrosian foothills and the mountain range between 1000 and 1700. The most striking findings were that only one taxon on average per year was newly described for Iraq, over the last 20 years, compared to around 50 taxa for Iran and Turkey confirming its status of the floristic knowledge coldspot. The current findings add substantially to our understanding of the endemism diversity in Iraqi Zagrosian part, and can serve as a base for future floristic investigation and biodiversity conservation studies.

KEYWORDS: Endemism, Biodiversity Conservation, Flora of Iraq, Zagros, Irano-Anatolian hotspot, Mesopotamia.

1. INTRODUCTION

Endemism concept is generally understood to mean the restriction of the natural distribution range of a species to a defined geographical area for political boundaries (Country, State, Province, etc.) or Ecogeographical boundaries regardless of their geopolitical boundaries (e.g. Mediterranean region, Zagros areas, Caucasian territory) (Olson *et al.*, 2001; Parra-Quijano *et al.*, 2012; Dinerstein *et al.*, 2017). From the evolutionary standpoint, the naturalists and botanists have a long fascination with the Endemism concept (Youssef, 2011; Youssef *et al.*, 2011; Hobohm, 2014). On a broad scale, the endemism topic is an important component of biodiversity, particularly for their conservation and management issues (Shevock, 1996; Kunin & Gaston, 2012; Hobohm, 2014). From biodiversity loss issues standpoint, the endemic

taxa are particularly vulnerable due to their restricted distribution range, specific habitat requirements, small populations and often low genetic diversity (Thompson, 2005; Kunin & Gaston, 2012). This growing world's biodiversity loss issue is becoming increasingly difficult to ignore, particularly in the global climatic changes and the excessive human destructive activities (Blondel *et al.,* 2010). Consequently, recent development in the field of biodiversity conservation has highlighted the important role of the preservation of the endemic and endangered taxa in all conservation planning and management strategies (Heywood & Iriondo, 2003; Mittermeier *et al.,* 2011). In general, the endemic taxa are increasingly used to designate the biodiversity hotspots, protected areas, important plant areas or conservation priorities (Mittermeier*et al.,* 2004; Bacchetta *et al.*, 2011).

The Irano-Anatolian (IA) areas are one of the worldwide biodiversity hotspot, and recognized as the richest biodiversity terrestrial regions (Mittermeier *et al.,* 2004; Hobohm, 2014). They are a vast mountainous complex in the confluence of the Mediterranean, Temperate, arid and semi-arid biogeographical regions (Hobohm, 2014; Youssef *et al.,* 2019a). This important biodiversity hotspot covers an area around 899,773 km², including major parts of C & E Turkey, N & W Iran and W Armenia, a small part of N Iraq, S Georgia, W Azerbaijan and W Turkmenistan (Mittermeier *et al.,* 2004; CEPF, 2020). This IA hotspot harbours various ecosystems and habitats, mainly mountainous complex separating the natural and semi-natural communities of the cultivated Mesopotamian plains and the dry plateaus of Western Asia (Mittermeier *et al.,* 2004, Hobohm, 2014). These areas of high biological diversity are supporting a diverse array of the native species, wild edible plants, arable and domesticated flora (rare, endemic, threatened and remarkable plant species) (Noroozi *et al.,* 2019a,b; Youssef *et al.,* 2019a, 2020).

Despite the IA's high biodiversity value, the species richness and endemicity are not uniformly distributed within the hotspots (Sales & Hedge, 2013; Noroozi *et al.,* 2019a,b) neither their remarkable diversity has been equally studied leading some parts of IA hotspot to be designated as coldspot for floristic knowledge (Vela, 2017; Youssef *et al.,* 2019a): Recent floristic surveys and investigations particularly have shown the local centers of endemism in the IA hotspots of Iranian part (e.g. Zagorisan Iranian, Alborz, andthe Kopet Dagh) and Turkey's part (e.g. Anatolian diagonal and Zagrosian Turkish areas (Şekercioğlu *et al.,* 2011; Vanderplank, 2014; Gür, 2016; Noroozi *et al.,* 2019a,b). In contrast, the Zagrosian Iraqi's part is still largely under investigation and thus remains designated as a coldspot for the floristic knowledge (Youssef *et al.,* 2019a). So far, nevertheless, there has been a partial advance in the field of floristic diversity and endemicity that can be seen as a spotlight on the remarkable biodiversity of IA's Iraqi part (Sales & Hedge, 2013; Ghazanfar & McDaniel, 2015; Youssef *et al.*, 2019a). For instance, at the Iraqi scale and to the best of our knowledge, only one recent phytogeographical analysis has been carried out by Ghazanfar & McDaniel (2015). On the other hand, numerous studies have attempted to show the plant endemism rate rather than providing an updated checklist of endemic plant species. Furthermore, more recently, literature has emerged that offers contractor finding of the endemism rate: By the way of illustration, Zohary (1950) may have been the first pioneer to describe the endemism patterns in Iraq based on the floristic diagnostic approach. He estimated the country endemism level of 10% (with c. 190 taxa) where a major part of them (181 taxa) occurred in the Zagros mountain range and Mesopotamian plains. While, 65 years after, Ghazanfar & McDaniel's phytogeographical study (2015) showed that the Iraqi endemism level is 5.6 % (181 of 3300 are endemic species), without providing a detailed list of endemic plant species. Besides that, Miller & Neale (2015) have reported the provisional International Union for Conservation of Nature (IUCN) Red List of endemic species of Iraq (121 endemic taxa). Therefore, the debate continues about a lack of a detailed and updated list of endemic plant species of Iraqi territories and their floristic diversity. Therefore, the main aim of this paper is to provide a first updated checklist of endemic plant species in Iraq with their baseline information. This updated checklist can be considered as the first step towards a better understanding of the biodiversity and the endemicity distribution of the Iraqi Flora, and can play a key role in initiating future conservation priority strategies. The study also aim to present a global overview of floristic analysis, biological life form, and geographical distribution of the Iraqi endemic plant species.

2. MATERIAL & METHODS

One of the most direct means to detect the endemic status of a taxon is to search in which territory they naturally occur. Therefore, the first step for initiating a checklist was the inventory of endemic taxa of Flora of Iraq, including subspecies and varieties (Townsend & Guest, 1966–1985, Rechinger, 1964; Ghazanfar & Edmondson, 2013–2019). In this study, it has been considered only the taxa strictly occur in Iraq territories and none elsewhere. At the same time, it excluded all doubtfully steno-endemic taxa of Iraq this checklist such as the sub-endemic and near-endemic occurring in the surrounding countries to Iraq borders i.e. Iran, Syria, and Turkey. Secondly, this initial endemic checklist has been completed, verified and refining according to several valuable floristic sources of western Asia including Zagros and Mesopotamian territories. The study relied on the following main classical Floras: Flora of Iran (Rechinger, 1963–2012; Akhani, 2006), Flora of Syria (Mouterde, 1966–1984), Flora of Turkey (Davis 1965–1988; Güner *et al.*, 2000, 2012); Flora Orientalis (Boissier, 1867–1888). Thirdly, for adding the Iraqi endemic taxa newly described, it has been retrieved it from the botanical papers and the International Plant Names Index (IPNI, 2020). Finally, this dataset has been verified and updated in terms of their geographical distribution worldwide by consulting the World checklist of Selected Plant Families (WCSP, 2020), Euro+Med Plant Base (2006).

For each endemic plant species, the following data are given: valid scientific name, family, distribution in phytogeographical districts of Iraq, altitudinal distribution range, biological life form, and IUCN assessment if the species have been evaluated (IUCN, 2020).

Data from the IUCN assessments were gathered from the provisional IUCN Red List of Iraq's endemic plants conducted by Tony & Neale (2015) and completed by the online database of the IUCN Red List of Threatened Species (IUCN 2020).

The biological life form classification has been based on the Raunkiaer (1934) and consequently they classified as therophytes (Th), hemicryptophytes (He), chamaephytes (Ch), phanerophytes (Ph), and geophytes (Ge).

3. RESULTS & DISCUSSION

1.1. The first checklist of endemic plant species and their floristic diversity analysis:

Endemism inventories are becoming increasingly an important tool for documenting the floristic diversity of a specific geographic area. In reviewing the literature, to the date, there is no comprehensive and updated database of the endemic plant species of Iraq. Therefore, one of the more significant to emerge from the present study is the first checklist of the endemic vascular plant species of Iraq and their geographical distribution and floristic diversity analysis. This list includes a total of 174 plant species endemic to Iraq (153 species, 11 subspecies, and 10 varieties) belonging to 75 genera and 27 plant families (Appendix 1). These 174 endemic taxa represent an endemism rate of 5.3% of the total estimated 3,300 native plant species in Iraq according to Ghazanfar & McDaniel (2015). This endemicity level is significantly low compared to those of neighboring IA' hotspot countries i.e. the rate of endemism is (32%) and (33%) for Iran and Turkey (Vanderplank *et al.*, 2014), respectively.

The results of the family diversity showed that the highest number of endemic plant species belonged to *Asteraceae* (44 species), *Papilionaceae* (26 species), *Boraginaceae* (14 species) and *Apiaceae* (12), in such way that these species consisted the 55.2% of total endemic plant species (Fig. 1a); Nevertheless, the families contain only one endemic species represented by e.g. *Araceae*, *Dipsacaceae,* and *Vitaceae*. Monocots are represented by 13 plant species (7.4% of the total endemic flora) distributed among five families (*Liliaceae*, *Poaceae*, *Iridaceae*, and *Araceae*). Contrary to expectation, no genera are exclusively endemic to Iraq; but the genera *Astragalus*, *Cousinia* and *Centaurea* are by far the richest in the number of endemics with 21, 14 and 10 plant species, respectively. Interestingly, out of the 90 genera, 65 are represented by only one endemic taxon (Fig. 1b). In general, this study produced results (in term of highest divers' genera and families) which corroborate the findings of a great deal of the previous research floristic works in IA hotspot (Noroozi *et al.*, 2019a,b; Vanderplank *et al.*, 2014).

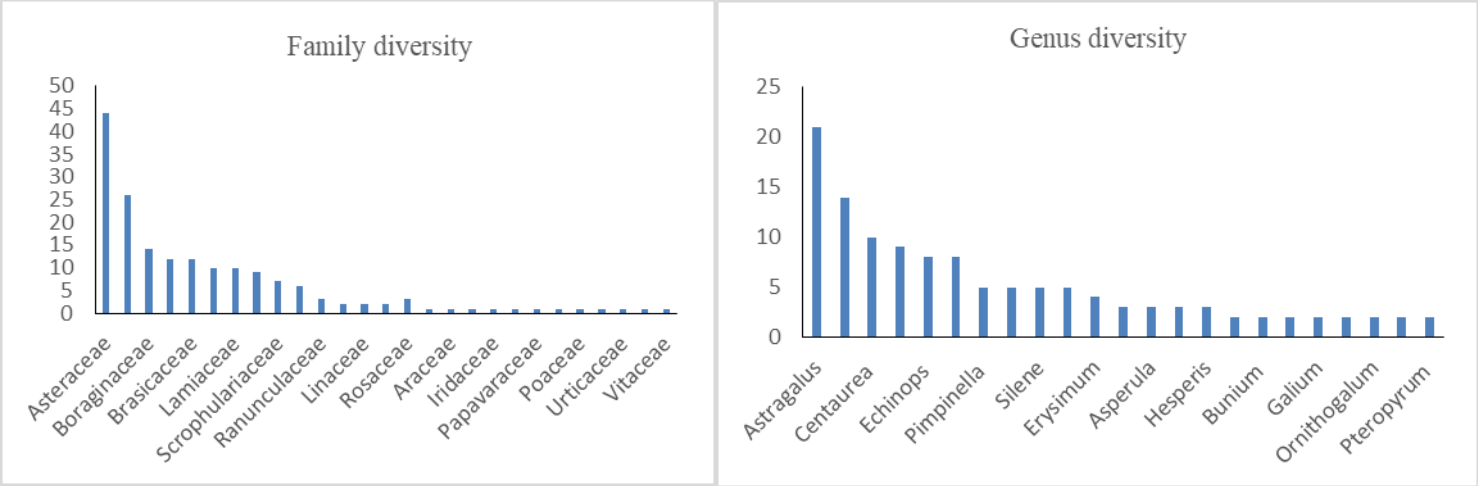

Fig. (1): The diversity of the endemic family and genera in Flora of Iraq. a) Number of endemic plant species in the richest families; b) number of endemic plant species in the richest genera.

In terms of the life biological forms, the Iraqi endemic flora is grouped into 77(44%) chamaephytes, 55(32%) hemicryptophytes, 23(13%) therophytes, 12(7%) geophytes and 7(4%) phanerophytes. The diversity in life forms of plants in this region is an indication of adaptation to Irano-Anatolian environmental conditions (Vanderplank *et al.*, 2014; Vajari *et al.*, 2014). The high frequency of chamaephytes with non-negligible geophytes may be attributed to the high elevation with harsh continental climatic conditions (cold winter with hot summer) of the Zagrosian mountain ranges (Manafzadeh *et al*., 2017; Noroozi *et al.*, 2019a,b; Vanderplank, 2014). Indeed, a major part of these Zagrosian chamaephytes represented in small thorn-cushion form as a singular evolutionary adaptation strategy to avoid over-grazing, drought, wind and high light condition of the arid and semi-arid mountainous zone (Kürschner, 1986; Vajari *et al.*, 2014). These harsh IA's environmental conditions may be able to explain the low occurrence of the endemic phanerophytes. Besides that, the presence of several hemicryptophytes perennial herbs such as *Cousinia* and *Echinops* on the foothills of Zagros maybe is linked to relatively increased rainfall and reduced heat of this medium-altitude range (800 to 1800 m). Interestingly, the result of this study indicates that 14% of the annual endemic plant species were found in the semi-arid steppes of the Mesopotamian and arid areas of the west of Iraq. These arid and semi-arid steppic areas are characterized by their short rainfall period of winter and early spring and thus these annual plants have an effective adaptation strategy to avoid the dry climatic conditions (Vajari *et al.*, 2014).

1.2 Distribution of endemic species along the altitudinal gradient and phytogeographical district:

In the current study, the distribution of the 174 endemic plant species was examined according to the altitudinal gradient and phytogeographical district. One of the high significant findings to emerge is that the Iraqi endemic species are unevenly distributed in phytogeographical districts where the majority of them have narrow distribution range restricted to one or a few districts. In four phytogeographical districts, the mountains one is the highest in the number of endemic plant species, while the desert plateau and alluvial Mesopotamian districts are the lowest richness (Fig. 2a). Furthermore, the Mesopotamian plains and the Zagrosian foothills include an important number of endemic species. At the global overview, these results are partially consistent with the floristic analysis conducted by Ghazanfar & McDaniel (2015). Indeed, they reported three important local centers of endemism: northern mountains of Iraq, Jabal Sinjar, and Tigris-Euphrates alluvial salt marshes. One serious limitation used to estimate the endemicity was again the rudimentary data (i.e. incomplete and outdated) on endemic plants and their distributions. In contrast to their earlier findings, however, no evidence of local endemism center in alluvial Mesopotamian districts was detected. On the other hand, the researcher has detected another local endemism center in Mesopotamian plains and Zagrosian foothills such as upper Jasira, Nineveh and

Persian foothills district. By way of illustration, the Jabal Hamrin and Jabal Maqlob foothills are home for a significant endemic plant species such as *Anthemis hamrinensis* Iranshahr, *Onosma wheeler-hainesii* Riedl, *Ornithogalum iraqense* Feinbrun, *Wendlandia ligustroides* (Boiss. & Hohen.) Blakelock, etc. At the global overview, one expected finding is that the mountain regions are the richest in floristic diversity including the endemic plant species. This also accords with earlier observation, which showed that the mountainous areas are hotspots for biodiversity, with a high concentration of endemic taxa, and effectively influence the distribution and diversification of plant species over time (Hobohm, 2014; Hoorn *et al.*, 2018). This general biodiversity distribution trend also has been reported in IA hotspots, with a high endemism rate in the relatively high mountains of Anatolian and Zagrosian mountainous areas (Vanderplank, 2014; Noroozi *et al.*, 2019a,b). Interestingly, the results of the current research also confirmed the high occurrence of the endemic plant species in the Iraqi Zagrosian mid-mountains between 1000 and 1700 m (Fig. 2b). This finding supports previous research into this brain area which links endemism diversity richness pattern with altitudinal gradient. For example, it has been found a high endemism diversity richness from 1400 to 2100m in Iranian mid-mountains and from 1000 to 1700m in Turkish mid-mountains (Noroozi *et al.*, 2019a,b). There are several possible explanations for this endemism distribution pattern: Mountain range has high topographic complexity, diverse favorable micro-climates, glacial refugia, and habitat stability (Médail & Diadema, 2009; Irl *et al.*, 2015; Steinbauer *et al.*, 2016). Consequently, these IA's local endemism centers in Iraq, like Iran and Turkey, are no exception and consistent with the general rule that the local endemism tend to be correlated with mountain zones (Gür, 2016; Vajari *et al.*, 2014). However, this study has been unable to demonstrate that the alpine Iraqi Zagros part is a local endemism center like that has been recently described in Turkey and Iran. These differences can be explained in part by the proximity of the Iraqi alpine zone to Irano-Turkish borders. Indeed, the Halgurd-Sakran summit areas with more than 3500m are less than 4 km far from the borders. Therefore, a major part of the alpine plant species are sub-endemic, and not steno-endemic to Iraq, often found in Iran and Turkey. Another possible explanation for this might be that the glacier development within Zagros mountain range was limited to summit mountains, above 3000m, during the Pleistocene (Atalay, 1996) or also these alpine zones have less been explored by the botanist due to their difficult access and the instability of the geopolitical situation at the Iraqi borders.

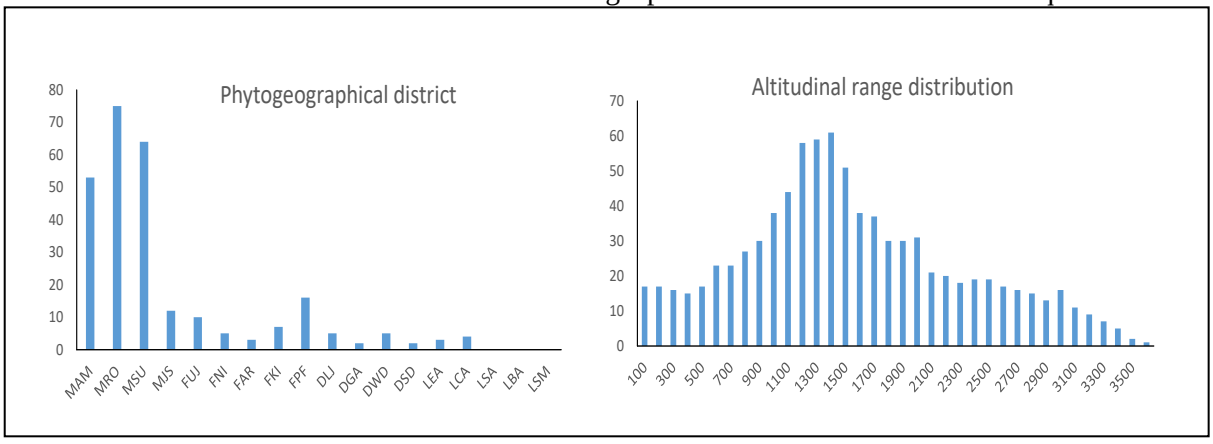

Fig. (2): The diversity and distribution of the Iraqi endemic plant species. a) The frequency of the endemic plant species in the phytogeographical district of Iraq (MAM = Amadiya district; MRO = Rowanduz district; MSU = Sulaimaniya district; MJS = Jabal Sinjar district; FUJ = Upper Jazira district; FNI = Nineveh district; FAR = Arbil district; FKI = Kirkuk district; FPF = Persian Foothills district; DLJ = Lower Jazira district; DGA = Ghurfa-Adhaim district; DWD = Western desert district; DSD = Southern Desert district; LEA = Eastern Alluvial Plains district; LCA = Central Alluvial Plains district; LSM = Southern Marsh district; LBA = Basra Estuarine district). b) The proportion of the endemic plant species along with the altitudinal range.

1.2. Iraqi Zagros part is hotspot for biodiversity versus cold spots for floristic knowledge:

The IA hotspot, as an extensive mountainous and foothills system, is a territory of high biological diversity values harbouring at least 6,000 plant taxa, approximately 2,500 of them are endemic, constituting one of the major genetic resource centers in western Asia (with c. 41% plant endemism) (Bolous *et al.,* 1994; Sales & Hedge, 2013; Hobohm, 2014). The major part of these endemic taxa are thorn-cushion chamaephytes, perennial herb, geophytes, which many found in an open steppic habitats of IA's mountainous and foothills areas (Vanderplank, 2014; Manafzadeh, 2017). Interestingly, the IA hotspot is an important origin diversity center for many plant taxa such as *Aethionema (*Al-Shehbaz *et al.,* 2006), *Astragalus (*Podlech *et al.,* 2014), *Cousinia* subg. *Cousinia* (Mehregan, 2008), *Gundellea* (Vitek, 2019), *Onobrychis (*Safaei *et al., 2012)*, *Elburzia* (Hedge, 1969), *Verbascum* (Zohary, 1973). Despite its high floristic diversity, the endemicity is not uniformly distributed leading to identify smaller hotspot "local endemism centers" within larger hotspots particularly including, but not limited to, Anatolian Diagonal and Zagrosian areas (Kaya & Aksakal, 2005; Şekercioğlu *et al.,* 2011). These IA's local endemism centers are no exception and consistent with the general rule that the local endemism tends to be correlated with mountain zones (Vanderplank, 2014; Vajari *et al.,* 2014). Despite these hotspots represent a way for biological conservation prioritizes, however, some of them remain coldspots for knowledge (Katouzian, 2016; Vela, 2017). For some parts of hotspots, the true magnitude of biodiversity and endemism knowledge is far from being complete, and it is even more valid for the floristic field inventory which stills largely unknown (Cañadas *et al.,* 2014; Heywood & Iriondo, 2003; Vela, 2017). In reviewing the recent taxonomical and systematic literatures within the IA hotspots, researcher quickly realized that the floristic diversity has not uniformly been explored and studied. Interestingly, the results as shown in Figure 3, indicate that there were around 1000 (with an average of more 50 species per year) new species have been described since over the last 20 years for both Turkey and Iran countries. Moreover, there has been an increasing interest in biodiversity investigation in Iranian and Turkish Zagrosian parts leading to provide a general overview of their floristic diversity and endemism rate (Vanderplank, 2014; Noroozi *et al.*, 2019a,b). In contrast, there were few newly described species for others IA countries i.e. Iraq, Armenia, Azerbaijan, Georgia, and Turkmenistan. For example, there were in total only 20 (~ 1 species per year) new plant species have been described in Iraq.

Interestingly, this paper seeks to give an account of a global overview of the recent advances in the field of the floristic and endemicity diversity of the Iraqi Zagros part. In contrast to Iranian and Turkish IA parts, the Zagrosian Iraqi area is still largely under-explored and thus remains designated as a coldspot for the floristic knowledge (Vela, 2017; Youssef *et al.,* 2019a): The lack of a complete and updated flora of Iraq has always been a key issue for the Iraqi botanists to studying the plant diversity and describing the new plant species (Fig. 3). Additionally, the chronic geopolitical instability, considerably limited the field floristic investigation, and thus significant mountainous areas are still mined and/or inaccessible. Therefore, the biodiversity issues grown in importance in light of the strong lack in confirmed taxonomists or the lack of attraction aspect of the biodiversity studies don't facilitate filling the gaps of floristic data on unexplored areas. In this circumstance, the Iraqi territories have been less investigated from evolutionary, biosystematics and biodiversity conservation perspectives. By the way of illustration, its unknown, to the date, the true number of species in Iraq, but it is estimated to be around 3300 to 3400 taxa (Ghazanfar & McDaniel, 2015). What is striking is that there is no detailed national endemic list of Iraq, and most floristic studies have only focused on the endemism rate rather than provide a checklist (Zohary, 1950; Ghazanfar & McDaniel, 2015). Moreover, this endemism rate is scalable over time thanks to several recent findings regarding the description of new species or also the geographical distribution range and nomenclatural changes. For instance, recent evidence revealed that a major part of these Iraqi local endemic taxa, according to Flora of Iraq, has now been found outside it political border and thus they are now sub-endemic taxa (Miller & Neale, 2015). In addition, the low endemicity level (around 5.3%) in Iraq may be attributed to the fact that the flora is underexplored as well as a major part of the plant species is ecoregional endemic to Zagros areas. By way of illustration, many species,

previously believed to be endemic to Iraq, now it occurs in Iranian and Turkish Zagros parts such as *Allium calocephalum* Wedelbo (Firat & Azirat, 2016), *Allium trachycoleum* Wendelbo (Mahmood *et al.*, 2019), *Allium qaradaghense* Feinbrun (Youssef *et al.*, 2019b), *Viola pachyrrhiza* Boiss. et Hoh. (Youssef & Vela, 2019). Therefore, the endemic checklist of the present study has a number of important implications for future practice. It can help to focus on conservation efforts and provide a framework for botanical research, and biodiversity conservation priorities for these endemic taxa.

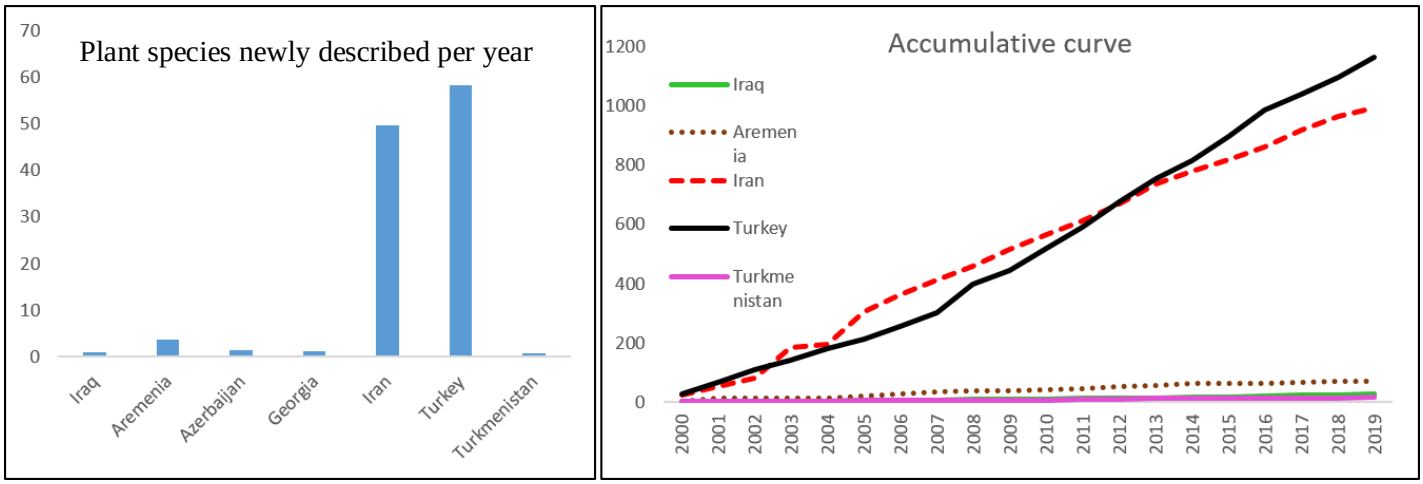

Fig. (3): Number of the new species described

from 2005 to 2019 in Irano-Anatolian hotspot's countries according to the International Plant Names Index (IPNI 2020) and the World Checklist of Selected Plant Families (WCSP 2020).

1.3. Conservation priorities of Iraqi endemic taxa:

The endemic flora is an important component in identifying the biodiversity hotspots, and plays a key role in drown up the conservation priorities (Huang, 2016). The assessment of the endemic species is increasingly used as a helpful tool to conceive effective management strategies for biological conservation. In this regard, among the total 176 steno-endemic taxa of Iraq, 90(60%) taxa are threatened according to IUCN Red List criteria (9, 25 and 58 are critically endangered, endangered and vulnerable, respectively) (Fig. 4). On the other hand, a major part of them still assessed as non-evaluated (68 taxa) or data deficient (15 taxa). In fact, one way to assess effectively the threatened plant species is collecting maximum information about their ecology, biology, geographical distribution range and the environment impacts on their population dynamics. While, a significant number of the Iraqi endemic taxa are only known from few localities, and several of them have not been seen over 100 years ago according to Flora of Iraq. This difficulty is compounded by the outdated and incomplete Flora, and there is a lack of available data on environment impact assessment on the natural resources. However, numerous studies have revealed that the IA hotspots is exposed to high biodiversity erosion. In this regard, recent evidence suggests that a major part of them arrow endemic taxa at IA hotspot scale and, even more true for Zagrosian mountain range, can be assigned as endangered and threatened species according to IUCN Red List criteria (Vanderplank, 2014; Miller & Neale, 2015). From a biodiversity conservation standpoint, the most likely causes of probable increasing extinction risk for these geographically restricted taxa could be associated with anthropogenic destructive activities exacerbated by climate change (Ambarlı *et al.*, 2016). In fact, the IA areas is one of the earliest centers for the agricultural emergence (Zohary *et al.*, 2012; Riehl *et al.*, 2013) where the massive land-use changes are still having a serious impact on natural landscape transformation (transformation the fertile steppes to the arable lands) resulting in a significant shift in biodiversity patterns.

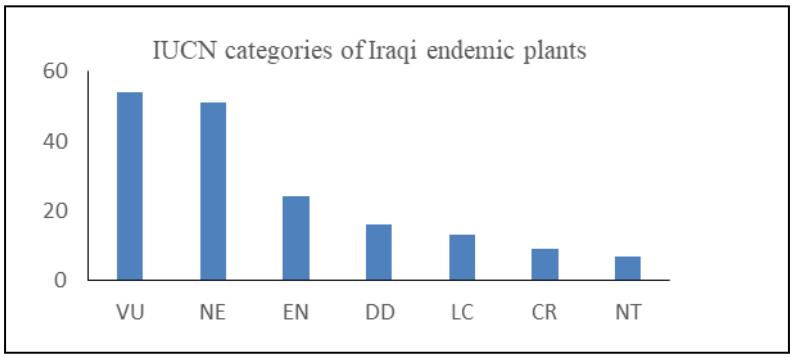

Fig. (4): Number of endemic plant species according to the IUCN Red List of Threatened Species criteria (IUCN 2020). Extinct (EX); Extinct in the Wild (EW); Critically Endangered (CR); Endangered (EN); Vulnerable (VU); Near Threatened (NT); Least Concern (LC); Data Deficient (DD); Not Evaluated (NE).

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جورین رووەکین خوجهین عیراقی: ژ شلوقەکرنا جورە و جوریا رووەکی بو نرخاندنا رەخنی

پوختە

رووەکین ئیندیمیك تینە هژمارتن ناڤەروکا تیگەهشتنا مە ژ بو جورە و جوریا زیندەوەران د نهادا، و رولەکی گرنك د گیریت د دانانا ستراتیژیین ریڤەبرنەکا سەرکەفتی ژ بو پاراستنا جورە و جوریا زیندەوەران ل سەرتاسەری جیهانی. د چارچوڤی ئاخا عیراقیدا، هەرچەندە نرخا وی یا بلند یا جورە و جوریی، هیشتا کریارا ئیندیمیکب ریژەکا زور یا ل بن ڤەکولینا دایە و ج بنگەهین نویکرنا کومکرنا داتایان نینن ژ بو جورین رووەکین خوجهین عیراقی. ژ بەر ڤی چەندی ئەڤ ڤەکولینە هاتەکرن ژ بو نویکرنا لیستا رووەکین خوجهین عیراقی، دگەل شلوقەکرتا ژمارەیی بو جورین رووەکان و فورمین جورە و جوریا زیندەوەرزان هەروەسا بەلافبونا وان یان جوگرافی. ئەفە ئیکەمین لیستا فان جورانە ل عیراقی و دبیتە دەستپیکەك بو باشتر تیگەهشتنا مە بو جورە و جوریا ڤان رووەکان و د شیان دایە رولەکی باش هەبیت ژ بو پاراستنا فان جوران د پاشەروژیدا. ئەف لیستا رووەکین خوجهین عیراقی پالپشتیا ل سەر فلورا عیراقی یا کەڤن کری و هەروەسا یا هاتیە تمامکرن ژ لایی فلورایین وەلاتین دەوروبەرین عیراقی. بو چیکرنا لیستەکا نوی رابوین بدانانا هەمی جورین رووەکین خوجهین عیراقی پیت هاتیە بەلافکرن و شلوقەکرن د ڤەکولین و سایتیتن زانستی. بو هەر جورەکی نوی ئەم رابوین بدانانا ڤان پیزانینان: ناڤی زانستی، خیزانا وی جوری، بەلافبونا جوگرافی یا وان جوران، بلنداهیا جهین وان، فورمین جورە و جوریا زیندەوەرزان و تقیمکرنا IUCN. ئەنجامین ڤی ڤەکولینا کو بو جارا ئیکی تیتە ئەنجامدان بو نویکرنا لیستا جورین رووەکین خوجهین عیراقی کو پیك دهیت ب کوی گشتی ژ 174 جورین خوجهی (153 جور و 11 جوری بجیکتر و 10 پررەنگ) ژ 27 خیزانان و 75 جینیرا. تینە هەژمارتن بریژا 5.3% ژ فلورا عیراقی کو ریژەکا کیمە ئەگەر بەراوردیی بکەین دگەل وولاتین دەوروبەر (ایران و ئەناتولیان). خیزانا Asteraceae, Papilionaceae, Boraginaceae و Apiaceae ژ خیزانین زەنگینن ژ لایی رووەکان ڤە. فورمین ژیانا زیندەوەران هوسا دیار دکەت کو بریژین مەزن رووەکین خوجهی پیك دهین ژ (chamaephytes (44% و hemicryptophytes (32%)) نیشانەك بو ژ بو خو گونجاندنا ڤان جوران دگەل کەش و هەوایی توند و هشك ل ناوچین چیایی یین ایران و ئەنادولی. ئەف شلوقا ژمارەیی پشتەڤانیا وی هزری دکەت یا دیاردبیت زەنگینیا جوران و خوجهیا وانا بشیوی ریك و پیك نە هاتینە بەلاڤەکرن ژ لایی بلنداهی و ناوچین جوگرافی ل عیراقی. بو نمونە، ژمارەکا زور یا جورین ئیندیمیکدکەڤنە گر و چیایین زرگروسیان کو بلنداهی دناڤبەرا 1000 بو 1700 دایە. ئەنجامی ژ هەمیان دیارتر هەر سال جورەکی نوی تیتە دیتن ل عیراقی، بو ماوی 20 سالانە، دهەمان دەمدا ل ایران و تورکیا نیزیکی 50 جورا دبینن و هوسا دیار دبیت کو پیزانینیت فلوریستیك دکیمن. ڤان ئەنجامین ڤەکولینی تیگەهشتنەکا باشتر دا جورە و جوریا جورین رووەکین ئیندیمیکل ناوجا زاگروسیان ل عیراقی، و هەروەسا ببیتە بنگەهەك ژ بو ڤەکولینین پاشەروژی ل سەر جورین رووەکان و ڤەکولینین پاراستنا جورە و جوریا زیندەوەران.

الأنواع النباتية المتوطنة في العراق: من تحليل التنوع النباتي إلى المراجعة النقدية

الخلاصة

تعد النباتات المتوطنة صميم فهمنا للنقاط الساخنة للتنوع الحيوي الحالي، وتلعب دوراً حاسماً في رسم استراتيجيات إدارة ناجحة للحفاظ على التنوع الحيوي العالمي. في إطار الأراضي العراقية ، و على الرغم من قيمتها العالية للتنوع النباتي ، لا يزال ظاهرة التوطن غير مدروسة إلى حد كبير ولا توجد قاعدة بيانات محدثة للنباتات المتوطنة العراقية. لذلك ، هدفت هذه الدراسة في تقديم قائمة محدثة بالأنواع النباتية المتوطنة في العراق ، بما في ذلك التحليل الكمي للأنواع النباتية ، وأشكال الحياة البيولوجية ، والتوزيع الجغرافي. تعد هذه القائمة للأنواع العراقية المتوطنة على أنها الخطوة الأولى نحو فهم أفضل للتنوع النباتي ، ويمكن أن تلعب دوراً هاماً لأولويات الحفظ الحيوي المستقبلية. استندت هذه القائمة المتوطنة في البداية على الفلورا العراقية و من ثم تم تنقيحها وفقاً لفلورا الدول المجاورة. ولإنشاء قائمة محدثة ، تم إضافة جميع الأنواع العراقية المتوطنة الموصوفة حديثاً من خلال المراجع والمواقع التصنيفية المتخصصة.حيث قدمنا لكل نوع متوطن المعلومات الأساسية التالية: الاسم العلمي ، واسم العائلة ، والتوزيع الجغرافي النباتي ، ونطاق الارتفاع ، وأشكال الحياة الحيوية، و تقييم IUCN. تظهر نتائج هذه الدراسة و لأول مرة قائمة محدثة للأنواع النباتية العراقية المتوطنة و التي تحتوي على ١٧٤ نوعًا مستوطنًا (١٥٣ نوعاً و ١١ تحت نوع و ١٠ أصناف) في ٢٧ عائلة و ٧٥ جنساً. وهي تمثل معدل توطن يبلغ ٥,٣ ٪ من إجمالي نباتات العراق المقدرة والتي تشكل مستوى منخفضًا مقارنة بتلك الموجودة في الدول المجاورة. حيث عائلة *Asteraceae* و *Papilionaceae* و *Boraginaceae* و Apiaceae كا نت من أغنى العائلات النباتية. تشير الأشكال البيولوجية للحياة إلى أن جزءاً كبيراً من الأنواع المتوطنة هو chamaephytes(٤٤ ٪) و hemicryptophytes(٣٢ ٪) كمؤشر للتكيف مع الظروف البيئية القاسية والجافة للمناطق الجبلية الإيرانية الأناضولية. تدعم هذه التحليلات الكمية الفلورية فكرة أن غنى الأنواع وتوطنها لا يتم توزيعهما بشكل موحد حسب النطاقات الارتفاعية والمناطق الجغرافية النباتية في العراق. على سبيل المثال ، يتركز جزء كبير من الأصناف العراقية المتوطنة في سلسلة جبال زاغروس ما بين ارتفاعات ١٠٠٠ و ١٧٠٠ م. وكانت أكثر النتائج المدهشة أنه يتم تصنيف نوع واحد فقط كل عام للعراق على مدار العشرين عامًا الماضية ، مقارنة بمعدل ٥٠ نوع لإيران وتركيا ، مما يؤكد هويتها كبقعة باردة للمعرفة النباتية. تضيف النتائج الحالية بشكل كبير إلى فهمنا لتنوع الانواع المتوطنة في الجزء العراقي من سلسلة جبال زاغروس ، ويمكن أن تكون بمثابة قاعدة لاستقصاءات النباتية المستقبلية ودراسات الحفاظ على التنوع الحيوي.

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Appendix 1: List of the steno-endemic plant species of Iraq.

Taxa	Family	Taxa	Family	Taxa	Family	Taxa	Family
Acantholimon astragalinum Mobayen	*Plumbaginacea e*	*Asperula friabilis* Schoenb.-Tem.	*Rubiaceae*	*Astragalus zoharyi* Eig	*Papilionaceae*	*Cousinia gigantosphaera* Rech.f.	*Asteraceae*
Achillea aleppica DC. subsp. *densa* (Blakelock) Hub.-Mor.	*Asteraceae*	*Asperula inopinata* Schönb.-Tem.	*Rubiaceae*	*Bellevalia parva* Wendelbo	*Liliaceae*	*Cousinia inflata* Boiss. & Hausskn. ex Boiss.	*Asteraceae*
Ajuga zakhoensis Rech.f.	*Lamiaceae*	*Astragalus acetabulosus* Townsend	*Papilionaceae*	*Bufonia leptoclada* Rech.f	*Caryophyllaceae*	*Cousinia kopi·karadaghensis Rech.f.*	*Asteraceae*
Alchemilla kurdica Rothm.	*Rosaceae*	*Astragalus baijiensis* C.C. Towns.	*Papilionaceae*	*Bunium avromanum* (Boiss. & Hausskn.) Drude	*Apiaceae*	*Cousinia kurdica* C.Winkl. & Bornm.	*Asteraceae*
Allium notabile Feinbrun	*Liliaceae*	*Astragalus caryolobus* Bunge	*Papilionaceae*	*Bunium cornigerum* (Boiss. & Hausskn.) Drude	*Apiaceae*	*Cousinia macrolepis* Boiss. & Hausskn. ex Boiss.	*Asteraceae*
Allium vinicolor Wendelbo	*Liliaceae*	*Astragalus chionobiiformis* C.C. Towns.	*Papilionaceae*	*Camelinopsis kurdica* (A.G.Mill.) Al-Shehb. & A.G.Mill.	*Brasicaceae*	*Cousinia mazu-shirinensis* Rech.f.	*Asteraceae*
Alyssum aff inflatum Nyar	*Brasicaceae*	*Astragalus crenophilus* Boiss.	*Papilionaceae*	*Centaurea alveicola* Rech.f.	*Asteraceae*	*Cousinia odontolepis* Sch.Bip. ex DC.	*Asteraceae*
Alyssum penjwinense Dudley	*Brasicaceae*	*Astragalus dendroproselius* Rech.f.	*Papilionaceae*	*Centaurea elegantissima* Bornm.	*Asteraceae*	*Cousinia qandilica* Rech.f.	*Asteraceae*
Alyssum singarense Boiss. & Hausskn.	*Brasicaceae*	*Astragalus dolius* Boiss. & Hausskn.	*Papilionaceae*	*Centaurea foveolata* Blakelock	*Asteraceae*	*Cousinia rawanduzensis Mehre gan*	*Asteraceae*
Anthemis corymbulosa Boiss. & Hauss kn.	*Asteraceae*	*Astragalus fieldianus* Hub.-MoT.	*Papilionaceae*	*Centaurea fusiformis* Blakelock	*Asteraceae*	*Cousinia wheeler-hainesii* Rech.f.	*Asteraceae*
Anthemis hamrinensis Iranshahr	*Asteraceae*	*Astragalus filamentosus* Bunge	*Papilionaceae*	*Centaurea gigantea* subsp. *Rechin geri* Negaresh	*Asteraceae*	*Crataegus azarolus L. var. sharania Zeravan*	*Rosaceae*
Anthemis handel-mazzettii Eig	*Asteraceae*	*Astragalus gillettii* C.C. Towns.	*Papilionaceae*	*Centaurea gudrunensis* Boiss. & Hausskn. ex Boiss.	*Asteraceae*	*Crepis kurdica* Rech.f.	*Asteraceae*
Anthemis homalolepis Eig	*Asteraceae*	*Astragalus helgurdensis*	*Papilionaceae*	*Centaurea hadacii*	*Asteraceae*	*Delphinium*	*Ranunculaceae*

		C.C. Towns.		Wagenitz		*micranthum* Boiss. & Hohen.	
Anthemis kurdica IRANSHAHR	*Asteraceae*	*Astragalus laguriformis* Freyn	*Papilionaceae*	*Centaurea handelii* Wagenitz	*Asteraceae*	*Delphinium micranthum* Boiss. et Hoh.	*Ranunculaceae*
Anthemis micrantha Boiss. & Hausskn.	*Asteraceae*	*Astragalus latus* Zarre	*Papilionaceae*	*Centaurea longipedunculata* Sch.Bip. ex Boiss.	*Asteraceae*	*Echinops amoenus* Rech.f.	*Asteraceae*
Anthemis micrantha Boiss. & Hausskn.	*Asteraceae*	*Astragalus leiophyllus* Freyn & Bornm. var. *nigropedunculatus* C.C. Towns	*Papilionaceae*	*Centaurea singarensis* Boiss.	*Asteraceae*	*Echinops armatus* Boiss. & Hausskn. var. *armatus* Rech.f.	*Asteraceae*
Anthemis microlepis Eig	*Asteraceae*	*Astragalus lobophorus* Boiss. var. *pilosus* (Bornm.) C.C. Towns.	*Papilionaceae*	*Choriantha popoviana* Riedl	*Boraginaceae*	*Echinops candelabrum* Rech.f.	*Asteraceae*
Anthemis plebeia Boiss. & Noe	*Asteraceae*	*Astragalus peristereus* Boiss. et Hausskn.	*Papilionaceae*	*Climacoptera khalisica* Botsch.	*Chenopodiacea e*	*Echinops faucicolus* Rech.f.	*Asteraceae*
Arenaria kurdica McNeill	*Caryophyllacea e*	*Astragalus porphyrodon* C.C. Towns.	*Papilionaceae*	*Cousinia acanthophysa* Rech.f.	*Asteraceae*	*Echinops nitens* Bornm.	*Asteraceae*
Arnebia linearifolia DC. subsp. *desertorum* Riedl	*Boraginaceae*	*Astragalus pseudofragrans* C.C. Towns.	*Papilionaceae*	*Cousinia algurdina* Rech.f.	*Asteraceae*	*Echinops rectangularis* Rech.f.	*Asteraceae*
Arum hainesii Agnew et Hadac ex Riedl	*Araceae*	*Astragalus pushtashanicus* C.C. Towns.	*Papilionaceae*	*Cousinia azmarensis* S.A.Ahmad, A.Rastegar, & F.Attar	*Asteraceae*	*Echinops shakrokii* S.A. Ahmad	*Asteraceae*
Asperula comosa Schoenb.-Tem.	*Rubiaceae*	*Astragalus sarae* Eig	*Papilionaceae*	*Cousinia carduchorum* C.Winkl. & Bornm.	*Asteraceae*	*Echinops tenuisectus* Rech.f.	*Asteraceae*
Eragrostis boriana Launert	*Poaceae*	*Linum velutinum* Steud. Ex Planch.	*Linaceae*	*Pterocephalus laxus* I.K. Ferguson	*Dipsacaceae*	*Thymus neurophyllus* (Rech.f.) R.Morales.	*Lamiaceae*
Eremurus rechingeri Wendelbo	*Liliaceae*	*Myosotis kurdica* Riedl	*Boraginaceae*	*Pteropyrum naufelum* Al-Khayat	*Polygonaceae*	*Trifolium guestii* Blakelock	*Papilionaceae*
Eryngium hainesii C.C. Towns.	*Apiaceae*	*Neogaillonia olivieri* (A. Rich. ex DC.) Linch.	*Rubiaceae*	*Pteropyrum olivieri* Jaub. & Spach	*Polygonaceae*	*Tulipa kurdica* Wendelbo	*Liliaceae*
Erysimum filifolium Boiss. & Hausskn.	*Brasicaceae*	*Nepeta autraniana* Bornm.	*Lamiaceae*	*Ranunculus polyanthemos* var. *robu stus*	*Ranunculaceae*	*Turgenia lisaeoides* C.C. Towns.	*Apiaceae*

Erysimum gladiiferum Boiss. et Hausskn.	*Brasicaceae*	*Onobrychis lunata* Boiss.	*Papilionaceae*	*Reseda haussknechtii* Muell. Arg.	*Resedaceae*	*Valerianella deserticola* Hadac	*Valerianaceae*
Erysimum iraqense Polatschek	*Brasicaceae*	*Onosma albo-roseum* Fisch. & C.A.Mey subsp. *macrocalycinum* Hausskn. & Bornm.	*Boraginaceae*	*Rhus coriaria* var. *zebaria* S. E. Shahbaz	*Anacardiaceae*	*Verbascum arbelense* Bornm.	*Scrophulariacea e*
Erysimum strophades Boiss.	*Brasicaceae*	*Onosma angustiloba* Rech. f. & Riedl	*Boraginaceae*	*Rhynchocorys elephas* (L.) Griseb. subsp. *carduchorum* Burbidge & Richardson	*Scrophulariacea e*	*Vicia singarensis* Boiss. & Hausskn.	*Papilionaceae*
Ferula shehbaziana S.A.Ahmad	*Apiaceae*	*Onosma haussknechtii* Bornm.	*Boraginaceae*	*Salvia ali-askaryi* S.A.Ahmad	*Lamiaceae*	*Vitis hissarica* subsp. *rechingeri* Vassilcz.	*Vitaceae*
Ferulago abbreviata C.C. Towns.	*Apiaceae*	*Onosma hawramanensis* S.A.Ahmad	*Boraginaceae*	*Satureja metastasiantha* Rech.f.	*Lamiaceae*	*Thymus neurophyllus* (Rech.f.) R.Morales.	*Lamiaceae*
Fibigia thesigeri Reeh. f.	*Brasicaceae*	*Onosma qandilica* Rech. f. & Riedl	*Boraginaceae*	*Scilla kurdistanica* Speta	*Liliaceae*		
Fritillaria crassifolia Boiss. & A. Huet subsp. *poluninii* Rix	*Liliaceae*	*Onosma striata* Riedl	*Boraginaceae*	*Scrophularia amadiyana* Ghaz. & Haloob	*Scrophulariacea e*		
Galium hainesii Schonb.-Temb.	*Rubiaceae*	*Onosma sulaimaniaca* Riedl	*Boraginaceae*	*Scrophularia atroglandulosa* Grau	*Scrophulariacea e*		
Galium qaradaghense Schonb.-Temb.	*Rubiaceae*	*Onosma wheeler-hainesii* Riedl	*Boraginaceae*	*Scrophularia kollakii* S.A.Ahmad	*Scrophulariacea e*		
Glaucium cuneatum Cullen	*Papavaraceae*	*Ornithogalum iraqense* Feinbrun	*Liliaceae*	*Scrophularia kurdica* Eig subsp. *Kurdica*	*Scrophulariacea e*		
Halothamnus iraqensis Botsch. var *hispidulus* Botsch.	*Chenopodiacea e*	*Ornithogalum kurdicum* Bornm.	*Liliaceae*	*Scrophularia sulaimanica* S.A.Ahmad	*Scrophulariacea e*		
Hedysarum singarense Boiss. et Hausskn.	*Papilionaceae*	*Parietaria rechingeri* Chrtek	*Urticaceae*	*Silene assyriaca* Hausskn. & Bornm. ex Lazkov	*Caryophyllaceae*		
Heliotropium albo- villosum Riedl	*Boraginaceae*	*Paronychia mesopotamica* Chaudhri	*Caryophyllace ae*	*Silene monantna* Boiss. & Hausskn. ex Boiss.	*Caryophyllaceae*		
Heliotropium confertiflorum Boiss. & Noë	*Boraginaceae*	*Petrorhagia sarbaghiae* S.A.Ahmad	*Caryophyllace ae*	*Silene retinervis* Ghaz.	*Caryophyllaceae*		
Heliotropium lasianthum Rie	*Boraginaceae*	*Petrorhagia wheeler-*	*Caryophyllace*	*Silene schizopetala*	*Caryophyllaceae*		

dl		*hainesii* Rech.f.	*ae*	Bormn.	
Hesperis blakelockii F.Dvořák	*Brasicaceae*	*Pimpinella brachyclada* Rech.f et Riedl	*Apiaceae*	*Silene shehbazii* S. A. Ahmad	*Caryophyllaceae*
Hesperis kurdica F. Dvořák & Hadač var. *unguiculata* Dvořák	*Brasicaceae*	*Pimpinella hadacii* Engstrand	*Apiaceae*	*Stachys babylonica* Hamodie & Wilcock	*Lamiaceae*
Hesperis novakii F.Dvořák var. *mirabilis* Dvorak	*Brasicaceae*	*Pimpinella kurdica* Rech.f. & Riedl	*Apiaceae*	*Stachys fragillima* Bornm.	*Lamiaceae*
Himantoglossum hircinum (L.) Spreng. var. *pseudocaprinum* J.J. Wood	*Orchidaceae*	*Pimpinella nephrophylla* Rech.f. & Riedl	*Apiaceae*	*Stachys graveolens* Nábelek	*Lamiaceae*
Iris zetterlundii Rukšāns	*Iridaceae*	*Pimpinella zagrosica Boiss. & Hausskn.*	*Apiaceae*	*Stachys iraqensis* Bhattacharjee	*Lamiaceae*
Leutea rechingeri (Leute) Pimenov	*Apiaceae*	*Pisum formosum* (Stev.) Alef. var. *pubescens*	*Papilionaceae*	*Stachys nephrophylla* Rech.f.	*Lamiaceae*
Linum mucronatum Bertol. subsp. *pubifolium* (P.H.Davis) P.H.Davis	*Linaceae*	*Prunus longispinosa* S.E. Shahbaz & S.S. Abdulrahman	*Rosaceae*	*Staehelina kurdica* Merxm. & Rech.f.	*Asteraceae*