

Threatened or poorly known? The case of the Mediterranean narrow endemic *Valeriana amazonum* in Sardinia

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Abstract The Mediterranean flora is characterized by a high number of narrow endemic plant species that are often restricted to a few small populations. One of these species, *Valeriana amazonum*, a perennial plant occurring only in the Supramontes region of central eastern Sardinia, is categorized as Critically Endangered on the IUCN Red List because of its restricted range, small population size and an inferred decline caused by several threats. During 2007–2022, we monitored all mature individuals of this plant annually and surveyed ecologically suitable sites for the species. We identified two previously unknown populations and also learnt of two successful translocations carried out independently by an unknown local citizen. As our monitoring data indicate there has been no decline in the number of mature individuals over the period of monitoring, the species' conservation status requires reassessment. We recommend that *V. amazonum* should be recategorized as Near Threatened as it seems to be poorly known rather than highly threatened. This could also be the case with other narrow Mediterranean endemics, especially those that grow in inaccessible habitats for which long-term studies are needed to assess conservation status.

Keywords Endemic, Habitat Directive, IUCN Red List, plant conservation, plant translocation, population monitoring, Sardinia, *Valeriana amazonum*

The Mediterranean Biogeographic Region, one of the 36 global biodiversity hotspots (Médail & Myers, 2004), is characterized by high plant diversity that is mainly concentrated in restricted areas such as islands and micro-island systems (Cañadas et al., 2014; Fenu et al., 2020). These areas are characterized by a concentration of endemic species, notably range-restricted taxa that are of conservation importance because of their often reduced, isolated and threatened populations (Orsenigo et al., 2018; Fenu et al., 2020). Narrow endemism is the cornerstone of Mediterranean plant diversity, with c. 60% of all native taxa occurring only in this region and c. 37% being narrow

endemic species (Thompson, 2020), with the latter comprising c. 11,000 taxa (Médail & Baumel, 2018). However, the Mediterranean region faces severe threats from both natural and anthropogenic factors. These have led to a high degree of habitat fragmentation as a result of soil overexploitation, the conversion of much of the pristine vegetation into agricultural landscapes, and climate change (Fenu et al., 2020, 2023).

The narrow endemic plant *Valeriana amazonum* (Fridl. & A. Raynal) Christenh. & Byng (basynonym: *Centranthus amazonum* Fridl. & A. Raynal; Fridlender & Raynal-Roques, 1998), of Sardinia, was included in Annex II of the EU Habitats Directive 92/43/EEC as a species of conservation value for which monitoring and in situ conservation are required (Fenu et al., 2021). *Valeriana amazonum* (Plate 1) is perennial, with glaucous stems and leaves. The lower leaves are smallest, and the intermediate and upper leaves are petiolate. The inflorescence has bi-trichotomic corymbs with white-pink flowers, and the elongated achene has a flattened face with longitudinal veins and a convex face with single veins (Fridlender & Raynal-Roques, 1998; Bacchetta et al., 2008). Flowering is during May–July and fruiting is in July.

Valeriana amazonum grows in limestone karst areas (Plate 1a) with other Sardinian endemic plant species such as *Cephalaria squamiflora* (Sieber) Greuter subsp. *mediterranea* (Viv.) Pignatti, *Ptychotis sardoa* Pignatti et Metlesics, *Campanula forsythii* (Arcang.) Bég., *Armeria morisii* Boiss., *Arenaria bertolonii* Fiori, *Cerastium supramontanum* Arrigoni, *Seseli praecox* (Gamisans) Gamisans, and *Sesleria insularis* Sommier subsp. *barbaricina* Arrigoni. This plant community falls into the habitat type Calcareous rocky slopes with chasmophytic vegetation (code 8210) of the EU Habitats Directive.

Valeriana amazonum is endemic to the Supramontes region, a 450 km² limestone karstic area in central–eastern Sardinia that is rich in endemic and narrow endemic plant species (Fenu et al., 2010). Only two populations of this species were previously known: a population of < 100 individuals in Mount Corraisi (Oliena) at 1,300 m altitude, and two individuals in the gorge of Codula di Luna (Urzulei) at 140 m altitude (Fig. 1) (Fridlender & Raynal-Roques, 1998; Bacchetta et al., 2008).

Although this species primarily grows on inaccessible rocky cliffs, it is threatened because of its small population size and the potential negative effects of touristic activities,

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PLATE 1 (a) Characteristic habitat of *Valeriana amazonum*, (b) the species in its habitat, and (c) detail of inflorescence. Photos: (a) & (b): Giuseppe Fenu; (c): Ninni Marras.

the grazing of wild ungulates (the mouflon *Ovis aries musimon*), and the natural collapse of limestone cliffs, which could cause a reduction in the population size (Bacchetta et al., 2008). Currently, this species is categorized as Critically Endangered because of its limited range, small population size and an inferred continuous decline, but this assessment needs updating (Fridlender, 2006).

As part of the monitoring of the threatened flora of Sardinia, we have regularly monitored the populations of *V. amazonum* at Mount Corrasi and Codula di Luna since 2007. In addition, we have surveyed the Supramontes region at sites that appear ecologically suitable for this species. We

assigned a unique code to each individual plant known or newly discovered, to facilitate monitoring. As this rupicolous species grows on rocky cliffs, we counted only mature individuals (sensu IUCN) as the species is more easily located when it is flowering. We monitored all mature individuals twice per year during flowering, when individuals are most visible (mid June–early July).

The population on Mount Corrasi has the greatest number of mature individuals, and this has remained relatively stable over time, with small differences between years as a result of some individuals failing to flower or because of grazing (Table 1). There was a reduction in the number of

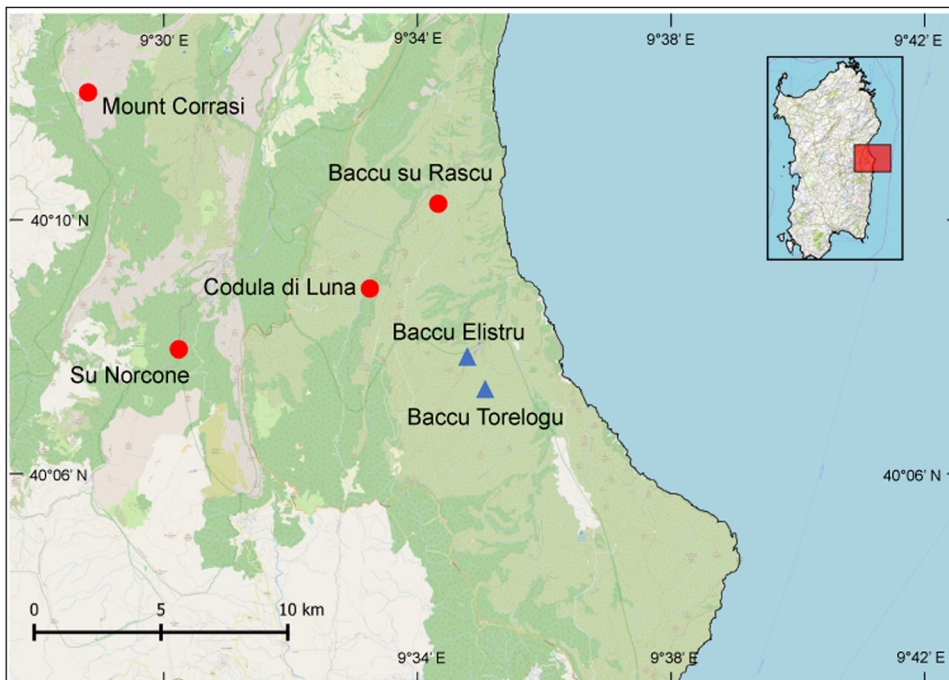


FIG. 1 The six known populations of *Valeriana amazonum* in the Supramontes region of central eastern Sardinia (Table 1). The populations at Mount Corrasi and Codula di Luna were previously known, those at Su Norcone and Baccu su Rascu were discovered during this study, and those at Baccu Elistru and Baccu Torelogu were translocated by a local citizen.

TABLE 1 Number of mature plants recorded in each population during 2007–2022 (data for 2020 are absent as we were unable to survey because of the Covid-19 pandemic).

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2021	2022
Natural populations															
Mount Corراس	39	40	40	41	40	40	33	34	34	34	34	34	34	33	34
Codula di Luna	1	1	1	1	1	1	1	1	1	1	14	14	15	15	15
Su Norcone									2	22	24	24	24	24	24
Baccu su Rascu															2
Translocated populations															
Baccu Elistru								9	15	15	15	15	16	16	16
Baccu Torelogu									11	10	11	10	10	11	11
<i>Total</i>	40	41	41	42	41	41	34	44	63	82	98	97	99	99	102

mature plants in 2013 when part of a rocky cliff collapsed, but overall there has been no obvious continuous decline. This suggests this species has the traits of a long-lived plant, as do many other rupicolous species. The Codula di Luna population comprised only a small number of individuals (Bacchetta et al., 2008), but additional mature individuals were found on a nearby rocky cliff in 2017 (Table 1).

In 2015, we found *V. amazonum* in a small gorge at Su Norcone that has similar ecological conditions to Codula di Luna, at 1,035 m altitude (Fig. 1, Table 1). In 2022, this population comprised 24 mature plants (Table 1). In June 2022, we found two mature individuals in a gorge at Baccu su Rascu, at 165 m altitude (Fig. 1, Table 1). These discoveries and the abundance of suitable habitat for this species in the region suggest that other populations of *V. amazonum* could be present in this area.

The mean Euclidean distance between the four known natural populations of *V. amazonum* is c. 11.4 km. The characteristics of the four locations are similar: limestone cliffs or ravines, with a northern or north-eastern exposure, in plant communities rich in endemic plant species that are referred to as the endemic alliance of *Centaureo filiformis*–*Micromerion cordatae* (Arrigoni & Di Tommaso, 1991).

During our field trips, we spoke about the species with local inhabitants (mainly farmers and forestry workers). In one of these conversations we learnt of successful translocations carried out by a local enthusiast at two sites where this species was not previously present (Table 1). We believe the first translocation was in 2010 and the second in 2012, using seeds collected from the Mount Corراس and Codula di Luna populations, respectively. Data on these translocations indicate that mature plants were already present in 2014 and 2015 in Baccu Elistru and Baccu Torelogu, respectively. These translocations were carried out without scientific support and outside any legislative framework, a phenomenon already documented in the Mediterranean area (Fenu et al., 2023).

There are now sufficient data available for a re-evaluation of the conservation status of *V. amazonum*. Despite potential

threats, there has been no continuous decline in the population size over the years monitored and, in addition, the two newly discovered populations and the two translocated populations should be considered in a revised assessment (IUCN, 2022). We recommend that *V. amazonum* should be categorized as Near Threatened because, despite its small population size, it does not currently qualify for one of the threatened categories.

Our discovery of two previously unknown populations of *V. amazonum*, and the two translocations, suggests this species is more common than previously believed. However, the extensive area of the Supramontes territory, rich in ravines and inaccessible areas, together with the inconspicuousness of *V. amazonum*, may have resulted in underestimation of the range of this species. The current categorization of *V. amazonum* as Critically Endangered appears to reflect a lack of knowledge rather than the species' actual conservation status. This could also be the case for other narrow Mediterranean endemics, especially those that grow in mountainous, rocky or inaccessible habitats for which long-term studies are needed to assess their conservation status.

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Conflicts of interest None.

Ethical standards This research abided by the *Oryx* guidelines on ethical standards.

Data availability The data are available from the corresponding author upon reasonable request.

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