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Broad-ranged, highly disjunct, locally rare and severely endangered: the challenging risk assessment and a global conservation strategy for *Erica sicula* Guss. *sensu lato* (Ericaceae)

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Title

Broad-ranged, highly disjunct, locally rare and severely endangered: the challenging risk assessment and a global conservation strategy for *Erica sicula* Guss. *sensu lato* (Ericaceae)

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Summary

The distribution of Erica sicula Guss. sensu lato ranges throughout the central-Eastern Mediterranean Basin. However, this species, which probably represents one of the most ancestral members of the genus Erica, shows a significantly disjointed and fragmented distribution pattern and is subject to multiple threats, leading to continuous regression at the local scale. The species is distributed across five regions, Sicily, Libya, Cyprus, Anatolia and Lebanon, and counts two subspecies, subsp. sicula and subsp. bocquetii, represented by 29 and 8 subpopulations, respectively. This work provides a global update on the knowledge related to the distribution, ecology and conservation status of its two subspecies. New distributional analyses and ecologically relevant data were collected from fieldwork, literature and herbarium specimens. In Sicily, unmanned aerial systems and high-resolution digital elevation models were employed to perform a detailed census of the only extant subpopulation. This enabled a comprehensive mapping of its distribution and the calculation of its 3D occupation surface. Based on the result of our analyses, species is Least Concern (LC) at the global level, despite each subspecies and subpopulation being classified as nationally endangered. Erica sicula subsp. sicula was assessed as Critically Endangered (CR) (B1ab(i,ii,iii,iv) + 2ab(i,ii,iii,iv)) in northwestern Sicily where two out of the three subpopulations have probably disappeared. The situation of E. sicula subsp. *sicula* in eastern Mediterranean is equally alarming, being assessed under the category VU B1ab(i,ii,iii,iv) + 2ab(i,ii,iii,iv) in the three countries where it occurs; in Lebanon, it is severely threatened by the increasing impact of quarrying, urban sprawl, road and dam construction, in the island of Cyprus it is prone to the growing impact of goat overgrazing and fire, whilst in Anatolia it is affected by urban sprawl and coastal touristic development. In Libya, E. sicula subsp. sicula was evaluated as VU (B1ab(iii) + 2ab(iii)) considering the current degradation of the quality of its habitat. E. sicula subsp. bocquetii, previously known to occur only in few locations on the mountains of southern Anatolia and recently found in several other locations at lower altitudes, was assessed as VU (Blab(iii) + 2ab(iii)). Further fieldwork is recommended to better assess the demographic trend of the different subpopulations. Moreover, genetic analyses are needed to clarify the taxonomic value of several infraspecific taxa previously described and help targeting future in-situ and ex-situ conservation projects on the most unique and genetically rich subpopulations. Improving knowledge and the conservation strategies of taxa like Erica sicula s.l. requires the expertise of specialists from all the countries concerned, making it essential to maintain networks of experts in the Mediterranean.

Keywords

Conservation priorities, Disjunct distribution range, International partnership, Threats, Unmanned Aerial Systems, Woody relict species

Introduction

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Biogeographic interest of the heathers of the subgenus Pentapera

Extreme geographical disjunction is a very rare and fascinating feature among Mediterranean plants living in vertical environments. In fact, very disjunct subpopulations usually have been isolated long enough to have differentiated into separate species (Davis 1951). Nevertheless, there are several examples of species disjunction of considerable magnitude. Most cases refer to Paleogene relict species that failed to evolve into separated species even when their populations were very far from one another for a very long time-lapse. The large majority of these taxa survived in very conservative habitats (e.g., North-facing cliffs, gulleys), enjoying low anthropogenic disturbance (overgrazing, fires), low interspecific plant competition and low drought stress due to particularly favourable microclimatic conditions (Thompson 2020).

In some cases, ongoing differentiation involving the disjointed species' populations has reached varietal or subspecific level. This is the case of the taxa related to *E. sicula*. These heathers form a rather distinct and isolated species group (Ojeda et al. 1998, McGuire and Kron 2005, Mughrabi de Kuppler 2013) that has been framed into the distinct genus *Pentapera* (Klotzsch 1838) for more than one century and up to a few decades ago.

The investigated taxa have pentamerous flowers in contrast to the tetramerous of all the other *Erica* species of the world. As pentamery has been interpreted to be a primitive trait, several scholars consider this subgenus as a basal group within the genus *Erica*, probably a remnant of the Paleogene xeromorphic flora of tropical Africa (Chevalier 1923). However, due to inconstancy of pentamery and the lack of other strikingly distinctive traits, many other authors (e.g., Bentham 1839, Boissier 1875, Bentham and Hooker 1876, Drude 1897) argued that this group of heathers do not deserve being framed into a separate genus or subgenus.

The taxonomic treatment of this group is lively debated (Web and Rix 1972, McClintock 1980, McClintock 1989, Meikle 1985, Nelson 2011), primarily due to the high variability in the distinctive traits observed across its wide distribution range. These variations may be significantly influenced by local abiotic factors, such as substrate and climate, as well as disturbances. A taxonomic prospect of the epithets referring to *Erica* subgenus *Pentapera* is presented in Table 1. Additional interest to this puzzling study case is given by the extremely small surface occupied by the known subpopulations of these taxa in each country (Fig. 1). With the exception of the subpopulations present in NW Sicily, all other subpopulations of Erica sicula subsp. sicula are situated in countries of the eastern Mediterranean. The subpopulations growing in Lebanon, Cyprus and southwestern Anatolia were previously considered as a separate taxon, E. sicula subsp. libanotica (Yaltırık 1967, Browicz 1983). Similarly, the subpopulations of northern Libya have been referred to subsp. cyrenaica (Brullo and Furnari 1979). Concerning E. sicula subsp. bocquetii (Pesmen 1968) it is documented to occur in the Antalya region in western Taurus (southwestern Anatolia). The main morphologically distinctive traits among the populations of the *E. sicula* group are summarised in Supplementary File 1, whilsts Supplementary File 2 provides a list of the available drawings related to the taxa belonging to the subgenus Pentapera.

The geographic distances between the subpopulations are remarkable (Fig. 1): 900 km between SW Anatolia and N Libya, 1050 km between W Sicily and N Libya, 1600 km between W Sicily and SW Anatolia, 300 km between SW Anatolia and N Cyprus, 1050 km between SW Anatolia and Lebanon, 900 km between Cyprus and Lebanon.

Aims of the paper

Based on the collected information, we present an overview of the distribution and an update on the ecology of the taxa belonging to the *Pentapera* group, along with an updated assessment of the extinction risk of the species and the two subspecies at the global and national scale. We also aimed to identify the knowledge gaps and urgently needed measures to improve the conservation status of these taxa.

Methods

Researchers from the five countries where these taxa are found came together to collaborate on this study. We analysed combined historical and recent first-hand field data to trace the past and present distribution and clarify the ecological requirements of the different heathers of the *Pentapera* group. To begin, we meticulously analysed the extensive scientific and horticultural literature available on these taxa, including local floras, such as the floras of Lebanon (Mouterde 1983), Syria, Palestine, and Sinai (Post and Dinsmore 1932), Turkey and the East Aegean Islands (Davis et al. 1965), Cyprus (Meikle 1985) and Europe (Webb and Rix 1972). We then examined all the specimens preserved in various herbaria located in several European countries (AMD, B, BM, BOLO, C, COI, E, FI, G, K, L, LD, LM, NAP, P, PAV, PI, RO, S, W, WAG, WSI), paying special attention to the collections gathered in the countries and regions where the taxa live, namely Sicily (CAT, PAL), Cyprus (NEUN), Lebanon (BEI), Libya (ULT) and Turkey (AEF, AKDU, ANK, EGE, GAZI, HUB, ISTE, ISTF, NGBB). The acronyms of the above listed herbaria agree with the standard abbreviations of the Index Herbariorum (Thiers 2021). We also referred to the national database of Turkish master's and doctoral theses (Republic of Turkey, Council of Higher Education, Thesis Center, https://tez.yok.gov.tr/UlusalTezMerkezi/giris.jsp) to gather occurrence data related to the Antalya district. Additionally, we compiled an inventory of specimens kept in the European herbaria. Geographic coordinates were assigned wherever possible to facilitate mapping of both the literature records and the dry specimens.

Then field work was conducted in Cyprus, Lebanon, and Sicily to explore the historical localities where the species was reported previously, to discover new subpopulations in potential habitats, to accurately map the distribution and to gather additional information on the ecology and threats. In Lebanon, the valley of Nahr Ibrahim, or Adonis River, where the taxon occurs, was thoroughly surveyed by one of the authors in 2022 and 2023. In Cyprus, fieldwork was conducted in 2020 by one of the authors through the Kyrenia mountain range to map the entire extent of the occurrence of the subpopulations. In Libya and Anatolia, fieldwork could not be conducted, so most of the research on the taxa growing there was based on literature data and herbarium specimens. In Sicily, we utilised the data previously collected between 2017 and 2020 by one of the authors from the sole remaining locality where E. sicula subsp. sicula occurs, namely Mt. Cofano (de Simone 2020). Additional explorations in the neighbouring mountains were carried out between 2019 and 2022. In Sicily it was also possible to exploit unmanned aerial systems (UAS) to perform a detailed census of its only extant subpopulation: through the use of UAS-derived 3D models of target areas where the species was present and high-resolution digital elevation models of the entire study area, we were able to perform a detailed census of the subpopulation, map in detail its distribution and calculate its 3D occupation surface. For logistic reasons, UAS could not be used in Cyprus and Lebanon).

Spatial data were all mapped using the software QGIS (QGIS.ORG 2023). The extinction risk for each subspecies of *Erica sicula* was assessed separately in each country according to the International Union for Conservation of Nature Red List categories and criteria (IUCN 2012). The Extent of Occurrence (EOO) was calculated as the minimum convex hull based on the taxon occurrence records. The Area of Occupancy (AOO) was calculated using a cell width of 2 km, equivalent to a 4 km² grid cell. When existing, previous assessments were reviewed and updated, as it was the case for Sicily (Domina et al. 2012) and Lebanon (Stephan et al. 2017). Finally, the comprehensive global assessment of the species *Erica sicula* was carried out by consolidating the data provided by each national assessment.

Results and Discussion

Past and present distribution of the taxa belonging to Erica subgen. Pentapera

In this paragraph we present and comment the data on the distribution of the pentamerous heathers issuing from the botanical literature. Further occurrence data were obtained from the exsiccata that we consulted. Supplementary File 3 provides a comprehensive list of the geographic locations based on the records from both literature and herbarium specimens. Geographic coordinates are given in decimal degrees using the WGS84 coordinate system (EPSG: 4326).

The Sicilian subpopulation of *E. sicula* subsp. *sicula* occurs only on Mt. Cofano in NW Sicily, where it was first observed growing on its north-facing cliffs ("al Crocefisso": Gussone 1821; "al Passo della Zita": Ponzo 1900; Fig. 2a-c). Claims about the occurrence of other western Sicilian stands date back to the early XIX century and have never been confirmed afterwards (Fig. 3). On Marettimo Island, it was reported as extremely rare by Gussone (1832, 1843). No specimen confirms its past occurrence on the island, where it seems to have long disappeared (Francini and Messeri 1956, Scuderi 2003, Gianguzzi et al. 2006, Gianguzzi et al. 2011, Domina et al. 2019; L. de Simone, *pers. obs.*), although Pignatti and Pignatti-Wikus (1990) state to have observed it growing on a N-facing cliff beneath the top of Pizzo Falcone and Osti (2009) claimed to have seen it on the island, too. It was observed on Monte Erice only by Gasparrini, who did his field collections in Sicily between 1828 and 1831 (Alippi Cappelletti 1999). Its past occurrence there, reported by Lojacono-Pojero (1907) but not by Ponzo (1900), is documented by a single specimen kept in PAL (see Supplementary File 3). Furthermore, extensive field investigations conducted during last years on the nearby and most similar cliffs of the adjacent mountains (namely Mt. Monaco and Mt. Passo del Lupo) were unsuccessful (L. de Simone, L. Scuderi and S. Pasta, *pers. obs.*).

The occurrence of *E. sicula* in Malta was communicated by Gulia to C. F. Nyman when the latter visited the island on 1844. In his report on Malta's vegetation, Nyman (1846) only cited *Erica multiflora* L., whilst the occurrence of *E. sicula* was first reported by Duthie (1875), and subsequently reported by several other authors (Nyman 1879, Caruel in Parlatore 1889, Fiori and Paoletti 1898). Later, Sommier and Caruana-Gatto (1915) pointed out that no herbarium specimen was available, and more recently this record has been considered as a mere misidentification and the species was ruled out from the Maltese vascular flora (Brullo 1982, Lanfranco 1982).

In Lebanon, *E. sicula* subsp. *sicula* occurs in Nahr Ibrahim Valley, historically known as the River of Adonis, located in the central part of Mount Lebanon. This taxon shows a scattered distribution as it occurs in two separated areas of Nahr Ibrahim Valley, the lower and the upper part (Fig. 2d-e, Fig. 4). The lower part of the valley constitutes a canyon known as the Gorges of Yahchouch, while the upper part consists of several exposed cliffs overlooking Aqoura and Afqa.

More in detail, the taxon has been historically observed and collected at Belhos (also Billa, Billaa or Bil'âs, Balhas) below the bridge located between Machnaqa and Qartaba (according to a specimen collected by Lortet mentioned by Mouterde 1983), at Frat (Post and Dinsmore 1932), in the gorges of Yahchouch, (specimens in the herbaria of Gombault, Pabot and Thiebaud according to Mouterde 1983), at Afqa (also Afka) under the river catchment (Mouterde 1983) and at Ehmej (also Ihmish and Ehmège: herbarium of Tannous Boutros mentioned in Mouterde 1983). Post and Dinsmore (1932) quote a specimen collected "above Milassa". However, there is no village by that name in Lebanon; the toponym that most closely resembles is Lassa, but we chose to discard this uncertain record. *E. sicula* subsp. *sicula* has been recently observed also at Aaqoura (also Aakoura and Akoura: Tohmé and Tohmé 2014, Stephan et al. 2017), Qartaba (also Kartaba; Browicz 1983). Chouwen in the buffer zone of the Jabal Moussa Biosphere Reserve (Tohmé and Tohmé 2014) and Janna (Stephan et al. 2017).

The results of the field surveys conducted in all the historical areas confirmed the destruction of two subpopulations. The historical subpopulation once located in Belhos was destroyed around 20 years ago by numerous quarries, as also documented in the national assessment (Stephan et al. 2017). We calculated that the area on which the habitat was completely erased by these quarrying activities equals 302 ha. The other subpopulation located on the cliffs of the canyon in Janna was destroyed by the construction of a dam that began in 2014. The entire locality, covering an area of 85.66 ha, was excavated and the adjacent cliffs were stripped up to a height of 50 metres. Despite extensive and repeated exploration in the area, the subpopulation of Ehmej couldn't be located. This area was also exploited by multiple quarries, leading to the degradation of its local cliff habitats The specimen labelled as collected in Qartaba was probably collected in the road between Qartaba and Janne, as we didn't observe any subpopulation in Qartaba. The subpopulations of Yahchouch, Chouwen and Frat are confirmed in the lower part of the canyon. The subpopulation of Afqa is confirmed as it was found

just above the cave where the river of Ibrahim-Adonis begins its flow. Three additional subpopulations were found in the upper part of the valley, in Mejdel and Aqoura. These four subpopulations of the upper valley actually are the most conspicuous in terms of size. In total, seven subpopulations were mapped in Lebanon.

In total, seven subpopulations were found in Cyprus. All the extant subpopulations of *E. sicula* subsp. sicula from Cyprus are located on the Kyrenia Mountain range (Fig. 2f-g, Fig. 5). Meikle (1985) provides a detailed list of all historical records: the taxon was first found by Kotschy at Pentadaktylos in April 1859 and at Agios Khrysostomos in 1862 (Unger and Kotschy 1865). The subpopulation of Buffavento, first noticed by Kotschy (1862), has been repeatedly observed also in more recent times, e.g., by Syngrassides on 1937 (Meikle 1985), in September 2013 by S. Brullo and G. Giusso del Galdo (Wagensommer 2017), and in June 2019 by S. Cambria (pers. comm.). Other early records refer to a subpopulation located near Akanthou (Sintenis and Rigo 1880, Merton 1967) and in the gorges west of Saint Hilarion (Hartmann 1904-1905, Casey 1951). Few new stands were found between 1930s and 1960s: at Yaïlá (district Alevkaya-Halevga) it was recorded by Kennedy and Davis between 1938 and 1941, at Halevga by Davis between 1940 and 1949, above Phamoudhi (district of Kyrenia) by Merton in 1967. During the prospection campaign carried out during 2020, two new subpopulations have been discovered in the highest peak of the Kyrenia Mountains at 1024 m a.s.l. at Kyparissovouno (= Selvilitepe, authors' note) and in Kantara. The only historical record from the Troodos Mountain range was located on Mount Afamis (c. 1050 m a.s.l.) in the Limassol-Lemesos District, where the heather was reported by Kennedy in 1937 (Meikle 1985). However, this stand was no longer confirmed despite repeated ad hoc expeditions carried out between 2003 and 2007.

In southwestern Anatolia, subsp. *sicula* occurs in few localities in the southeastern sector of the province of Antalya (Fig. 6). In fact, it was reported to grow at Kezme Boğaz south of Kemer and at Göynük, Beldibi (Stevens 1978, Browicz 1983); a third stand was noticed in 2006 at Kasaba, SE Dirgenler, gorge of Demre Çayi, 140 m a.s.l., on NW-facing limestone (marble) cliffs by Parolly and Eren (2007). Last stand was found by Gülkokan et al. in 2015 (Fener 2018, Fener and Aykurt 2019; "Gülkokan" was the surname of D. Fener before she married, Authors' note) on the calcareous stony slopes near Kemerköy (Antalya).

E. sicula subsp. *bocquetii* (Fig. 2g) was discovered and described by Peşmen (1968). Its type locality is located at about 1750 m a.s.l. in a clearing of *Cedrus libani* A. Rich. forest at Çiğlikara, Dokuzgöl Mevkii, in western Taurus (southwestern Anatolia, province of Antalya, district of Elmalı; see Fig. 6). Indeed, a specimen kept in the herbarium of J. Bornmüller at Berlin (see Supplementary File 3) suggests that this taxon was already collected in the very same area 80 years before (1888). In more recent times, the plant has been observed and collected between 1600 and 1850 m a.s.l., close to the type locality, within the Elmalı Cedar Research Forest, first in 1989 by McClintock (1990) and then in 2008 by Ari et al. (2014) (see also Supplementary File 3). Another stand was found by Burton (1995) at approximately 1200 m a.s.l. growing under warmer climatic conditions on the steep limestone outcrops in an area (between Sinekçibeli and Kaş, Antalya) dominated by *Pinus brutia* Ten. This finding is also documented by a specimen bearing the label "An. 1143", once stored in the herbarium of the Heather Society and currently kept in RHS Herbarium (WSY) (Miller and Nelson 2008).

The Libyan subpopulations of *E. sicula* subsp. *sicula* (locally named "hamra"; Siddiqi 1978) are located on the coastal sector of the hilly region called Jabal El-Akhdar in northern Cyrenaica (NE-Libya) according to both literature and herbarium specimens (see Supplementary File 3). After geolocating the identified subpopulations where the specimens were collected, we mapped the distribution of the taxon in Libya (Fig. 7). More in detail, these occurrences data included samples collected in Barca (also Barqa or Barce: Arcangeli 1894), today's al-Marj; in Marsa Susa, the ancient city of Apollonia (Authors' note; Vaccari 1913 in Béguinot and Vaccari 1913b), 'in the valley of the aqueduct' (Vaccari 1913 in Béguinot and Vaccari 1913c); in Gouba (also El Gubba, Quba, al Qubbah); in Wadi Sarak, 'quite common in the woods' and in Wadi Naga, mountains at the north of

the valley (Taubert 1887 in Durand and Baratte 1910), Derna (aldo Darnah; Haimann 1881 and Taubert 1887 in Durand and Baratte 1910), Wadi Derna (Vaccari 1912 in Béguinot and Vaccari 1913a, Longa 1912 in Pampanini 1912), Wadi Zaza (El-Barasi et al. 2003) and Wadi Haboon (El Rabiai and Al Tira 2015). Omar (2019a) reported to have collected it inside the maquis at Marsa Susa (180-195 m a.s.l.), in the forest at Wardamah (500-550 m a.s.l.) and at Shahhat (500-550 m a.s.l.).

All the unplaced wadis probably belonged to the catchment area of the Wadi Derna (Authors' note). Additional generic information on this taxon is provided by Durand and Baratte (1910), Béguinot and Vaccari (1913a), Béguinot and Vaccari (1913b), Béguinot and Vaccari (1913c), Pampanini (1931), Brullo and Furnari (1979, 1994) and Siddiqi (1978).

During the last 15 years *E. sicula* subsp. *bocquetii*, previously thought to grow exclusively in mountainous areas, has been found at much lower altitudes; in fact, a stand located at 250 m a.s.l. was discovered in 2009 (Z. Aytaç, *pers. comm*; see Supplementary File 3). Ten years later Dilek (2018) and Dilek (2020) reported three more stands, located near Enişdibi (Demre, Antalya), close to Üçağız Cemetery (Demre, Antalya) and on Kekova Island, whilst Fener (2018) and Fener and Aykurt (2019) reported its occurrence at 762 m a.s.l. at Çığlıkara Püreni, and there is a herbarium specimen ("Gülkokan 1871") collected in the roadsides between Akçay and Kemer.

The remarkable altitudinal range of E. sicula subsp. *bocquetii* probably induces striking differences in the blossoming times between of the lowland and the mountain subpopulations of *E. sicula* subsp. *bocquetii* (June to September), thus causing significant reproductive isolation between them (McClintock 1980). Moreover, the finding of *E. sicula* subsp. *bocquetii* at lower altitudes makes it necessary to verify its biological distinction from subsp. *libanotica*, with which is sympatric.

Ecology and biology of the investigated taxa

The subgenus *Pentapera* includes only chasmophytes and comophytes, i.e., plants growing exclusively on vertical cliffs or in the ledges and large fractures of these cliffs, respectively; such ecological behaviour proves to be a globally rare feature among heathers. Additionally, all the pentamerous heathers grow on limestones and dolomias, whereas most members in the family Ericaceae thrive on acid or very acid soils (Webb and Rix 1972, Oliver 1991). Although these very unusual edaphic requirements are intriguing, there is currently no available information on the soil biota (e.g., ericoid mycorrhizae capable of capturing soil nitrogen) connected with Erica sicula s.l. In NW Sicily, E. sicula subsp. sicula grows on dolomitic cliffs and ledges between 100 and 630 m a.s.l. and may be considered a primary chasmophyte. This taxon has been indicated as a characteristic species of a plant community rich in endemic taxa only occurring on Mt. Cofano, described as phytosociological subassociation with the name Scabioso limonifoliae-Centauretum ucriae subass. ericetosum siculae (Brullo and Marcenò 1979, Gianguzzi and La Mantia 2008). In the proximity of the ledges, it may co-occur with other woody species such as Quercus ilex L., Arbutus unedo L., Pistacia lentiscus L., P. terebinthus L. and Erica multiflora L. or with the tussock grass Ampelodesmos mauritanicus (Poir.) Dur. et Schinz. The field surveys carried out by de Simone (2020) pointed out that *E. sicula* subsp. *sicula* is absent on south-facing slopes, while it is present on all other orientations. A plot-based analysis showed that E. sicula subsp. sicula has an ecological preference for east- and west-facing cliffs with inclinations between 60° and 90°. Moreover, it prefers the ridges more exposed to the cool-humid breeze rather than the sites located at the base of cliffs (de Simone 2020).

In eastern Mediterranean, *E. sicula* subsp. *sicula* also grows on shady calcareous cliffs, ledges, and karst formations in open areas or in mixed woodlands dominated by conifers, deciduous or evergreen broadleaved species. Throughout its distribution range, this taxon occurs at different altitudes; for instance, in Anatolia, it grows near the coast between 60 and 100 m a.s.l., under fully thermo-Mediterranean climatic conditions, often accompanied by *Globularia davisiana* O. Schwarz (Davis et al. 1965, Stevens 1978). In Cyprus, it occurs between 275 and 975 m a.s.l., mostly growing on north-facing sites, but on south-facing slopes at its highest location at Buffavento. It typically thrives in the crevices of hardly accessible cliffs, occasionally in sclerophyllous maquis and within gaps

among natural or artificial conifer woodlands of *Pinus brutia* Ten. and *Cupressus sempervirens* L. on mountain slopes (Meikle 1985, Viney 1994, Hand et al. 2011, Wagensommer 2017).

In Lebanon, E. sicula subsp. sicula mostly grows between 400 and 1600 m a.s.l. (Mouterde 1983, Browicz 1983, Mughrabi de Kuppler 2013) preferring north-facing rocky slopes and enjoying the exceptionally cool and shady microclimatic conditions found in the bottom of gullies (Gombault 1946, Bou Dagher-Kharrat et al. 2013). Therefore, according to the zonation of Abi-Saleh (1982), the species shows ranges from the meso- to the supra-Mediterranean levels. During the field surveys, we observed the species growing in at least five different habitat types, thus co-occurring with a wide variety of accompanying species. In the lower part of the valley, on both north- and south-oriented slopes, near Yahchouch, Chouwen and Frat, E. sicula subsp. sicula occurs in meso-Mediterranean Ouercus coccifera woodlands and Pinus brutia woodlands (corresponding to the habitat types T213 LB1 and T3A5 according to El Zein et al. 2022). Pinus brutia, Arbutus andrachne L., Ptilostemon chamaepeuce (L.) Less, Rosularia libanotica (L.) Sam., Sedum spp., and Dryopteris pallida (Bory) Maire et Petitm. subsp. libanotica (Rosenst.) E. Nardi are typical accompanying species, as mentioned in the previous national assessment (Stephan et al. 2017). In the higher part of the valley, the plant occurs on north- and west-oriented cliffs between 1400 and 1600 m a.s.l. at the zone. There it was observed in scattered supra-Mediterranean Quercus coccifera L. woodlands (habitat T213 LB2), Ostrya carpinifolia Scop. woodlands (habitat T19B1 LB1) and Juniperus oxycedrus L. thickets (habitat S2314). It was accompanied by scattered individuals of Pistacia palaestina Boiss., Potentilla libanotica Boiss., Onosma frutescens Lam. and Hirtellina lobelii DC.

In Libya, *E. sicula* subsp. *sicula* grows on the cliffs and ledges of the steep calcareous slopes of several seasonal streamsides (called 'widien', plural of 'ouadi/wadi'), between (100)250 and 500 m a.s.l. (Browicz 1983, Brullo and Furnari 1994). More in detail, according to Brullo and Furnari (1994) it takes part to different chamaephytic communities like the garrigue formations referred to the *Asperulo tragacanthoidis-Rosmarinetum offinalis* (Susa and el-Hilal between 180 and 310 m a.s.l.), and the chasmophilous assemblages referred to the *Origano cyrenaici-Putorietum calabricae* (wadi beneath Susa and el-Hilal from (100)250 to 310 m a.s.l.) and the *Telephio barbeyani-Darnielletum cyrenaicae* (Wadi Derna from 260 to 300 m a.s.l.).

According to Davis et al. (1965) *E. sicula* subsp. *bocquetii* grows on north-facing limestone cliffs within *Cedrus libani* woodlands in the montane-Mediterranean vegetation belt in Çığlıkara Nature Reserve. Another subpopulation was collected in the west of Bey Mountains in the same habitat in Elmali Cedar Research Forest (Yaltırık 1971, McClintock 1991, Kendir 2005, Kendir and Güvenç 2008). More recently this taxon has been recorded also under fully thermo- and meso-mediterranean conditions, always on limestone cliffs, ledges and cracks facing the northwest.

Concerning the vegetative growth, Raunkiær (1934) probably had the opportunity to observe the behaviour of a cultivated individual of *Pentapera sicula*, remarking that the plant was able to produce dwarfed and denser foliage on shorter shoots under stressful conditions. As for vegetative propagation, trials carried out so far with woody cuttings showed low rates of rooting success (43.5%) for *E. sicula* subsp. *sicula* harvested in February. These rates are even lower (from 0 to <20%) in other harvesting periods and for subsp. *bocquetii* (Ari et al. 2015). Low success was also recorded for green cuttings, suggesting that the applied techniques need to be improved (A. Cristaudo, *pers. comm.*).

Population genetics, pollination biology and seed dispersal studies on this species would be extremely beneficial to assess if fragmentation might be a threat, considering that reduced fecundity has been previously reported to affect this species (Commission of the European Communities 2009).

Available information on reproductive biology (e.g., breeding system, seed duration and seedling survival) is very poor. Unfortunately, the available accessions collected in the framework of the Genmedoc and Semclimed Projects in the 2000s and stored in the germplasm bank of the Department of Biological, Geological and Environmental Sciences of the University of Catania (BGS-CT) proved to be totally devoid of viable seeds. This fact may depend - at least for the plants growing on the foothills of Mt. Cofano - on a very low reproductive performance (A. Cristaudo, *pers. comm.*).

Germination tests carried out on Lebanese material of *E. sicula subsp. libanotica* at the University Saint Joseph of Beirut, kept at 16 °C on agar medium with alternate cycles of 12h light/12h dark, showed that the seeds are orthodox. Their germination rate is approximately 25%, and seedlings start to emerge around 30 days after sowing (Lebanon Flora 2020). In contrast, another Lebanese accession studied at Kew showed a germination rate of 100% after 63 days at 10 °C with 1% agar under 8h light/16 dark regime (source: SER, INSR, RBGK 2023; https://ser-sid.org/species/5dc3038b-0eb7-4a23-b665-3cec9a4aacc8 and https://ser-sid.org/species/1aed0b53-1f32-4a6f-9df8-c9036134337c). Probably all members of the Pentapera group possess pollen tetrads, as verified in Lebanese (Haddad

1969) and Cypriot (Sarwar 2007) subpopulations of *E. sicula* subsp. *sicula*, as well as in *E. sicula* subsp. *bocquetii* (Pinar and Oybak 1995).

Moreover, neither the pollination ecology nor the dispersal strategies of the species complex have been properly investigated yet. Within the genus *Erica* plant breeding is often vehiculated by complex networks of insects (Rebelo et al. 1985, Ballantyne et al. 2015, Bouman et al. 2017, Moquet et al. 2017, Heystek and Pauw 2014). So, it cannot be ruled out that the subpopulations of Lebanon and Cyprus are interconnected through pollinators allowing effective gene flow. The seeds of the heathers of the *Pentapera* group are very light 0.5-0.9 mg), small (0.5-0.8×0.3-0.5 mm) and winged (Fagúndez and Izco 2011), suggesting wind dispersal, although the distance they might travel before landing on suitable habitat remains unknown.

Census and Assessment of AOO and EOO at global and national scale

The overall EOO of *Erica sicula sensu lato* (i.e., including all the related subspecies) exceeds 715000 km², whilst the AOO is only 140 km². Fig. 1 displays the extent of the species' range throughout the Mediterranean Basin.

A partial census was carried out using a UAS at Mt. Cofano, the type locality of *E. sicula* subsp. *sicula*. The census ascertained the presence of 985 individuals on four sampled areas in its suitable habitat, covering a total cliff surface of 5.91 ha (de Simone 2020). Based on 2×2 km wide cells, Domina et al. (2012) estimated that EOO = 4 km² and AOO = 4 km², assessing that the surface effectively occupied by *E. sicula* subsp. *sicula* is about 25 ha. In this work, we updated in detail the EOO and AOO of the subspecies: We calculated a more accurate AOO for the subspecies accounting for locations where the presence of the species was confirmed by terrestrial and aerial surveys in the whole research area. Moreover, the role played by dimension Z in the estimation of the AOO is of paramount importance when assessing the conservation status of plant species linked to cliff habitats. In the case of the subspecies was confirmed and using a 2×2 m digital terrestrial model, we found that *E. sicula* subsp. *sicula* has a real AOO of 57.84 ha, while the projected AOO is 25.12 ha. Calculating the minimum convex polygon of the projected AOO, the EOO is 100.63 ha.

Assuming that the areas surveyed are representative of the total stand and considering the total extension of the cliffs where the species was observed, we can estimate that the total subpopulation in Sicily may range between 4186 and 9638 individuals, with the oldest and biggest ones (whose crown may be more than 2 m wide) growing at higher altitudes (de Simone 2020). However, the number of individuals may be an overestimate of the effective total subpopulation, which could rather be half or even less. In fact, de Simone (2020) demonstrated that, due to the micro-topographic preferences of the species, the cliffs are not homogeneously colonised. Our estimate is based on the assumption that the species homogenously occupies the area where it is present, thus underrating the impact of local abiotic (slope, rockiness, etc.) and biotic (competition with other rupicolous species) factors.

The field campaign carried out between 2022 and 2023 enabled a more precise calculation of the EOO and AOO of E. sicula subsp. sicula in Lebanon, respectively 55.067 km² and 28 km². The discovery of additional subpopulations led to larger values for EOO and AOO compared to the previous assessment (Stephan et al. 2017), which were 45 km² and 20 km², respectively.

Similarly, the recent survey provided detailed information about the 7 subpopulations living on Cyprus, with their total area amounting to 6.64 ha. No recent data are available on the two subpopulations reported in the district of Limassol, where the taxon may have gone extinct. Based on 2×2 km wide cells, the EOO of the Cypriot subpopulations is around 327 km², the AOO = 28 km².

Based on the location of the subpopulations of *E. sicula* subsp. *sicula* in Antalya province, the EOO of the Turkish subpopulations is about 153 km^2 , while the AOO is 24 km^2 .

Based on the geographic coordinates of the herbarium specimens, we were able to map most of the historical records of *E. sicula* subsp. *sicula* in Libya. As a result, we measured an EOO of 2185 km² and a AOO of 32 km^2 .

In Anatolia, the EOO for *E. sicula* subsp. *bocquetii* is 525 km², while the AOO is 28 km².

Current conservation, main threats and demographic trends

The minimum viable value for *E. sicula* was estimated to be 500-1000 mature individuals per subpopulation (Commission of the European Communities 2009). Most likely, two out of three Sicilian stands have disappeared during the last two centuries. The whole population falls within the Special Area of Conservation of the Natura 2000 network ITA010016 "Monte Cofano e littorale" and in the regional nature reserve 'Monte Cofano". Mt. Cofano is also an Important Plant Area (hereinafter IPA; Blasi et al. 2010). The type subspecies is featured in all the national (Conti et al. 1992, Conti et al. 1997, Scoppola and Spampinato 2005, Rossi et al. 2013) and regional (Raimondo et al. 1994, Raimondo et al. 2011) red lists. The increasingly frequent wildfires which recently affected Mt. Cofano represent the only factor currently affecting local subpopulation. Another threat is represented by plant collectors. In fact, in the European herbaria we found more than 60 specimens from Mt. Cofano (see Supplementary File 3), suggesting that most plants are safe from collectors (but not from fire), while the more accessible portion of local ubpopulation has been systematically damaged for two centuries by botanists eager to possess their own specimen. Additionally, the fast spread in the adjacent municipalities of the invasive alien perennial grass *Cenchrus setaceus* (Scuderi and Pasta 2009), may soon pose a serious threat to the Sicilian subpopulation.

In Lebanon, *E. sicula* subsp. *sicula* is severely threatened by the increasing impact of human activities. In fact, the primary threats to most of the Lebanese subpopulations are quarrying, urban sprawl and the construction of built infrastructure such as dams and roads. The increasingly frequent fires severely affect some of the stands, especially in the lower parts of the canyon and constitute a secondary threat. Overgrazing occurs in the upper part of the valley and may hinder the expansion of few remnant nuclei in cliffs areas accessible to goats. The total subpopulation size in Lebanon is estimated at 5000 individuals, with 4000 distributed in the areas of Afqa, el Mejdel and Aaqoura, and 1000 in the area of Yahchouch Chouwen and Frat. At least two of the known subpopulations were destroyed in the two last decades by quarrying and the construction of the dam of Janna. Only a small part (<10%) of the subpopulations fall in the territory of Jabal Moussa Biosphere Reserve. Although the entire valley of Nahr Ibrahim has been identified as an Important Plant Area (IPA) according to two studies (Radford et al. 2011, Bou Dagher et al. 2018) and as a Key Biodiversity Area (El Zein et al. 2018), only the small area included in Jabal Moussa is a protected area. Hence a total of 6 currently threatened locations were identified.

On Cyprus *E. sicula* subsp. *sicula* grows in areas of high conservation interest, but these sites currently are not yet protected by law. The most recent field census suggests an overall number of approximately 4700 individuals forming seven distinct subpopulations, whose number and size are expected to shrink in the long term due to goat overgrazing and to increasingly frequent wildfires (S. Gücel, *pers. comm.*). Although some of its stands went extinct during the last decades, this taxon is not included in the Red Data Book of the Flora of Cyprus (Tsintides et al. 2007).

In the IUCN Red Data Book of the Turkish Vascular Flora (Ekim et al. 2000), both *E. sicula* subsp. *bocquetii* and *E. sicula* subsp. *sicula* (under subsp. *libanotica*, Authors' note) were classified as Vulnerable (VU), while Tezel et al. (2020) cite *E. sicula* subsp. *bocquetii* as Critically Endangered (CR) with no further details. Some of the Turkish subpopulations of *E. sicula* subsp. *sicula* fall within

the Beydağları Sahil Milli Parkı (= Beydağları Coastal National Park) and/or the Kaş-Kekova Special Environmental Protection Area, while the type locality of *E. sicula* subsp. *bocquetii* falls within the Çığlıkara Tabiat Koruma Alanı (= Çığlıkara Nature Reserve) (O. Şentürk, *pers. obs.*).

As for Libya, the lack of recent updates does not allow to evaluate the exact number and the size of the subpopulations of the local subspecies. All the Libyan subpopulations grow in the Jabal El-Akhdar Region, a territory that has been designated as IPA by El-Rtaib (2010) and by Radford et al. (2011), but that is not protected by law. Threats to vegetation in the massif of Jabal El-Akhdar are well documented. Human activities were relatively more restricted in this area in the past, aimed at protecting the forests. However, the situation has changed during the last decade following the political instability, which led to civil unrest and movement of human populations. The main threats are firewood collection, charcoal production, over-harvesting of medicinal and aromatic plants, bush fires, quarrying, urban sprawl, overgrazing, agriculture expansion and uncontrolled camping (Saaed et al. 2022). The habitat extent and quality are still declining now. Several dams were built along Wadi Derna in the 1970s to prevent seasonal floods and to collect water for irrigation purposes. These dams sadly hit the headlines in September 2023 because of their collapse after an intense rainstorm, causing thousands of human casualties. Many N Libyan subpopulations of *E. sicula* subsp. *sicula*, which were concentrated within the catchment area of this seasonal stream might have been severely affected by this event.

Extinction risk assessment

Table 2 provides a synthetic overview about the thresholds and the criteria followed to perform the extinction risk assessment both at the global/species scale and at the subspecies-regional scale. At the global scale E. sicula sensu lato was evaluated as Least Concern (LC). In the one hand, the EOO is rather extensive, with 715366 km²; in the other hand the AOO is of 140 km² and a continuing decline was observed (b) in EOO (i), AOO (ii), area, extent and/or quality of habitat (iii) and number of subpopulations or locations (iv). However, the species distribution pattern is not severely fragmented as the various subpopulations have been able to survive within the five countries. As for the national assessments, E. sicula subsp. sicula present in Sicily has been listed by Domina et al. (2012) as Critically Endangered (CR) based on the subcriterion B1ab(i,ii,iv,v). Based on the data collected during the fieldwork by de Simone (2020), we are able to confirm the risk level assigned to this subspecies; yet, we applied different and additional sub-criteria - Blab(i,ii,iii,iv) + 2ab(i,ii,iii,iv) - to support the previous assessment: the EOO (4 km²) and AOO (4 km²) are very restricted (B1 + B2), there is one sole location (a) and a continuing decline observed (b) in EOO (i), AOO (ii), area, extent and/or quality of habitat (iii), number of subpopulations or locations (iv). In Lebanon, the updated data collected during surveys on distribution, number of subpopulations and threats have allowed us to review the EN status previously evaluated in the initial assessment (Stephan et al. 2017). We assessed the taxon as VU at the national scale of Lebanon under the subcriteria B1ab(i,ii,iii,iv) + 2ab(i,ii,iii,iv): the EOO (55.067 km²) and AOO (28 km²) are very restricted (B1 + B2), there are six locations (a) and a continuing decline observed (b) in EOO (i), AOO (ii), area, extent and/or quality of habitat (iii), number of subpopulations or locations (iv). On Cyprus, the data yielded during the recent field investigations allowed us to assess E. sicula subsp. sicula as VU at the island scale under the subcriteria B1ab(i,ii,iii,iv) + 2ab(i,ii,iii,iv): both the EOO (326.8 km²) and the AOO (28 km²) are very restricted (B1 + B2), there are seven locations (a) and a continuing decline observed (b) in EOO (i), AOO (ii), area, extent and/or quality of habitat (iii), number of subpopulations or locations (iv). In Anatolia, the taxon was evaluated as nationally VU under the subcriteria B1ab(i,ii,iii,iv) + 2ab(i,ii,iii,iv): the EOO (153 km²) and AOO (24 km²) are very restricted (B1 + B2), there are six locations (a) and a continuing decline observed (b) in EOO (i), AOO (ii), area, extent and/or quality of habitat (iii), number of subpopulations or locations (iv). In Libya, E. sicula subsp. sicula was assessed as VU at the national scale under the subcriteria B1ab(iii) + 2ab(iii): the EOO (2,185 km²) and the AOO (32 km²) are restricted (B1 + B2), there are seven locations (a) and a continuing decline observed (b) in the area, extent and/or quality of habitat observed (iii).

E. sicula subsp. *bocquetii* was previously evaluated as Critically Endangered (CR) according to the criteria B1a+2a, as already suggested by AKS Planlama Mühendislik (2010). Following updated analyses, we assessed the taxon as VU at the global scale under the subcriteria B1ab(iii) + 2ab(iii): EOO (959.454 km²) and AOO (32 km²) are restricted (B1 + B2), there are eight locations (a) and a constant decline (b) in the (iii) area, extent and/or quality of habitat was observed.

E. sicula subsp. *sicula sensu lato* is assessed as LC at the global level: the EOO (715366 km²) is extensive, while the AOO is quite restricted (140 km²). As for the assessment at the species level, the distribution pattern seems not to be severely fragmented. Indeed, even if long-lasting monitoring activities would be required to ascertain the demographic trends and the reproductive fitness of the subpopulations, actually these have been able to survive within the five countries.

Conclusion

The information provided in this paper may be used to better protect all the known and threatened subpopulations of the taxa referred to *E. sicula sensu lato*. Identifying the knowledge gaps is the second step for effective plant conservation. In fact, once we point out the missing information, we can try to fill those gaps in order improve our understanding on the real ecological requirements of the target species and to envisage the most effective protection measures in the mid- and long-term.

The global conservation status of a taxon is assumed to depend on the conditions and challenges it faces in the countries where it occurs. However, as illustrated by the case of *Erica sicula*, the global status may not accurately reflect the distinct risks of extinction in each individual country where the species occurs. This observation could also underscore a potential flaw in the guidelines and criteria of the IUCN Red List. Thus, it is of paramount importance to carefully consider the regional assessments when dealing with species counting many subspecies and subpopulations scattered across an extensive range. To understanding and prevent species' extinction risk, a careful examination of the status and risk levels of each subspecies is required. Although they all share the same habitat (calcareous cliffs), the pentamerous heathers show some differences in terms of altitudinal range that are striking enough to raise taxonomic questions. For instance, the Sicilian, Anatolian and Libyan subpopulations of *Erica sicula* subsp. *sicula* only occur under strictly thermo-Mediterranean climate, whereas the Cypriot and Lebanese subpopulations grow only on mountain ranges subject to meso- and supra-Mediterranean climatic conditions.

All the taxa of this group are located on very steep slopes, show extremely low reproductive performance, are narrow-ranged and their population appear fragmented and shrinking at the national scale. Low competitivity and ongoing shrinkage are probably triggered by more than one single factor; hence, future investigations should go in several directions.

For instance, we need to record detailed diachronic data on the microclimatic requirements of the pentamerous taxa through data-loggers (Marcenò et al. 2022). In fact, these heathers probably benefit from favourable climatic conditions (cool summers at higher altitudes) and microclimatic factors (overnight moisture supply near the coast or riverbeds) that help reduce seasonal water stress. In this regard, it is worth mentioning that de Simone (2020) recorded almost constant values of air humidity and daily temperature values in the N-facing cliffs of Mt. Cofano (Sicily). This would explain, for example, why some attempts to plant *E. sicula* subsp. *sicula* at lower altitudes, conducted on Cyprus Island, have failed (S. Gücel, *pers. comm.*). The use of drones allows to monitor the subpopulations and to better understand the auto- and synecology of these cliff-dwelling taxa in otherwise inaccessible contexts (de Simone 2020, Reckling et al. 2021, Li et al. 2022); if combined with more detailed climatic data, occurrence and ecological data may significantly improve the quality of the IUCN risk assessment and the precision of niche models (e.g., Bazan et al. 2012).

New prospections and a more intense sampling effort are needed - not only on the less investigated subpopulations of Anatolia and Libya - in order to assess the genetic diversity within and among all the members of the subgenus *Pentapera*, trying to gather more material from cliff individuals to capture the whole variability of each taxon. This could help to define the evolutionarily significant

units and to identify the genetic diversity hotspots, with the ultimate goal of assisting future projects of *in-situ* and *ex-situ* conservation.

Furthermore, enhancing our knowledge about the physical, chemical, and biological properties of the soils where the pentamerous heathers grow is proving to be crucial. For instance, soil microbiota may host mycorrhizae useful for inoculation that may facilitate the establishment of the saplings during plant translocation initiatives.

Ad hoc research on reproductive biology, namely on plant-insect interactions (pollinators, predators), seed dispersal strategies and seedling/sapling establishment rate may explain - and perhaps help to solve - the problems of low reproductive fitness likely affecting all the members of the subgenus.

As for *ex situ* conservation, the only known attempt to cultivate *E. sicula* outside its native range has been carried out at Kew (T. Freeth, *pers. comm.*). According to the registers, in 1952 the Royal Botanic Gardens hosted a plant grown in open ground, whose provenance and identity remains uncertain; in 1984 Kew hosted many individuals of *E. sicula* subsp. *sicula* issuing from seeds collected by J.J. Archibald near Kemer (Anatolia). Cultivated both in pot culture and in the alpine houses, and more recently on the rock garden when hardiness in UK climate was assured, these plants have persisted through time facing different hostile weather conditions, e.g., warm wet and regularly frozen winters, and long summer droughts (T. Freeth, *pers. comm.*).

Along with the above-mentioned multifaceted research needed, some concrete interventions should be carried out as soon as possible. For instance, considering the clear preference of *Erica sicula sensu lato* for shady and humid habitats, in the coming decades the increasing frequency of extreme heat and drought events and wildfires will probably affect the survival of the members of this group across their entire distribution range (MedECC Members 2019). Hence, to fight against the ongoing decline of many subpopulations, translocation initiatives should be encouraged (e.g., Abeli et al. 2021), especially where the frequency and intensity of local disturbances are expected to last or even to increase in the next future, as in the case of Sicily, Libya, Lebanon, and Cyprus.

In the specific case of *E. sicula* subsp. *sicula*, much more efforts should made to prevent and fight against the spread of invasive alien plants like the tussock alien grass *Cenchrus setaceus*, rapidly spreading along the disturbed coastal areas of NW Sicily and getting every year closer to Mt. Cofano (Pasta et al. 2010).

Contacts with the large number of scientists involved in this study were greatly facilitated by networks of Mediterranean specialists such as the IUCN/SSC/Mediterranean Plant Specialist Group and GENMEDA (http://www.genmeda.net/members/current_members/iucn). On this purpose, this study represents a paradigmatic case of international collaboration. Similar efforts should be encouraged and multiplied to strengthen the relationship between countries and improve knowledge, data sharing and produce effective, shared and long-lasting conservation policies, going beyond the political and administrative borders of the countries hosting broad-ranged endangered plants.

Authors' Contribution

SP led the research and the writing of the manuscript; HEZ, OS and SG provided data from herbarium, literature and/or unpublished field reports; HEZ, SG and LDS conducted field surveys respectively in Lebanon, Cyprus and Sicily; HEZ produced the maps and supported risk assessments using GIS software; the additions and remarks of HEZ, LDS and BDM significantly improved the final quality of the first draft. All the co-authors revised, improved, and accepted the manuscript before submission, and declare that there is no potential conflict of interest among them. HEZ must be considered as first co-author *ex aequo* together with SP.

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Figures and Figure Captions



Figure 1. Distribution range of the two subspecies of *Erica sicula* Guss.

Figure 2. a-b: *Erica sicula* subsp. *sicula* in its type locality, Monte Cofano (NW Sicily): flowers and overall habit (photo credit: D. Salemi) and habitat (photo credit: L. de Simone); d-e: *E. sicula* subsp. *sicula* at Aaqoura, Byblos District, Lebanon: flowers and habitat (photo credit: H. El-Zein); f-g: *E. sicula* subsp. *sicula* at Buffavento, Cyprus: flowers and habitat (photo credit: S. Cambria); h: *Erica sicula* subsp. *bocquetii* at Kaş, Antalya: flowers (photo credit: Z. Aytaç).





Figure 3. Past and present distribution of *Erica sicula* subsp. *sicula* in Sicily. Detailed information on the current distribution on Mt. Cofano based on de Simone (2020).



Figure 4. Past and present distribution of *Erica sicula* subsp. *sicula* in Lebanon. The current distribution map is based on the field data collected between 2022 and 2023. Belhoss quarries and Janna dam correspond to the areas where the local subpopulations were wiped out due to habitat destruction.



Figure 5. Distribution of *Erica sicula* subsp. *sicula* on Cyprus based on literature data and herbarium specimens (Meikle 1985) and on the occurrence data collected during the field surveys carried out in 2022.



Figure 6. Distribution of *Erica sicula* subsp. *sicula* and *Erica sicula* subsp. *bocquetii* in Anatolia based on the location of the herbarium specimens (see Supplementary File 3).



Figure 7. Distribution of *Erica sicula* subsp. *sicula* in Libya based on the location of the herbarium specimens (see Supplementary File 3).



Table 1. Taxonomic prospect of the epithets referring to *Erica* subgenus *Pentapera*: In bold the epithets used in the paper.

Erica sicula Guss., Cat. Pl. Hort. Boccadifalco: 74. 1821 (subsp. sicula) *Pentapera sicula* (Guss.) Klotzsch, Linnaea 12: 498. 1838

Pentapera sicula (Guss.) Klotzsch var. libanotica Barb.-Boiss. & Barbey, Herb. Levant: 144. 1882
Erica sicula Guss. var. libanotica (Barb.-Boiss. & Barbey) Holmboe, Stud. Veg. Cyprus: 142. 1914
Pentapera sicula (Guss.) Klotzsch subsp. libanotica (Barb.-Boiss. & Barbey) Yalt., Notes Roy. Bot.
Gard. Edinburgh, 28: 13. 1967
Erica sicula Guss. subsp. libanotica (Barb.-Boiss. & Barbey) P.F. Stevens, Fl. Turkey & East Aegean
Islands, 6: 97. 1978

Erica sicula Guss. subsp. cyrenaica Brullo & Furnari, Webbia, 34: 164. 1979

Pentapera bocquetii Peşmen, Candollea, 23. 271. 1968 *Erica bocquetii* (Peşmen) P.F. Stevens, Fl. Turkey 6: 97. 1978 *Erica sicula* Guss. subsp. *bocquetii* (Peşmen) E.C. Nelson, Hardy Heathers: 299. 2011 **Table 2.** Overview of the thresholds and criteria followed for the extinction risk assessment of *Erica sicula* at the species-global scale and at the subspecies-regional scale. N.a. = not assessed.

Taxon	Country/Reg ion	Locati on	EOO (km²)	AO O (km	Estimated subpopulat ion size	Severely fragment ed	Threats	Criteria	Stat us
				²)	(nr)				
E. sicula subsp. sicula	Sicily	1	4	4	4186-9638	no	wildfires, invasive alien plants	B1ab(i,ii,iii, iv) + 2ab(i,ii,ii,iv)	CR
E. sicula subsp. sicula	Libya	8	2185	32	n.a.	no	firewood collection for charcoal production, overharvest ing for medicinal purposes, wildfires, quarrying, urban sprawl, overgrazing , dam constructio n	B1ab(iii) + 2ab(iii)	VU
E. sicula subsp. sicula	Cyprus	7	327	28	4700	no	overgrazing , wildfires	B1ab(i,ii,iii, iv) + 2ab(i,ii,ii,iv)	VU
E. sicula subsp. sicula	Anatolia	6	153	24	n.a.	no	urban sprawl	B1ab(i,ii,iii, iv) + 2ab(i,ii,ii,iv)	VU
E. sicula subsp. sicula	Lebanon	7	55	28	5000	no	quarrying, dam constructio n, road constructio n, urban sprawl, wildfires	B1ab(i,ii,iii, iv) + 2ab(i,ii,ii,iv)	VU
E. sicula subsp. bocque tii	Anatolia	8	525	28	n.a.	no	overgrazing , wildfires	B1ab(iii) + 2ab(iii)	VU
E. sicula sensu lato	Global	37	7153 66	140	n.a.	yes		B2ab(i,ii,iii, iv)	LC

Supplementary File 1. Brief morphological description of the members of *Erica* subgenus *Pentapera*

E. sicula subsp. sicula

<u>Sicilian subpopulation</u>: erect 20-60 cm tall cushion-shaped shrub, with robust woody erect to ascending branches; the young twigs are subterete, densely pubescent in their upper side due to small patent glandular hairs; evergreen leathery leaves densely pubescent when young, linear, patent, 1×5 -6 mm, in whorls of 4(-5), glossy dark green above, whitish beneath, with incompletely revolute and contiguous margins, concealing the lower surface forming a whitish line; flowers actinomorphic, 5-merous, grouped in terminal umbels of 4-6(10); pedicels 2×4 mm with 3 pink lanceolate bracteoles near the middle; 5 sepals ovate-lanceolate, pubescent, pink, 4 mm (2/3 of the corolla); 5 petals entirely welded forming a white or very pale pink urceolate, sparsely pubescent corolla, 4×6 -8 mm; stamens 10, dark purple, anthers without appendages, included; ovary 5-locular, pubescent; stigma capitate. *E. sicula* subsp. *sicula* starts to flower in December, but the usual blooming period begins in February, its acme is between April and May and lasts until June (L. de Simone, *pers. obs.*), whilst the fruits ripe during the summer season. Out of curiosity, the blooming time of the congeneric *Erica multiflora* L., often co-occurring in close vicinity with *E. sicula*, is autumn (September to November), so the two heathers are probably visited by different pollinators.

<u>Anatolian subpopulation</u>: according to Stevens (1978), local plants, previously referred as to *E. sicula* subsp. *libanotica*, would differ from those of the type (Sicilian) locality for several traits, like the size of the individuals (up to 150 cm), their almost glabrous twigs, the longer and narrower leaves (8.5- $13 \times 0.8 - 1.3$ mm), the lack of a whitish mucrone on the leaf tip, the bigger and less hairy flower parts (pedicels 7-15 mm, sepals 6.5 mm, petals 7.5-9×5-5.5 mm) and the colour of the corolla (usually bright pink instead of pale pink-white).

<u>Cypriot subpopulation</u>: local plants are smaller than the Turkish ones, probably because of stressful conditions induced by overgrazing and frequent fire disturbance. According to Viney (1994): "spreading shrub to 60 cm with tough, brown, flaking stems, needle leaves c. 7 mm long with edges rolled over, in close whorls of 4; flowers in umbels of 3-8 or more at the end of branches; corolla in various shades of pink (even to white), 7-8 mm long, bell-shaped-cylindrical, with 5 tiny-ended lobes; dark purple anthers inside the bell, but style shortly protruding. Flowering: March-July" (until August according to Meikle 1985).

<u>Libyan subpopulation</u>: according to Brullo and Furnari (1979), who described these plants as belonging to *E. sicula* subsp. *cyrenaica*, the plants growing in Cyrenaica differ from the type for their dwarfed habit, mostly growing as subshrubs (but Trotter 1915 observed well-developed individuals reaching 1 m), and for having $4.5-5 \times 1.5-1.8$ mm sepals, a 6 mm long corolla inflate in the lower part and evidently strangulated in the upper one, the teeth up to 1 mm long, stamens 5 mm long, anthers 1.5-1.8 mm long, styluses 4.5 mm long hairy only in the upper part and rarely in the lower one.

E. sicula subsp. bocqueti

Small, 25-40 cm high, irregularly branched shrub that differs from the other taxa of the group for its overall dwarfed size: the flowers are smaller, the leaves are 3-4(-5) mm long, typically arranged in whorls of 3 rather that 4, and anthers lack spurs. The terminal inflorescence bears 1-4 purplish flowers, reduced leaves at the base (pedicels 8-13 mm, bracts and bracteoles 1.3-2 mm). Sepals 3-4 mm. Pale purple urceolate corolla $5-6(8)3 \times 2-4$ mm, somewhat pubescent. Filaments 2.4-4 mm, bent; anthers 2-2.5 mm, impressed styles 3.5-4 mm. Seeds compressed ovoid 0.5×0.3 mm (Peşmen 1968, Yaltırık 1971, Stevens 1978).

Supplementary File 2. Iconography

Erica sicula subsp. sicula Gussone, Ic. Fl. Sic. T. 197 (not found, Authors' note) C.F. Schmidt in Klotsch (1841-1844): table 19 http://plantillustrations.org/illustration.php?id illustration=187541&SID=0&mobile=0&code categ ory taxon=2&size=0 M. Smith in Hooker (1888): table 7030 http://plantillustrations.org/illustration.php?id illustration=4516&SID=0&mobile=0&code categor y taxon=2&size=0 J. Weathers (1874-1955): fig. 45, p. 335 http://plantillustrations.org/illustration.php?id illustration=384340&SID=0&mobile=0&code categ ory taxon=2&size=0 Fiori and Paoletti (1899-1904): fig. 2649, p. 312 Lojacono-Pojero (1907): fig. 1, plate I Trotter (1915) fig. 91, p. 243 Siddiqi (1978): fig. 2, p. 5 A. Zizza in Brullo and Furnari (1979): fig. 7, p. 165 (as Erica sicula subsp. cyrenaica) Mouterde (1983), Plate II, nº 4 (as Pentapera sicula) Nelson (2011), figs. A-T, p. 298

Erica sicula subsp. *bocquetii* Peșmen (1968): fig. 3 a and c, p. 272 (as *Erica bocquetii*) **Supplementary File 3.** List of the available dry specimens. As far as this indication is reported in the labels, the specimens referring to each taxon are listed in chronological order (i.e., from the earliest to the last collection date) and grouped together when they have been collected in the very same locality. The specimens referred to subsp. *libanotica* and subsp. *cyrenaica*, currently considered as falling within the variability of subsp. *sicula*, are presented separately.

Erica sicula subsp. sicula (specimens from Sicily)

Erica sicula Guss. / Florescit aestate / In praeruptis montosis prope Drepanum (Monte Cofano) (handwritten by Gasparrini) / PAV (specimen not digitized)

Maggio / Punta di Cofani presso Trapani (handwritten by Gussone himself) / NAP000224039 (specimen not digitized)

Erica an spec. nov.: sicula Nob. / confer Buxbaum Centur. IV Tab. XLIII (erased by Gussone himself) / Mag.[gio] Cofano (handwritten by Gussone) / NAP0002240 (specimen not digitized)

Maggio Mt. Cofano (handwritten by Gussone himself) / NAP0002241 (not digitized)

Erica sicula Nob. (handwritten by Gussone himself) / Mag.[gio] Cofani / NAP0002243 (specimen not digitized)

Erica sicula Guss. (handwritten by Gasparrini himself) / NAP0002242 (specimen not digitized) *Erica sicula* Guss. / Monte Cofani / PAL62900

Erica sicula Guss. / Maggio / Monte Cofani / PAL62901

Erica sicula Guss. (stored under *Pentapera*) / Herbarium Horti Bot. Panormitani / Trapani (probably written by Todaro) / PAL (not digitized)

Erica sicula / Monte Erice presso Trapani / + erica piccola / Monte Erice / Gasparrini (first label) / PAL92602

Erica sicula Nob. + M.te Cofani presso Trapani (handwritten by Gussone) / Ital. 4. V. 327 n° 5 + misit Gussone 1822 (written by Bertoloni) / BOLO-Hortus Siccus Florae Italicae

[Erica sicula Guss.] / s.c. / s.n. / s.l. / 1827 / G279159-3

[Erica sicula Guss.] [G. Gasparrini ex] G. Gussone / s.n. / reçu en 1828 / G00323951

[*Erica sicula* Guss.] / Monte Cofano / Aprile 1830 (handwritten by Gasparrini himself) / PAV (specimen not digitized)

[Erica sicula Guss.] / F.L. Splitgerber / s.n. / [collected May 1833, sent on] 1834 / G00323949

Erica sicula Guss. / Herbarium Parlatoreanum / in Monte Erice in Sicilia / communicavit cl. Gasparrini / specimen accepto a cl.[aro] Gussonio (written by F. Parlatore) / da Parlatore in Agosto 1842 (written by someone else) / FI055352

Pentapera sicula Klotz. (Erica sicula Guss.) / Monte Cofani prope Drepanum (Trapani in Sicilia) / F. L. Splitgerber / 06.05.1833 / L2594953

Erica sicula Guss. / Aprili, Majo / In rupibus calcareis / Monte Cofani presso Trapani (handwritten by Gussone himself) / [a second label contains the folowing information: 13 Mag. 1844 / Erica sicula Guss. / cult.[a in Horto] Bot.[anico] Pan.[ormitano] / NAP000224038 (probably the **holotype** designated by Meikle, 1985, p. 1060)

Erica sicula Guss. / Herb. Leresche 1846 / In rupibus abruptis calcareis maritimis montis Cofano prope Trapani in Sicilia occidentale / Junio 1844 / MNHN-P-P00420189

ad rupes Montis Cofani propè Trapani / 18.IV.1855 / Alfred et Edouard Huet du Pavillon / Herb. Willkomm / COI00041979

Todaro Flora Sicula Exsiccata / *Erica sicula* Guss. / in rupibus calcareis montosis maritimis / Trapani a Monte Cofano / Majo / comp.[rato] da Todaro in Gen. 1864 / Legit Todaro (written by A. Todaro) / FI055351

Erica sicula Guss. / Plantae Siculae rariores / In rupibus calcareis maritimis M. Cofani / M. Lojacono, 435 / 05.1880 / LD1576977

Trapani, rupi calcaree / Todaro / 1890 / BOLO-Erbario Generale (specimen not digitized) *Pentapera sicula* Klotzsch / Herbarium Horti Bot. Panormitani / Flora Sicula / Trapani: in rupibus calcareis / IV.1890 / com. A. Todaro (written by A. Todaro) / FI055349 *Pentapera sicula* / Trapani / in rupibus calcareis / IV.1890 / A. Todaro / RO-gen (specimen not digitized)

Erica (Pentapera) sicula Guss. / H. Ross Herbarium Siculum / n° 354 / in rupibus calcareis maritimis, Trapani / V.1902 / comp.[rata] da Ross nel Genn. (= bought by Ross in January) 1905 (2 duplicates, FI055350 and FI055353)

Pentapera sicula / Drepanum (Trapani) / in rupium fissuris mare prospicientibus montis Cofano prope sacellum del Crocefisso, solo calcareo-dolomitico / 16 Maj.[o] 1904 / A. Ponzo / Flora Italica Exsiccata / RO-gen

Erica sicula Guss. / Fra le rupi prospicienti il mare di Monte Cofano, presso Trapani / A. Ponzo / 04.1905 / PI055698

Erica (Pentapera) sicula Guss. / Herbarium Siculum / In rupibus calcareis maritimis, Trapani / V.1902/ H. Ross, 354 / LD1577097

Erica sicula Guss. / Sizilien, Provinz Trapani, ca. 14 km NE Trapani, Monte Cofano, S-exponierte Felswände, Alt. 385 m, Kalk, Felsspalten / R. Karl / 27.03.1997 / W0125132

Erica sicula Guss. subsp. *sicula* / Monte Cofano / L. Scuderi & L. Gianguzzi / 22.04.2004 / CAT20208

Erica sicula Guss. subsp. *sicula* / Monte Cofano / R. Guarino & S. Sciandrello / 08.09.2010 / CAT14460

Erica sicula Guss. / Todaro Flora Sicula Exsiccata / In rupibus calcareis montosis maritimis /

Trapani a Monte Cofano / Legit Todaro / Majo / 3 duplicates: MNHN-P-P00419518, P00419519 and P00419520

Erica sicula Guss. / In rupibus calcareis mari finitimis - Cofani (Sicilia) / Todaro / 1866 / MNHN-P-P00419522

Erica (Pentapera) sicula Guss. / In rupibus calcareis maritimis - Trapani / H. Ross Herbarium Siculum N. 354 / 05.1901 / MNHN-P-P00419523

Erica sicula Guss. / Trapani, in rupibus calcareis maritimis / Ross Herbarium Siculum 1902 N. 354 / MNHN-P-P00419524

Pentapera sicula Kl. / Plantae Siculae / Ad rupes montis Cofani propè Trapani / Leg. E. et A. Huet du Pavillon / 18.04.1855 / MNHN-P-P00419525

 Pentapera sicula K1. / Plantae Siculae / Ad rupes montis Cofani propè Trapani / Leg. E. et A. Huet

 du
 Pavillon
 /
 18.04.1855
 /
 WAG1788094

 (https://wedialib.gov/methics

(https://medialib.naturalis.nl/file/id/WAG.1788094/format/large)

Erica sicula / Sicilia (handwritten by Gussone himself) / Herbarium Richard, Legit Gussone (handwritten by Gussone himself) / MNHN-P-P00419526

Erica sicula nob. / In rupibus calcareis Trapani (handwritten by Gussone himself) - Herbarium Richard, Legit Gussone (handwritten by Gussone himself) / MNHN-P-P00419527

Pentapera sicula Kl. / Plantae Siculae / Ad rupes montis Cofani prope Trapani / Leg. E. et A. HuetduPavillon/18.04.1855/L2594954(https://bioportal.naturalis.nl/en/multimedia/L.259495401129628109)

Pentapera sicula Kl. / Plantae Siculae / Ad rupes montis Cosani [= Cofani, Authors' note] prope Trapani / Leg. E. et A. Huet du Pavillon / 18.04.1855 / L2594955 (https://medialib.naturalis.nl/file/id/L.2594955/format/large)

Pentapera sicula Klotz / Hab.[itat] in Sicilia prope Drepanum / 6 Maji 1833 / Monte Cofani prope Drepanum (Trapani in Sicilia / F. L. Splitgerber / L2594953 (https://bioportal.naturalis.nl/en/multimedia/L.2594953 0624069484)

Erica sicula Guss. / In rupibus calcareis, Trapani, Sicilia / Todaro Flora Sicula Exsiccata / majo / Todaro / L2594959 (https://bioportal.naturalis.nl/en/multimedia/L.2594959_637546062)

Erica sicula Guss. / In rupibus calcareis, Trapani, Sicilia / Todaro Flora Sicula Exsiccata / majo / Todaro / AMD.67784 (https://bioportal.naturalis.nl/en/multimedia/AMD.67784_333500687)

Erica (Pentapera) sicula Guss. / H. Ross Herbarium Sicilum n. 354 / in rupibus calcareis maritimis Trapani / H. Ross / V.1904 / WAG.1788095 (https://bioportal.naturalis.nl/en/multimedia/WAG.1788095 1388945142)

Erica sicula Guss. / In rupibus calcareis, Trapani, Sicilia / Todaro Flora Sicula Exsiccata / majo / Todaro / L2594950 (https://bioportal.naturalis.nl/en/multimedia/L.2594950 892606391)

Erica sicula Guss. / In rupibus calcareis, Trapani, Sicilia / Todaro Flora Sicula Exsiccata / majo / Todaro / L2594956 (https://bioportal.naturalis.nl/en/multimedia/L.2594956 02140745359)

Erica sicula Nob. / in rupibus calcareis Cofani prope Drepanum (handwritten by Gussone himself) / L2594957 (https://medialib.naturalis.nl/file/id/L.2594957/format/large)

Erica sicula Guss. / Hb Adrien de Jussieu / in praeruptis montosis prope Drepanum loco vulgo dicto monte Cofani (handwritten by Gasparrini himself) / G. Gasparrini / 1836 / MNHN-P-P00419528

Erica sicula Guss. / In monte Cofano prope Drepanum / M.(isit) Gasparrini 1840 / MNHN-P-P00419529

Erica sicula Guss. / Sicilia (handwritten by Gasparrini himself) / Herbarium Richard, Legit Gasparrini (handwritten by Gasparrini himself) / MNHN-P-P00419530

Erica sicula / Sicilia (handwritten by Gussone himself) / M.(isit) Gussone 1831 (probably written by A. de Jussieu) / MNHN-P-P00419531

Erica sicula Guss. / Plantae Siculae rariores 435 / In rupibus calcareis maritimis M. Cofani / Leg. M. Lojacono(-Pojero) / Majo 1880 / MNHN-P-P00419532

Erica sicula Guss. (*Pentapera*) / In rupibus calcareis, Trapani, Sicilia / Todaro / majo / MNHN-P-P00288831

Erica sicula Guss. / Monte Cofano (TP) / D. Ottonello / Herbarium Mediterraneum / 08.07.1985 / PAL83069

Erica sicula Guss. / OPTIMA Iter Mediterraneum III n. 323 / Mt. Cofano. Westward slope. Calcareous soil. Alt.: 400-600 m. / Leg.: F.M. Raimondo et al. OPTIMA Iter III 137 / 31.05.1990 / 2 duplicates: B100485669 and PAL68835

Erica sicula Guss. / Monte Cofano (TP) / L. Gianguzzi / Herbarium Mediterraneum / 18.12.1999 / PAL83936

Erica sicula Guss. / Monte Cofano près de Cornino Prov. De Trapani / roches calcaires, 200 m, SE / G. Certa & A. Gambino / 03.04.2001 / Herbarium Mediterraneum / 4 duplicates: PAL62904, PAL62905, PAL88516 and PAL89701

Erica sicula Guss. / Trapani / A. Todaro / s.d. / RO-gen (specimen not digitized)

Erica sicula Guss. / Trapani, in Sicilia / A. Todaro / s.d. / RO-gen (specimen not digitized)

Erica sicula Guss. / In rupibus calcareis montosis maritimis / Trapani a Monte Cofano / A. Todaro / s.d. / 3 duplicates:1 in RO-gen + 2 in RO-Cesati (specimen not digitized)

Erica sicula Spr. / Fra le rupi dolomitiche di M. Cofano (presso Trapani) che guardano il mare, a pochi metri di altezza dal suo livello / Aprile 1903 / leg. A. Ponzo (CAT007456, Herb. Tornabene) Todaro Flora Sicula Exsiccata / *Erica sicula* Guss., cat. H. Bocc. 1821, p. 74 / In rupibus calcareis

montosis maritimis – Trapani a Monte Cofano / Majo / Legit Todaro (CAT007458, Herb. Tornabene)

Erica sicula subsp. *sicula* (specimens from Lebanon)

Al Farat Leb.[anon] / herb. V. D. Post / 04.1900 / G001056622 Afka / s.c. / 13.05.1951 / G00105634 Nahr Ibrahim / P. Mouterde / 04.05.1966 / G00105639 Nahr Ibrahim / P. Mouterde / 11.05.1964 / G00105640 Nahr Ibrahim / P. Mouterde / 22.12.1957 and 04.03.1964 / G00105641 Nahr Ibrahim / P. Mouterde / 29.03.1955 / G00105642 Nahr Ibrahim / P. Mouterde / 14.04.1949 / G00105643 Nahr Ibrahim / P. Mouterde / 07.03.1962 / G00105636 Afka / P. Mouterde / 10.06.1935 / G00105637 [?]falle Kartaba / leg. Ernst Hartmann / s.d. / G00105623 Nahr Ibrahim / Pabot / 25.03.1954 / G00105644

Nahr Ibrahim / Pabot / 30.03.1953 / G00105645

Pentapera sicula (Guss.) Klotzsch var. *libanotica* Barb. / 21.02.1932 / dans la gorge du Nahr Ibrahim (Liban) / Herbier Gombault: Plantes des Etats de Syrie, du Liban, de Lattaquié et du Djebel Druze / 3 duplicates: MNHN-P-P005244754, P005244757 and P005244759

Pentapera sicula (Guss.) Klotzsch var. *libanotica* Barb. / 31.07.1932 / Aqoura (Liban) / Herbier Gombault: Plantes des Etats de Syrie, du Liban, de Lattaquié et du Djebel Druze / 2 duplicates: MNHN-P-P005244755 and P005244756

Pentapera sicula Guss. Var. *libanotica* Barb. / Akoura – 1500 m / 30.07.1932 / plantes collectées par le frère Louis – Herbier de Syrie et du Liban donné par les F.F. Maristes d'Alep en 1947 / 2 duplicates: MNHN-P-P005245446 and P05274541

Pentapera sicula Guss. (III 969) β *libanotica* var. nov. Barbey mss. In herborisation / Herborisation au Levant – Syrie / entre Billaas et Afka, Liban, à 1100 mètres / leg. W. Barbey / 04.06.1880 / G00105627 (holotype) (https://plants.jstor.org/stable/viewer/10.5555/al.ap.specimen.g00105627)

Erica sicula subsp. sicula (specimens from Cyprus)

Pentapera sicula (Guss.) Klotsch / Cypern, Felswände bei Akanthou (today's Tatlısu) / Paul Sintenis, 222 / 04.05.1880 / LD1576917

Erica sicula Guss. / Cyprus: north range – Klippen / Akanthou? (= Tatlısu?) / s.c. / 28.03.1970 / S-PL-21032 [duplicates also in C and LM according to Sarwar, 2007, not seen]

Pentapera (Erica Guss.) *sicula* Klotzsch – Boiss. / Theodor Kotschy / Iter cilicico-kurdicum 1859. Plantae e Cypro / 253. In rupibus Buffavento versus Castellum reginae / alt. 3300' (= c. 1000 m a.s.l.) / 03.04.1859 / 4 duplicates: MNHN-P-P00419514, P00419515, P00419516 and P00419517

Pentapera sicula [var. *libanotica* added after] / Flora of Cyprus / Yaïlá (Kyrenia range) / common in limestone cliffs, luxuriant in shade when it can measure 6 feet across; corolla and calyx pink, leaves dark green / 28.03.1941 / P.H. Davis / K2903

Pentapera sicula [var. *libanotica* added after] / Flora of Cyprus / n[ea]r Halefka (dist. Kyrenia), 2000-2500 ft / N cliffs, very saxatile / 04.08.1940 / P.H. Davis / K1919 (specimen not digitized)

Pentapera sicula var. *libanotica* / Flora of Cyprus / Yaïlá (Kyrenia range near Halefka) / shady limestone cliffs, 2000 ft, very saxatile; bell of calyx pink, leaves dark green / 20.03.1941 / P.H. Davis / K2796 (specimen not digitized)

E. sicula / 24.02.2006 / Karpaz Zeytinburnu 400 m a.s.l. / S. Gücel (NEUN1717)

E. sicula / III.2006 / Buffavento 650 m a.s.l. / Z. Maraşlı, S. Tekol & M. Ince (NEUN1532)

E. sicula / 23.04.2006 / Alevkaya Esentepe yolu (= road to Esentepe) 500 m a.s.l. / S. Gücel (NEUN0183)

E. sicula / 23.04.2006 / Esentepe yolu (= road to Esentepe) 400 m a.s.l. / S. Gücel (NEUN2750)

E. sicula / V.2006 / Buffavento 600 m a.s.l. / M.K. Meraklı, S. Gücel, S. Tekol & M. Ince (NEUN1388)

E. sicula / V.2006 / Buffavento 600 m a.s.l. / M.K. Meraklı & Z. Maraşlı (NEUN1718)

E. sicula / 09.04.2013 / Tatlısu 450 m a.s.l. / G. Karabardak (NEUN4023)

Erica sicula subsp. sicula (specimens from Anatolia)

Pentapera sicula [(Guss.)] Klotzsch added with a pencil] / Flora of Turkey (Davis et al. 1965) / Antalya, Kesme Bogaz near Kemer, 60-100 a.s.l., shady limestone cliffs with *Globularia davisiana* [36°36'03.20" N, 30°29'1.81"] E / P.H. Davis / 14.08.1947 / ref. 14049 / E (specimen not digitized), G00105633

Erica sicula / Flora of Turkey (Davis et al. 1965) / C3, Antalya, Kesme Boğaz near Kemer / coll. H. Ern / 14.05.1974 / E (specimen not digitized) [a specimen of Ern, collected from the same place as Davis' sample no. 14049 (mentioned as ibid.) is quoted without a date in Davis (1965)] *Pentapera sicula* [(Guss.)] Klotzsch / Flora of Turkey (Davis et al. 1965) / prov. Antalya, distr. Kemer (Lycia) / Gönük Canyon / 100 m / P.H. Davis / cliffs / 07.07.1949 [the date of collection does not feature in the Flora of Turkey] / ref. 15017 / E (specimen not digitized)

Antalya, Göynük / N-exposed limestone cliffs / H. Runemark & P. Wendelbo, 280 / 25.04.1972 / LD 1482789

Pentapera sicula (Guss.) Kloz. subsp. libanotica (Barbey) Yalt. [*Erica sicula* Guss. subsp. *libanotica* (C. & W. Barbey) Stevens added later] / Antalya civarı (= around Antalya), Göğnük Deresi, leg A. Attilla, 07.06.1949, det. F. Yaltırık, I.X.1966) / ISTF 8678

Pentapera sicula [Nom. *Erica sicula* Guss. subsp. *libanotica* (C. & W. Barbey) Stevens added later] / Antalya, Kemer, Tahtalı dağ (= mountain), ~ 1600 m a.s.l. *Cedretum, Pinetum brutiae* [36°32'31.14''N 30°27'14.27'' E]/leg. N. Olgun, A. Attila 27.VI.1960, det. H. Demiriz, 12.12.1973 / ISTF 17696

Pentapera sicula (Guss.) Klotzsch [*Erica sicula* Guss. subsp. libanotica (C. & W. Barbey) P.F. Stevens comb. nov.] / C3, Antalya, Gönük, 100 a.s.l. / P.H. Davis 15017 / 14.05.1974 / ANK (specimen not gitized)

Erica sicula Boiss. subsp. *libanotica* (C. & N. Barbey) P.F. Stevens / Antalya, Kemer / maki (= maquis) / Y. Akman / 02.04.1984 / ANK13610

Erica sicula Guss. ['subsp. *libanotica* (C & W. Barb.) P.F. Stevens added with a pen] / C3, Antalya, Kemer, Yangın kulesi arası, serpantin ve kalker arazi, 50-300 m (= between Kemer and fire tower, serpentine and limestone terrain, 50-300 a.s.l.) [36°35'01.54" N, 30°34'02.38" E] / H. Peşmen-A. Güner (HP 4747) / 27.02.1980 / ANK, HUB, ISTE52597

Erica sicula Guss. ssp. *libanotica* (C. & W. Barbey) P.F. Stevens / C3, Antalya, Beldibi, 20-30 m, kalker uçurum kayalıklar (= 20-30 a.s.l., limestone cliffs, rocky place) [added later with a black pen] / 27.viii.1993 / Leg. H. Duman, Z. Aytaç & A. Dönmez, Det. H. Duman 1993 / GAZİ5396

Erica sicula Guss. / C3 Antalya, Çakırlar, Hisarçandır-Karlıktepe arası, *P. brutia-Cedrus libani* ormanı, 800-1300 m (= between Hisarçandır and Karlıktepe, *P. brutia* and *Cedrus libani* forest, alt. 800-1300 m) [36°46'01.25" N, 30°29'12.41" E] / leg H. Peşmen 3834, det. H. Peşmen 1978 / 11.0.1978/ HUB (specimen not digitized)

Erica sicula Guss. / C3, Antalya, Kemer, Faselis koyu ve çevresi, *P. brutia* ormanı, 0-100 m (= Phaselis Bay and its surroundings, *P. brutia* forest, 0-100 a.s.l) [36°31'37.60" N, 30°32'43.84" E] / leg. H. Peşmen 4174 & A.Güner, det. H. Peşmen 1979 / HUB (specimen not digitized)

Erica sicula subsp. *libanotica* (C. & W. Barbey) / C3, Antalya, Antalya-Tekirova arası, Phaselis harabeleri üstleri, anayolun üstündeki tepeler, kireçtaşlı kayalıklar, 70 m (= between Antalya and Tekirova, above Phaselis ruins, hills above the highway, limestone cliffs, 70 a.s.l.) / leg. A.J. Byfield B2093 / 04.10.1995 / det. A.J. Byfield / ISTE69446

Erica sicula subsp. *libanotica* (C. & W. Barbey) / C3, Antalya, Antalya-Kemer arası, Göynük Nehri vadisine giriş, kireçtaşlı tepeler, makilik ve *Pinus brutia* ormanı açıklıkları, 100 m a.s.1 [36°40'55.23" N, 30°31'48.91" E] (= between Antalya and Kemer, entrance to Göynük River valley, limestone hills, maquis and *Pinus brutia* forest clearings) / leg A.J.Byfield B2069a / 04.10.1995 / det. A.J. Byfield / ISTE69421

Erica sicula Guss. / C3, Antalya, Antalya-Kemer arası, kayalık, kuru dere içi, 100 m (Between Antalya and Kemer, rocky place, inside the dry stream, 100 a.s.l) / leg. N. Özhatay, E. Özhatay, H. Duman, Iter Anat. 96/265 / 06.10.1996 / ISTE72359

Erica sicula Guss. subsp. *libanotica* (Barb.-Boiss & Barbey) P.F.Stevens / C3, Antalya, Kemer, Kesmeboğazı, ormanaltı, 150 m (=in the forest undergrowth, 150 a.s.l) / leg. R.S.G. 7562 / 17.iv.2013 / AKDU1603

Erica sicula Guess. subsp *libanotica* (Barb.-Boiss. & Barbey) P.F. Stevens / C2, Antalya, Kaş, Kıbrıs Çayı Yaban Hayatı Geliştirme Sahası, Akçay-Kemerköy yolu, Kemerköy Mevkii, yol kenarı, kireç taşlı yamaçlar, 800-1000 m (= Kıbrıs River Wildlife Development Area, Akçay-Kemerköy road, the location of Kemerköy, roadside, limestone slopes, alt. 800-1000 m) / leg. Düriye Gülkokan (1015), C. Aykurt, Mustafa Fener, 5.iv.2015, det. Düriye Gülkokan, Candan Aykurt / AKDU3940 (in Fener 2018; Fener & Aykurt, 2019 [Turkish vernacular name: Yılgun Çalısı])

[*Erica sicula* Guss.] / Antalya / vertical crevices of N-facing, calcareous cliff / N.J. Turland / 11.05.1992 / BM000098081

[*Erica sicula* Guss.] / Antalya / R.S. Göktürk & G. Kendir / 10.05.2003 / AEF23009 (Güvenç & Kendir 2012, specimen not seen)

Erica sicula subsp. *sicula* (specimens from Libya)

Erica sicula subsp. *cyrenaica* / sopra (= above) Apollonia / 13.V.1974 / Brullo & Furnari /CAT (holotype, specimen not digitized)

Pentapera sicula / Marsa Susa (= Apollonia, authors' note) / Vaccari VI.1913 / RO-generale

Erica sicula subsp. cyrenaica / Cyrenaica: Jbel Akhdar: Shahhat [Cyrene] - Apollonia road, on plateau overlooking Wadi Hulah / 32°52'21.00" N 21°54'54.00" E, alt 285 m / Plateau; limestone (karst) with terra rossa soils / Juniperus macchie scrub. Woody based herb to 30 cm; flowers pink / E00839997 Essokne. J. Firebrace Hall MH 3111 24.4.2009 R. & M. / (https://data.rbge.org.uk/herb/E00839997)

[*Erica sicula*] / Derna / Haimann / s.d. / 3 duplicates, RO-generale (specimen not digitized)

Erica sicula / Deep wadi east of Susa, Gebel Akhdar / L. Boulos 2165 o 2167 / 11.03.1968 / ULT (fide Siddiqi, 1978)

Pentapera sicula Klotzsch? / Wadi el-Teir, Gebel Akhdar, c. 24 km W Derna, along the coastal road to Susa / Loufty Boulos, 1173 / 19.01.1967 / LD1577157 and ULT fide Siddiqi (1978)

Erica sicula / Wadi al-Agar, about 14 km from Susa on the way to Derna / Shamin Al-Faruqi, 1388g / 24.5.1977 / ULT fide Siddiqi (1978)

Erica sicula / Wadi Qala'a above Ra's al Hilāl, 500 m, limestone rocks flat & sloping / erect 1-2 ft. shrub, flowers pale pink / P.H. Davis 50104 / 27.03.1970 / ULT fide Siddiqi (1978)

Erica sicula / 15-20 km after Susa along the coastal road to Baida (= today's Bayda, author's note), an undershrub in rocks / M. A. Siddiqi & E.B. Rateeb 22 / 17.10.1977 / ULT fide Siddiqi (1978)

Erica sicula / Wadi Mahbool, coastal road from Baida to Derna, shrubby & woody, pink flowers / S.I. AIi 1130. 1158 / 01.03.1973 / ULT fide Siddiqi (1978)

Erica sicula / halfway between Cyrene (Shahat) and Apollonia (Marsa Susa), in Wadi Roseyt, 350 m a.s.l., rocky limestone gorge, in macchia on rocks flowers pale pink, shrub / P. H. Davis 50130 / 20.3.1970 / ULT fide Siddiqi (1978)

Erica sicula Guss. / Apollonia [= Susa] Libya / N.Y. Sandwith & N.D. Simpson / 04.04.1939 / BM000915302

Erica sicula Guss. / Ra's al Helal (= al Hilāl), Darnah (= Derna), Libya / Miss Olive Brittan / 1952-1956 / BM000915301

Erica sicula Guss. / Ra's al Helal (= al Hilāl), Darnah (= Derna), Libya / Mr. Kenneth MacKinnon Guichard / 14.04.1954 / BM000915300

Erica sicula Guss. / Apollonia [= Susa], Libya / Mr. Kenneth MacKinnon Guichard / 01.08.1957 / BM000915299

Pentapera sicula Klotzsch / 'Argub el-Abiad, Gebel Akhdar, near Susa to the south, along the road to Shahhat (the ancient Cyrene, authors' note) / Loufty Boulos, 1237 / 19.01.1967 / LD1577337

Pentapera sicula K1. / P. Taubert, Iter cyrenaicum 1887 auspice W. Barbey 525 / Derna / 03.05.1887 / MNHN-P-P004932650

Pentapera sicula (Guss.) Kl. / P. Taubert, Iter cyrenaicum 1887 auspice W. Barbey 415 / Derna / 18.04.1887 / two duplicates: MNHN-P-P004932651 and P004932652

Pentapera sicula (Guss.) Klotzsch / D. R. Maire et M. Weiller - Iter Libycum 1938 / in rupibus calcareis supra Apollonia, 300 m / N° 1008 / 22.04.1938 / MNHN-P-P004932653

Pentapera sicula (Guss.) Klotzsch / D. R. Maire et M. Weiller - Iter Libycum 1938 - Herbier de l'Afrique du Nord / Cyrenaica in rupibus calcareis supra Apollonia, 300 m / N° 1008 / Calyx et corolla pallide rosei / 22.04.1938 / MNHN-P-P04506821

Pentapera sicula (Guss.) Klotzsch / D.R. Maire et M. Weiller - Iter Libycum 1938 - Herbier de l'Afrique du Nord / Cyrenaica in rupibus calcareis faucium amnis Derna (= limestone cliffs at the mouth of river Derna), 300 m / N° 1009 / Calyx et corolla pallide rosei / 25.04.1938 / MNHN-P-P04506822

Erica sicula Guss. / P. Taubert / Iter cyrenaicum 1887 / N° 525 – III. 969 / Derna / 03.05.1887 / MNHN-P-P04557597

Erica sicula Guss. / P. Taubert / Iter cyrenaicum 1887 / N° 525 – III. 969 – Derna / 18.04 and 14.05.1887 / MNHN-P-P04557598

Erica sicula subsp. *cyrenaica* / Sousse, maki (= maquis), alt. 180-195 m 32°53'7.20" N, 21°55'14.16" E [32 53 12K-21 55 236D in the label] / 09.08.2016 / Leg.: H.Y. Omar 1040 and 1046 (not seen), Det.: H.Y. Omar; 2019 / GAZI42203 (Omar, 2019a-b)

Erica sicula subsp. *cyrenaica* / Shehata, 500-550 m, iğne yapraklı orman (= coniferous forest) / 05.08.2017/ leg. H.Y. Omar 1096 (Omar, 2019a) / GAZI (not seen)

Erica sicula subsp. *cyrenaica* / Wardamah, iğne yapraklı orman (= coniferous forest), alt. 500-550 m, 32°48'32.58" N, 21°47'21.90" E [32 48 543 K-21 47 356 D in the the label] / Leg.: H.Y. Omar 1064, Det. H.Y. Omar; 2019 / GAZI40204 (Omar, 2019a)

Pentapera sicula Klotzsch / Wadi Qal'aa, above El-Hilal, Gebel Akhdar, 350-550 m a.s.l. /27.03.1970/L.Boulos/L2594951(https://bioportal.naturalis.nl/en/multimedia/L.2594951387047766)

Erica sicula subsp. *bocquetii* (Anatolia)

Pentapera sicula / Herbar J. Bornmuller 1888 / leg. Stöger / coll. Prof. [Buxbaum? Austriaco?] / inter Antalya and Elmali / vorzüglich auf Kalfelsen, polsterbildend (= mostly on calcareous rocks, cushionforming) / Çiğlikara kasa Kaş / zwischen 1800-2000 m seehöhe (= between 1800 and 2000 m a.s.l.) / B100253809

https://iiif.jacq.org/b/?manifest=https://herbarium.bgbm.org/object/B100253809/manifest.json *Pentapera bocquetii* Peşmen / S. Parlakdağ in H. Peşmen / Antalya, Elmalı, Taurus occidental Çığlıkara-Dokuzgöl, 1750 m / 15.07.1968 / Peşmen 2158 EGE5717 (holotype) / E00346448 (fragm.) (https://data.rbge.org.uk/herb/E00346448) / 28.04.1968 / Peşmen2157, Meyer & Oflas / EGE4507, G00105628 (https://www.ville-ge.ch/musinfo/bd/cjb/chg/adetail.php?id=130444&lang=en) (paratype) F. Mutlu in H. Peşmen / 03.09.1968 / Peşmen 2159 / EGE4570, G00105629 (https://www.ville-ge.ch/musinfo/bd/cjb/chg/adetail.php?id=130445&lang=en), HUB (paratype)

Erica bocquetii (Peşmen) P.F Stevens / Antalya, Elmalı, Çığlıkara, Dokuzgöl Mevkii / 20.06.1969 / leg. K. Fitz & F. Spitzenberger / det. Y. Gemici / EGE6176

Erica bocquetii (Peşmen) P.F Stevens / Antalya, Elmalı, Çığlıkara and Kuğudağı, *Cedrus* forest, alt 1400-1800 m / 12.06.1969 / leg. K. Fitz / det. Y. Gemici / EGE2887

Pentapera bocquetii Peşmen / Antalya, Elmalı, Çığlıkara, sedir ormanı, misafirhane civarı (= cedar forest, around the guesthouse) / 29.06.1974 / leg R. Çetik / ANK1948

Pentapera bocquetii Peşmen / Antalya, Elmalı, Çığlıkara sedir ormanı, misafirhane önündeki Don Çukuru civarındaki zemine yakın taşlı sırtlar, ca.1750 m (= Çığlıkara cedar forest, stony ridges close to the ground around the Don Çukuru in front of the guest house) / 01.07.1974 / leg. R. Çetik / ANK1949

Pentapera bocquetii Peşmen [Syn: *Erica bocquetii* (Peşmen) P.F. Stevens] / Antalya, Elmalı, Çığlıkara, sedir ormanı (=cedar forest) / 06.06.1976 / det. Y. Akman, P. Quezel / ANK6046

Erica bocquetii (Peşmen) P.F. Stevens / C2, Antalya, Elmalı, Çığlıkara, Tekkeyiğidi-Dokuzgöl arası, katran ormanı, kalkerli arazi (=between Tekkeyidiği and Dokuzgöl, cedar forest, calcareous terrain) / leg. A. Güner 11027-A, A. Dönmez, H. Şağban, 11.09.1992 / det. H. Şağban, 14.10.1992 / HUB

Erica bocquetii (Peşmen) P.F. Stevens / Antalya, Elmalı, Çığlıkara, Don Çukuru, 1650 m / 25.06.1985 / leg. B. Şarer, det. M. Vural 1988 / GAZİ V3398

Erica bocquetii / Flora of Turkey (Davis et al. 1965) / Çiğlikara, Dokuzgöl Mevkii / vertical ± shaded calcareous rocks 1750 m / 27.09.1989 / leg. [...] G.L. Osti, [...], D. McClintock [...] / Peşmen 2157

[*Erica bocquetii*] / Elmalı / McClintock et al. / 1989 / BM916288 [a not yet digitized duplicate may be stored in and K]

[*Erica bocquetii*] / Elmalı / A. and U. Güvenç and R.S. Göktürk / 19.07.2003 / AEF23016 (Güvenç and Kendir, 2012)

Erica bocquetii / C2, Antalya, Elmalı, Çığlıkara bekçi kulübesi – Dokuzgöl arası, kaya üzeri, 1780 m (= between Çığlıkara watch(guard) house and Dokuzgöl, on the rock) [36°31'42.96" N 29°49'00.77" E] / 17.06.2015 / Col: R. Göktürk (7857), H. Sümbül, M. Aydınkal, F. Gülenç, Ö. Demir, Det. R. Göktürk / NGBB004422

Erica bocquetii (Peşmen) P.F. Stevens / C2, Antalya, Elmalı, Çığlıkara, Dokuzgöl, Tekke'den çıkış, Dokuzgöle 1 km kala, kaya üzeri, 1700 m a.s.l. (= just out of the Tekke, 1 km before Dokuzgöl, on the rock) [36°31'44.09" N, 29°48'43.92" E] / 25.10.2014 / leg R.S. Göktürk (7722), det. R.S. Göktürk / AKDU3091

Erica bocquetii / Antalya, Kaş, Bayındır köyü, Kalker kayalıklar (= Bayındır village, limestone cliffs) / 19.03.2009 / Z. Aytaç 9339 (250 m a.s.l., Z. Aytaç, pers. comm.) / GAZI (specimen not digitized)