

CONSERVATION ASSESSMENT OF SOME RARE AND ENDEMIC *CREPIS* (ASTERACEAE) TAXA IN TURKEY

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Received: 29.05.2019. Revised: 12.07.2019. Accepted: 01.08.2019.

Red Listing is a valuable tool for raising the awareness about those taxa which face the risk of extinction. It is the first step towards highlighting the problem of species decline and loss, as well as encouraging policy makers. In this study, a new or revised threatened status of five rare and two endemic *Crepis* taxa from Turkey were presented, based upon IUCN red list categories and criteria. The following taxa are analysed: *Crepis amanica*, *C. aurea* subsp. *olympica*, *C. bithynica*, *C. dioscoridis*, *C. foetida* subsp. *glandulosa*, *C. rubra*, and *C. syriaca*. The area of occupancy (AOO) has been calculated for each taxon using the software GeoCAT (Geospatial Conservation Assessment Tool) and according to 2 × 2 km grid cell size. A distribution map has been drawn with ArcGIS version 10.3. Current IUCN red list categories and criteria were used to assess the conservation status of the taxa. New field observations and the population sizes were presented for each taxon. The taxa were placed into the group of critically endangered or endangered because of their small geographical distribution, narrow habitat specificity and non-abundant within the territory of Turkey. Based on the IUCN categorisation, our results show that all the taxa studied are directly and/or indirectly threatened by human activities, such as tourism, agriculture, grazing, pollution or urbanisation and competition with woody or invasive plants.

Key words: Cichorieae, distribution, IUCN, Red List, threatened

Introduction

The IUCN (International Union for Conservation of Nature) Red Lists are recognised worldwide as very powerful instruments for the conservation of threatened species (Lamoreux et al., 2003; Rodrigues et al., 2006; Maes et al., 2015). IUCN Red List categories and criteria are constructed to assess the threatened status of species or lower taxa on global or sub-global (national or regional) level as a means of classifying the relative risk of extinction of the concerning taxon (Gärdenfors, 2001; Miller et al., 2007; Tomović et al., 2007; Mace et al., 2008; Kahraman et al., 2012; Orsenigo et al., 2016; Khapugin et al., 2017a,b; Fenu et al., 2018; Kaky & Gilbert, 2019).

Crepis L. is a large, critical and taxonomically difficult genus in the tribe Cichorieae of the family Asteraceae. It comprises over 200 species (Bremer, 1994), mainly distributed throughout the northern hemisphere and Africa (Enke, 2009). It is thought that the origin of the genus *Crepis* is in the Altai/Tien Shan region in Central Asia (Babcock, 1947). The genus presently has its highest species diversity in the circum-Mediterranean area (Enke, 2008). The genus is represented with 40 taxa in Turkey, of which eight are endemic (*C. amanica* Babco., *C. armena* DC., *C. aurea* subsp. *olympica* (L.) Cass., *C. bupleurifolia* (Boiss.) Freyn & Sint., *C. dioritica* Schott & Kotschy ex Boiss., *C. hakkarica* Lamond, *C. macropus* Boiss.

& Heldr., *C. palaestina* (Boiss.) Bornm. subsp. *babcockii* Inceer & Aksu-Kalmuk (Lamond, 1975; Inceer & Kalmuk, 2018). In addition, *C. alpestris* (Jacq.) Tausch, *C. aurea* subsp. *olympica*, *C. bithynica* Boiss., *C. amanica*, *C. rubra* L., *C. palaestina* (Boiss.) Bornm. and *C. dioscoridis* L. were indicated as rare taxa in the Flora of Turkey and East Aegean Islands (Lamond, 1975).

Ekim et al. (2000) presented the conservation status of five rare (*C. aspera* L., *C. purpurea* (Willd.) M. Bieb., *C. pusilla* (Sommier) Merxm., *C. rubra*, *C. syriaca* (Bornm.) Babco. & Navashin) and seven endemic (*C. amanica*, *C. armena*, *C. aurea* subsp. *olympica*, *C. bupleurifolia*, *C. dioritica*, *C. hakkarica*, *C. macropus*) taxa of *Crepis* in Turkey based on the IUCN 1994 categories and criteria in the Red Data Book of Turkish Plants. After that some authors have presented IUCN threatened category for *C. bupleurifolia* (LC), *C. dioritica* (LC), *C. hakkarica* (EN), *C. macropus* (LC), *C. palaestina* subsp. *babcockii* (CR), and *C. purpurea* (CR) (Adıgüzel et al., 2006; Türkmen, 2014; Eker et al., 2015; Ertugrul & Tugay, 2018; Inceer & Kalmuk, 2018). However, no evaluation of conservation status of some rare and endemic taxa of *Crepis* has been carried out at regional level after Ekim et al. (2000).

The objective of this study is to assess the threat category of two endemic and five rare taxa of *Crepis* in Turkey according to the current IUCN Red List categories and criteria at regional level.

Material and Methods

Study area

Turkey is located between 36°–42°N and 26°–44°E in the northern hemisphere, near the junction of European, Asian and African continents. It is situated in the Mediterranean basin, with a total of 780 600 km² land area, and surrounded at three sides by water, from the Mediterranean, the Aegean and the Black Sea. Turkey is in the temperate zone with various climate types in different regions. A continental climate prevails in inland regions, a semi-arid climate in Central and Southeastern Anatolia, a temperate climate with high precipitation in every season along the Black Sea coast and a Mediterranean climate in the Mediterranean and Western Anatolian regions of Turkey (Akman, 1990; Avcı, 2005; Türe & Böcük, 2010).

Floristic studies

The floristic data were mainly obtained from field studies undertaken between 2011 and 2015 as a part of the taxonomic revision of *Crepis* in Turkey. During the extensive field surveys, the type and other known localities of the studied taxa, as well as a number of other potential distribution sites, were visited. The data on habitat, population size, distribution, the number of mature individuals, phenological and ecological features, GPS co-ordinates, and threat factors were recorded in the field. The herbaria ANK, BULU, EGE, GAZI, HUB, ISTE, ISTF, and VANF were also visited for possible records of the studied taxa in Turkey. The individuals of the studied taxa were collected in the field from native populations in Turkey. At the same time, general and detailed digital photographs of each taxon were taken in the habitat (Fig. 1). Vouchers were deposited in the herbarium at the Karadeniz Technical University, Department of Biology (KTUB).

The threat categories of seven *Crepis* taxa were revised and reassessed according to the recent version of the IUCN Red List Categories, version 13 (IUCN, 2017), based on field surveys, newly discovered localities, all relevant literature and the data from herbarium collections. The AOO was calculated for each taxon using the software GeoCAT (Geospatial Conservation Assessment Tool, according to Bachman et al., 2011), available in <http://geocat.kew.org/> and the IUCN recommended grid cell size 2 × 2 km.

The distribution of native vascular plants was described by the Grid System of Davis

(1965–1985) for the first time in the Flora of Turkey. Since then, all floristic and systematic studies have been based on this system (Türe & Böcük, 2010). In the current study, the same system has been used due to the ease of data integration. Distribution maps have been drawn by ArcGIS version 10.3 software (Fig. 2). The details of the threats have been presented for each taxon.

Results and Discussion

Crepis amanica Babcock

Distribution in Turkey: S and SW of Turkey. *Crepis amanica* is endemic to Turkey (Lamond, 1975), and it is a rare species. It has been known so far only from two localities. C6 Adana: Amanus, Mt. Dumanly, 700–1200 m a.s.l., Haradjian 3719 (G); C5 Adana: Misis Nur Dagi above Kizildere, 200 m a.s.l., 17.04.1957, Davis 26732 (E); C5 Adana: Misis Nur Dagi, 200 m a.s.l., 18.05.2013, Inceer 989 (KTUB) (Fig. 1A, Fig. 2).

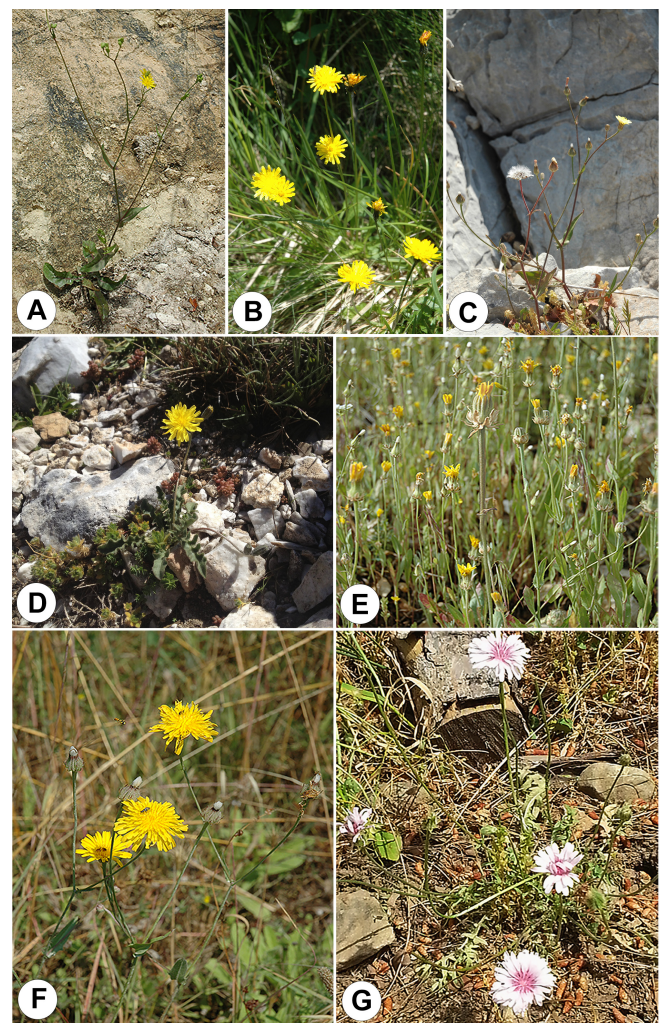


Fig. 1. Habit of *Crepis*: A – *C. amanica*; B – *C. aurea* subsp. *olympica*; C – *C. dioscoridis*; D – *C. bithynica*; E – *C. syriaca*; F – *C. foetida* subsp. *glandulosa*; G – *C. rubra*.

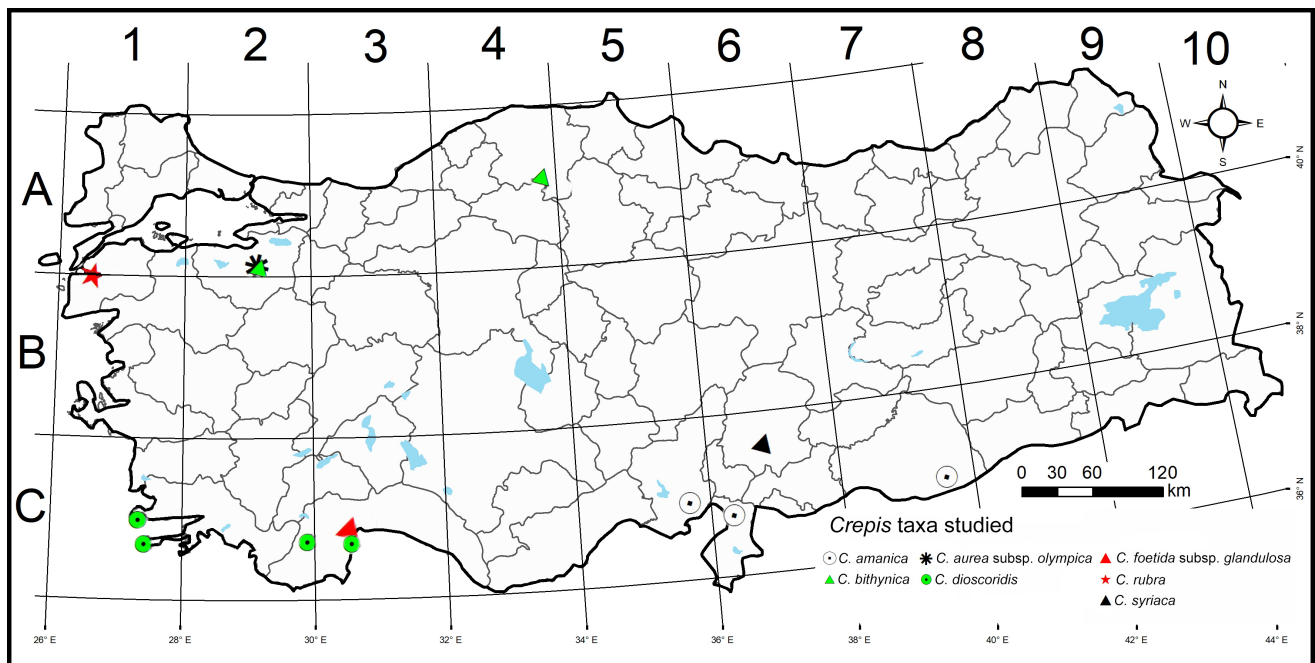


Fig. 2. Distribution of studied *Crepis* taxa in Turkey.

New chorological data, published here for the first time: C7 Sanliurfa: Between Akcakale and Ceylanpinar, 400 m a.s.l., 10.06.2014, *Inceer* 1087 (KTUB), Fig. 2.

Phenology: Flowering – from early May to early June and fruiting – June.

Habitat: *Crepis amanica* grows on grassland, roadsides and cultivated areas, 200–1200 m a.s.l.

Population information: The populations in Misis Nur Dagi (province of Adana) as well as in the province of Sanliurfa are estimated to a few hundred individuals, while the population in Amanus has not recently been checked in the field.

Threats: The main threats to this species are grazing which leads to habitat degradation, as well as soil pollution, e.g. due to pesticide use.

Previous assessment: The species was previously assigned to Vulnerable (VU) category at regional level (Ekim et al., 2000).

Criteria applied:

Criterion B: AOO: 8 km².

a) Number of locations: Two locations (Adana: Misis Nur Dagi and Sanliurfa)

b) Decline is estimated in the area of occupancy (ii), extent and quality of habitat (iii), number of subpopulations (iv) and number of mature individuals (v) and expected to continue in the future.

IUCN threatened status (in Turkey): Endangered – EN B2ab(ii,iii,iv,v).

***Crepis aurea* subsp. *olympica* Lamond.**

Distribution in Turkey: NW of Turkey. *Crepis aurea* subsp. *olympica* is endemic and extremely rare

in Turkey (Lamond, 1975). A2 Bursa: Uludag, 2000 m a.s.l., 19.06.1959, *E. Hennipman c. s.* 2034 (E); A2 Bursa: Uludag, 1950 m a.s.l., 27.07.1984, *Ö. Secmen* 11 & *Y. Gemici* & *H. Tabata* & *Yasuda* (EGE); A2 Bursa: Uludag, 02.07.1944, *M. Basarman* 3873 (ISTF); A2 Bursa: Uludag, 2035 m a.s.l., 29.07.2013, *Inceer* 1043 (KTUB) (Fig. 1B, Fig. 2).

Phenology: Flowering – from early to late June and fruiting – July.

Habitat: *Crepis aurea* subsp. *olympica* grows in marshy alpine meadows, 1950–2035 m a.s.l.

Population information: This taxon is known only from the type locality in Uludag National Park, Bursa. The population size of *C. aurea* subsp. *olympica* is very small and consists of less than 50 individuals.

Threats: It is threatened by trampling, grazing, degradation and fragmentation. Despite the fact that the habitat of *C. aurea* subsp. *olympica* is found in Uludag National Park, its population is prone to extinction in the near future, unless *in situ* and *ex situ* conservation strategies are established as soon as possible.

Previous assessment: It was assigned to the category Endangered (EN) in the Red Data Book of Turkish Plants at regional level (Ekim et al., 2000).

Criteria applied:

Criterion B: AOO: 4 km².

a) Number of locations: One location (Bursa: Uludag).

b) Continuing decline has been observed in the area of occupancy (ii), extent and quality of habitat (iii) and the number of mature individuals (v) and expected to continue in the future.

IUCN threatened status in Turkey: Critically Endangered – CR B2ab(ii,iii,v).

***Crepis bithynica* Boiss.**

General distribution: *Crepis bithynica* is a Balkan subendemic, distributed in the SW part of Asia Minor (Bithynian Olympus) and in the mountains of the S Balkan Peninsula (Yurukova-Grancharova & Dimitrova, 2006). This species was described from Turkey, and later recorded in Bosnia-Herzegovina, Greece, Bulgaria (Babcock, 1947), the Majella Massif (Central Apennines) (Ballelli, 1999), and was thus reported by Conti et al. (2005). According to Kamari (1991), its occurrence in Greece is doubtful and was not confirmed in Bosnia-Herzegovina by Bjelčić (1983).

Distribution in Turkey: N and NW of Turkey. *Crepis bithynica* is a rare species in the Turkish flora (Lamond, 1975). A2 Bursa: Uludag, Aug. 1942 Boissier, (G); A2 Bursa: Uludag, 1968, Quezel et al.; A2 Bursa: Uludag, 20.08.1945, M. Heilbronn, 39501 (ISTF); A2 Bursa: Uludag, summit calcareous rocks and ridges, 2210 m a.s.l., 30.07.2013, Inceer, 1045 (KTUB); A4 Kastamonu: Ilgaz Dagi, Kucuk Hacet, 1900–2000 m a.s.l., 16.08.2014, Inceer, 1115 (KTUB); A5 Kastamonu: Ilgaz Dagi, 23.07.1982, Sint. *ibid.*, 2300 m a.s.l. (Fig. 1D, Fig. 2).

Phenology: Flowering – from early July to early August and fruiting – August.

Habitat: It grows on summit calcareous rocks and ridges, 1900–2300 m a.s.l.

Population information: The populations in the Turkish flora of *C. bithynica* are represented by not more than 150 individuals each.

Threats: The main threats to this species are grazing and soil erosion which lead to habitat degradation, as well as the disturbance of species by mountain activities.

Previous assessment: *Crepis bithynica* is a species with restricted distribution in Turkey and international conservation interest. It is included under the category «rare» in the Red Data Book of Bulgaria (Velchev, 1984) and the IUCN Red List (Walter & Gillet, 1998). The species has been recorded recently in Bulgaria, and assigned to category Critically Endangered (CR) and the criteria B2ab(ii,iii) (Petrova & Vladimirov, 2009). Within Turkey, the species has been recorded from two localities, in Bursa and Kastamonu (Lamond, 1975). However, there is no threat estimation of this species in the Red Data Book of Turkish Plants (Ekim et al., 2000).

Criteria applied:

Criterion B: AOO: 8 km².

a) Number of locations: Two locations (Bursa and Kastamonu).

b) Decline is estimated in the area of occupancy (ii), extent and quality of habitat (iii), number of subpopulations (iv) and number of mature individuals (v).

IUCN threatened status in Turkey: Endangered (EN) – EN B2b(ii,iii,iv,v).

***Crepis dioscoridis* L.**

General distribution: Throughout Greece and adjacent islands, Crete, Dalmatia, Barbey-Lydia, Italy, France, Switzerland, Germany, Hungary and Turkey (Babcock, 1947; Lamond, 1975).

Distribution in Turkey: SW of Turkey. Despite the fact that the taxon is widespread in the Mediterranean region, it is a rare species in the Turkish flora (Lamond, 1975). C1 Mugla: Datca, Knidos, 80 m a.s.l., 04.05.2013, Inceer, 984 (KTUB); C1 Mugla: d. Marmaris, Knidos, 30 m a.s.l., D. 41216 (E); C2 Antalya: Ali Dagi, Elmali, Pichler 424; C3 Antalya: 30 m a.s.l., Tengwall 670.

New and yet unpublished chorological data on *C. dioscoridis* in Turkey: C1 Mugla: Bodrum, Akyarlar Village, rocky places, 20 m a.s.l., 01.05.2015, Inceer, 1144 (KTUB) (Fig. 1C, Fig. 2).

Phenology: Flowering – from early to late April and fruiting – May.

Habitat: *Crepis dioscoridis* thrives in mainly rocky places and on limestone cliffs, 20–80 m a.s.l.

Population information: Some specimens of *C. dioscoridis* from Mugla province have been collected, while not any specimen could be collected from Antalya province during the field studies. The populations of this species in Mugla are represented by not more than 100 individuals, covering an area of a few square metres at one single locality.

Threats: Urbanisation, grazing and tourism development lead to the disturbance and draining of habitats, which has a negative impact on the populations of this species.

Previous assessment: No assessment has been found for this species at either global nor regional level.

Criteria applied:

Criterion B: AOO: 8 km².

a) Number of locations: Two locations (Mugla-Bodrum and Mugla-Datca).

b) Decline is estimated in the area of occupancy (ii), extent and quality of habitat (iii), number of subpopulations (iv) and number of mature individuals (v).

IUCN threatened status in Turkey: Endangered (EN) – B2ab(ii,iii,iv,v).

***Crepis foetida* L. subsp. *glandulosa* (C. Presl) Arcang.**

General distribution: Sicily (Babcock, 1947), Turkey.

Distribution in Turkey: SW of Turkey. *Crepis foetida* subsp. *glandulosa* was doubtfully indicated by Ekim (2012) for the Turkish flora, but recently its occurrence in Turkey has been confirmed by Inceer et al. (2018). *Crepis foetida* subsp. *glandulosa* has a narrow distribution in Turkish flora. C3 Antalya: Konyaalti-Altinkaynak, 200 m a.s.l., 05.06.2011, Inceer, 860 (KTUB) (Fig. 1F, Fig. 2).

Phenology: Flowering – May, fruiting – June

Habitat: It grows in wet places and woodlands, 200 m a.s.l.

Population information: The population size is very small and consists of less than 50 individuals, the covering area of a few square metres.

Threats: This taxon is threatened by habitat loss due to competition from woody plants. The population of *Crepis foetida* subsp. *glandulosa* is prone to extinction in the near future, unless *in situ* and *ex situ* conservation strategies are established as soon as possible.

Previous assessment: This taxon had not been evaluated previously at either global or regional level.

Criteria applied:

Criterion B: AOO: 4 km².

- a) Number of locations: One location (Antalya).
- b) Decline is estimated in the area of occupancy (ii), extent and quality of habitat (iii), and number of mature individuals (v).

IUCN threatened status in Turkey: Critically Endangered (EN) – CR: B2ab (ii,iii,v).

***Crepis rubra* L.**

General distribution: S Italy, Dalmatia, Albania, Montenegro, Croatia, Macedonia, Thrace, Greece, Crete, Lesvos, and Asia Minor (Babcock, 1947; Lamond, 1975; Peev et al., 2009).

Distribution in Turkey: NW of Turkey, the region of Canakkale (Lamond, 1975). *Crepis rubra* is a rare species in the Turkish flora (Lamond, 1975). A1 (A) Canakkale: Erenkoy, 1856, *Kirk*. However, not any specimen could be collected from Erenkoy in the province of Canakkale during our field studies. We observed that urbanisation and agriculture activities were common in that area.

New and so far unpublished chorological data on *C. rubra* in Turkey: B1 Canakkale: Dömbrek Village, Dömbrek valley, 160 m a.s.l., 25.04.2014, Inceer, 1075 (KTUB) (Fig. 1G, Fig. 2).

Phenology: Flowering – from early April to early May and fruiting – May.

Habitat: It grows in meadows, wet places and woodland, 160 m a.s.l.

Population information: The population size is very small and consists of less than 50 individuals, the covering area of a few square metres.

Threats: It is threatened by conversion of natural habitats into arable land, as well as competition from woody plants. The population of this species is prone to extinction from the Turkish flora in the near future, unless *in situ* and *ex situ* conservation strategies are established as soon as possible.

Previous assessment: Vulnerable (VU) at regional level for Turkey (Ekim et al., 2000).

Criteria applied:

Criterion B: AOO: 4 km².

- a) Number of locations: One location (Canakkale).
- b) Continuing decline has been observed in the area of occupancy (ii), extent and quality of habitat (iii), and number of mature individuals (v).

IUCN threatened status in Turkey: Critically Endangered (EN) – CR: B2ab (ii,iii,v).

***Crepis syriaca* (Bornm.) Babcock.**

General distribution: Syria, Lebanon and Turkey (Babcock, 1947; Lamond, 1975).

Distribution in Turkey: S of Turkey. Distribution of *C. syriaca* is very local in Turkey. One locality for the species has been recorded in the Flora of Turkey (Lamond, 1975). C6 Maras: Ahir Dagi, 800 m a.s.l., *Haradj*, 1511; C6 Kahramanmaras: Ahir Dagi, 1390 m a.s.l., 18.05.2013, Inceer, 990 (KTUB) (Fig. 1E, Fig. 2).

Phenology: Flowering – from early to late May and fruiting – June.

Habitat: It grows in meadows, roadsides, rocky slopes and woodland in Turkey, 800–1390 m a.s.l.

Population information: The population is represented by several hundreds of individuals that grow in dense, but distant and fragmented subpopulations.

Threats: This species is threatened by habitat loss due to competition from woody and invasive plants.

Previous assessment: At regional level, the species was assigned to Vulnerable (VU) in Turkey (Ekim et al., 2000).

Criteria applied:

Criterion B: AOO: 4 km².

- a) Number of locations: One location (Kahramanmaras).
- b) Decline is estimated in the area of occupancy (ii), extent and quality of habitat (iii), number of subpopulations (iv), numbers of mature individuals (v).

IUCN threatened status in Turkey: Critically Endangered (CR) – CR: B2ab (ii,iii,iv,v).

Conclusions

The present results reveal that the studied taxa of *Crepis* are critically endangered (CR) or endangered (EN) in Turkey because of their small geographical distribution and narrow habitat specificity. In addition, all the taxa studied are directly and/or indirectly threatened by several antropogenic pressures such as tourism, agriculture, grazing, pollution or urbanisation, and competition with woody or invasive plants. Besides, our findings show that *C. aurea* subsp. *olympica* and *C. foetida* subsp. *glandulosa* are prone to extinction in the near future unless *in situ* and *ex situ* conservation strategies are established as soon as possible.

Acknowledgements

The authors thank anonymous reviewers for comments which improved the manuscript considerably, and the Scientific and Technological Research Council of Turkey (TUBITAK, Project No.112T132) for financial support.

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ОЦЕНКА ОХРАНЫ НЕКОТОРЫХ РЕДКИХ И ЭНДЕМИЧНЫХ ТАКСОНОВ *CREPIS* (ASTERACEAE) В ТУРЦИИ

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Составление Красных списков это ценный инструмент для повышения осведомленности о тех таксонах, которые находятся под угрозой исчезновения. Это первый шаг к освещению проблемы ухудшения состояния и исчезновения видов, а также поощрения политических деятелей в этом направлении. В этом исследовании представлены новые или пересмотренные статусы угрожаемости для пяти редких и двух эндемичных таксонов рода *Crepis* из Турции на основе категорий и критериев Красного списка МСОП. Были исследованы следующие виды: *Crepis amanica*, *C. aurea* subsp. *olympica*, *C. bithynica*, *C. dioscoridis*, *C. foetida* subsp. *glandulosa*, *C. rubra* и *C. syriaca*. Область обитания была рассчитана для каждого таксона с помощью программного обеспечения GeoCAT (Geospatial Conservation Assessment Tool) и с использованием сетки карты размером 2 × 2 км. Карта распространения была построена с помощью программы ArcGIS v. 10.3. Для оценки природоохранного статуса таксонов были использованы современные категории и критерии Красного списка МСОП. Новые полевые наблюдения, размеры популяций и новые или обновленные статусы угрожаемости были представлены для каждого таксона. Таксоны были распределены по группам «таксонов, находящихся на грани полного исчезновения» или «исчезающих таксонов» в связи с малым географическим распространением, узкой биотопической специфичностью и низким обилием на территории Турции. На основе категорий МСОП наши результаты показывают, что исследованные таксоны находятся под воздействием прямых и / или непрямых угроз со стороны человеческой деятельности (таких как туризм, сельское хозяйство, выпас скота, загрязнение среды или урбанизации), конкуренции с древесными или инвазионными растениями.

Ключевые слова: Cichorieae, Красный список, МСОП, распространение, угрожаемый