Conservation status of *Vicia cusnae* Foggi et Riccieri

MATTEO ANNESSI, FEDERICA CAPITANI, MADELEINE DONTSCHEV, ELENA ERBANI, VIOLA FILIPPINI, FABIO GARZUGLIA, DIANA LUCENTE, EMANUELE MANGANELLO, ALESSIA MIRCOLI, ANDREA PANSARDI, DOMIZIANO PISCOLLA, LEONARDO ROMANELLI, MONICA CAROSI, THOMAS ABELI
Course of Conservation Biology, Master in Biodiversity and Ecosystem Management (2021/2022) at Department of Science, Roma Tre University, Viale Guglielmo Marconi 446, 00146, Roma, Italy

NOÉMIE FORT
Conservatoire Botanique National Alpin, France

Abstract

This paper assesses the conservation status of *Vicia cusnae* Foggi et Riccieri, on a regional and a global level using the IUCN Red List Categories and Criteria. The assessment takes into consideration the population of Monte Cusna, in the Tuscan-Emilian Apennines National Park, which is the only known population in Italy, as well as the only two French populations of the species. The objective of this assessment was to address conservation strategies for the species. For this assessment the spatial data were calculated with the Qgis 3.16.6 software, using the minimum convex polygon method to obtain the species extent of occurrence (EOO). Furthermore, for the Italian population the area of occupancy (AOO) was calculated, using a grid system, and with field surveys the estimated number of mature individuals was estimated. Suitable IUCN red listing assessment criteria were applied to the obtained data assessing the status of *V. cusnae*. *Vicia cusnae* was assessed as Near Threatened (NT) for both sub-criteria B1 and B2. Other sub-criteria were also taken into consideration. The decline of the species was not quantifiable, possible threats were ultimately considered to be irrelevant in the current situation. Therefore, *Vicia cusnae* is not currently threatened. However, future threats may lead to a possible decline of the *V. cusnae,* and put the species in a delicate position, considering the limited distribution range.

Keywords: conservation, *Vicia cusnae*, International Union for Conservation of Nature (IUCN), Red List, regional assessment, extent of occurrence (EOO), area of occupancy (AOO), threatened category, Red List criteria, near threatened

Riassunto

Stato di conservazione di Vicia cusnae Foggi et Riccieri
Questo lavoro valuta lo stato di conservazione di *Vicia cusnae* Foggi et Riccieri, a livello regionale e globale, utilizzando le Categorie e i Criteri della Lista Rossa IUCN. La valutazione prende in considerazione la popolazione del Monte Cusna, nel Parco Nazionale dell'Appennino Tosco-Emiliano, unica popolazione conosciuta in Italia, nonché le uniche due popolazioni francesi della specie. L'obiettivo di questa valutazione era di affrontare le strategie di conservazione della specie. Per questa valutazione i dati spaziali sono stati calcolati con il software Qgis 3.16.6, utilizzando il metodo del poligono convesso minimo per ottenere l'estensione della specie (EOO). Inoltre, per la popolazione italiana, è stata calcolata l'area di occupazione (AOO) utilizzando un sistema a griglia. Con indagini sul campo è stato stimato il numero di individui maturi. Ai dati ottenuti per valutare lo stato di *V. cusnae* sono stati applicati criteri di valutazione della lista rossa IUCN adeguati. *Vicia cusnae* è stata valutata come Near Threatened (NT) per entrambi i sottocriteri B1 e B2. Sono stati presi in considerazione anche altri sottocriteri. Il declino della specie non era quantificabile, le possibili minacce sono state in definitiva ritenute irrilevanti nella situazione attuale, pertanto *Vicia cusnae* non è attualmente minacciata. Tuttavia, future minacce possono portare ad un possibile declino del *V. cusnae*, e mettere la specie in una posizione delicata, considerato il limitato areale.

Parole chiave: Conservazione, *Vicia cusnae*, Unione Internazionale per la Conservazione della Natura (IUCN), Lista Rossa, valutazione regionale, estensione dell'occorrenza (EOO), area di occupazione (AOO), categoria minacciata, criteri della Lista Rossa, quasi minacciata

Introduction

Italy is the country with the highest number of plant species in Europe. This high diversity, which includes nearly 13,000 and 2,500 endemic animal and plant species, respectively comes from the position of the country in the middle of the Mediterranean basin, which is one of the most important global "biodiversity hotspots" (Myers *et al.*, 2000). It is of key importance to know the conservation status of these endemic species in order to prevent their extinction. To do so, the IUCN (International Union for Conservation of Nature) created a system of Categories and Criteria used to assess the conservation status of species taking into consideration a several variables (IUCN, 2012a; IUCN, 2022). Red Lists are used to measure the distance of a species from the extinction and are important tools for prioritizing conservation activities (Fenu

et al., 2017), and to provide information about the state of biodiversity (VIÈ *et al.*, 2008). To evaluate the conservation status of a species, experts have to analyse characteristics such as the number of mature individuals, the species' distribution (in terms of AOO - Area of Occupancy, and EOO - Extent of Occurrence), the population decline. All these factors are compared with standard thresholds that allow the assignment of a species to a given threat category. This process can be made only after analysing the threats affecting a species. Threat categories ordered by an increasing degree of threat are as follow: Not Evaluated, Data Deficient (DD-reserved to species with missing information), Least Concern (LC), Near Threatened (NT), Vulnerable (VU), Endangered (EN), Critically Endangered (CR), Extinct in the Wild (EW) and Extinct (EX).

In recent years a group of botanists coordinated by the Italian Botanical Society assessed 2430 taxa of native Italian vascular plants, about 30% of the total vascular flora found in Italy (ORSENIGO *et al.*, 2020), including all Italian endemic plants (about 1340 species and subspecies; ORSENIGO *et al.*, 2018). Of the latter, about 300 (22.4%) were assigned to a risk category. These studies revealed several threats for the Italian endemic species, mostly related to agriculture and natural system modifications (ORSENIGO *et al.*, 2018; ORSENIGO *et al.*, 2020).

Vicia cusnae Foggi et Ricceri has not been assessed in the abovementioned red lists as this species is not an endemic plant, but has a subendemic distribution, being present in Italy and France. However, a regional assessment (Italy) of *V. cusnae* performed in 2008 (FOGGI *et al.*, 2008), assigned the species to the VU category. Indeed, a global assessment for this species has never been done.

Therefore, our aim is to assess the conservation status of *V. cusnae* at the global level and to update the regional (Italian) assessment of this species, after more than 10 years from the first assessment by FOGGI *et al.* (2008).

MATERIAL AND METHODS

Description of the species

Vicia cusnae Foggi et Ricceri (Figure 1) is a vascular plant belonging to the Fabaceae family, present globally in 3 geographically isolated mountain stations: two in France, on Mount Coyer and in the Montagne d'Aurouze, Devoluy area (Western Alps) and one in the Tuscan-Emilian Apennines, at Mount Cusna (FOGGI & RICCIERI, 1989). The species is typical of xeric subalpine habitats at altitudes between 1800 and 2100 m a.s.l., on slopes with southern exposure, on predominantly detrital soils consisting of sedimentary rocks (sandstones), near which, thanks to the ramified taproot-creeping root, it supplies contribution to

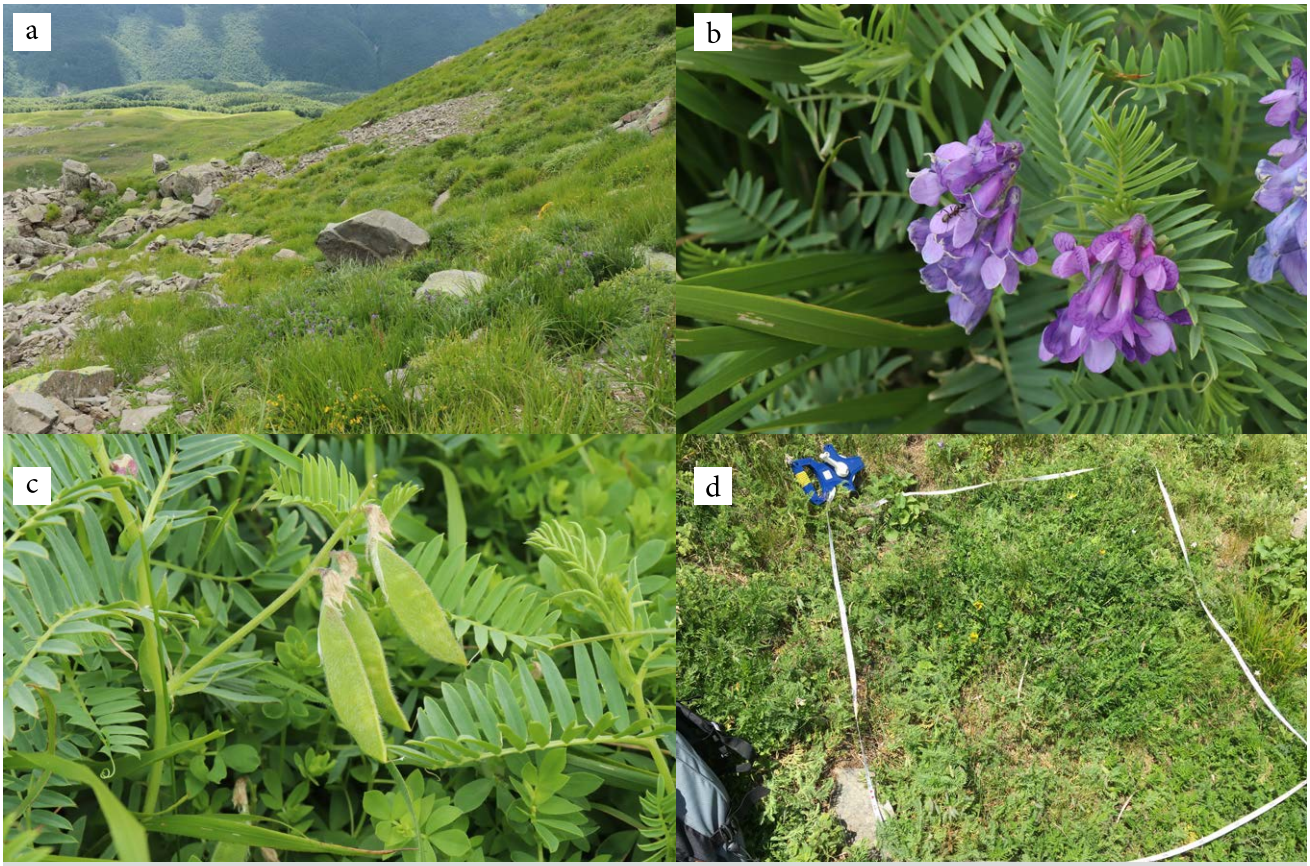

Fig. 1. *Vicia cusnae* Foggi et Ricceri. A) Habitat of *V. cusnae* at Mt. Cusna, Northern Italy; B) *Vicia cusnae* inflorescence; C) *V. cusnae* legumes; D) Plot used to estimate the population size of *V. cusnae* at Mt. Cusna.

soil stabilization. It looks like a perennial grass, with a maximum height of around 50 cm. The leaves are composed, with 8-14 linear-lanceolate segments, 13-18mm long and 2.5-3mm wide, presenting an undivided apical cirrus of 10-20mm. The stem is tetragonal, bialate (by extension of the petiole of the leaves). The inflorescence is of the unilateral racemic type, on a 9-11mm calyx, with a rosy-violet corolla 25-30 mm long, containing stamens with 1 mm anthers, ovary with a 4 mm style and bearded stigma, with entomophilic pollination (Foggi & Riccieri, 1989). The fruit (legume) is also covered with sparse hair, 25-30mm long, containing 2-3 globose-compressed seeds, 4-5mm diameter, marbled brown colour, with autocoral dispersion, with an explosion of the pod and consequent launch of seeds, or seeds produced underground (Van Rheede *et al.*, 1999; Flynn *et al.*, 2006). However, the preferential reproduction observed in nature is of the vegetative type, through underground stolons, with the emission of new jets close together, called ramets. It is also possible to obtain 80% of the successful germination from seeds, after scarification, at a temperature of 21°C (Flynn *et al.*, 2006). The number of chromosomes described is 2n = 10.

Red list assessment

The red list assessment was performed according to the IUCN red list categories and criteria (IUCN, 2022) and the guidelines for the application of the protocol at the regional level (IUCN, 2012a).

To perform the red list assessment of *Vicia cusnae* at the global and regional (Italy) level, we obtained spatial data, data on the number of individuals and trends for the global and regional populations of the species (Figure 2). We have also identified potential threats for the species.

Spatial data. From the coordinates of the existing populations, we computed the Extent of Occurrence (EOO), using the minimum convex polygon. This work has been carried out twice, once to determine the global EOO for the species, and once for the regional (Italian) EOO. To calculate the regional EOO, the outermost plants of the populations at mount Cusna were first geolocated with a GPS. Subsequently, the collected points were linked to form the margin of the minimum convex polygon (Figure 2).

Then we computed the Area of Occupancy (AOO), by using a 2 x 2 km grid overlapping the populations. The cells where the species was present were counted. Also in this case, AOO was computed twice, at the global and at the regional (Italian) level. We also determined the distance in a straight line between the Italian population and the nearest French population, which is 360 km. For calculating the spatial data, the Geographic Information System (GIS) Qgis 3.16.6 software was used.

Mature Individuals. The number of mature individuals was estimated only for the Italian population. Eight 1 x 1 m non-permanent plots were randomly placed, along the southern slope of Mt. Cusna. Within each plot all the flowering ramets were counted. Subsequently, the average number of flowering ramets per square meters was calculated and multiplied by the regional EOO, which also corresponds to the area of the population. There is no data for the global or regional population trends. However, according to past surveys at Mt. Cusna, it seems that the Italian population is stable (personal observation T.A.).

Threats. Threats for *V. cusnae* at the global level were identified based to the codification provided by the IUCN Threat Classification Scheme, version 3.2; IUCN, 2012b). A few threats were considered as potential threats for *V. cusnae* but were eventually considered not relevant for the reasons explained below.

- 2.3.1 Nomadic grazing. While the area is grazed in summer by sheep, the steep rocky slope where *V. cusnae* grows and a partial toxicity for livestock discourages direct grazing on the species (Alessandrini *et al.*, 2003).
- 5.2 Gathering of terrestrial plants. The steep slope where *V. cusnae* grows protects the plants from intentional and unintentional gathering.
- 11 Climate change and alterations. *V. cusnae* is only found in mountain environments; given that it is an heliophilous and xerophilous plant is unlikely to be negatively impacted by global warming. However, a reduction of flowering and fruiting ramets has been observed during exceptional heatwaves (Abeli *et al.*, 2012).

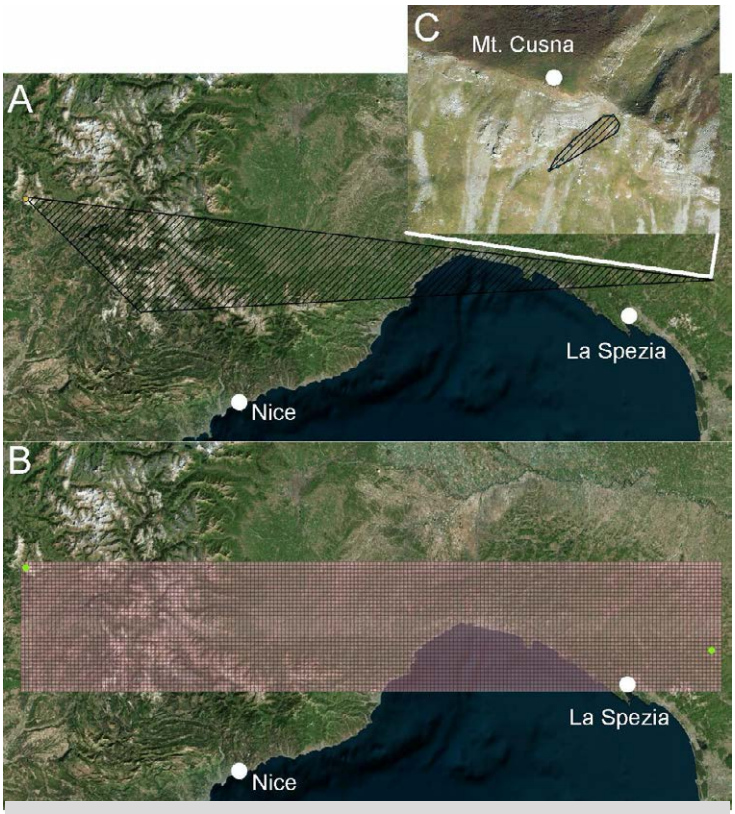

Fig. 2. Calculation of Extent of Occurrence (EOO; panel A) and Area of Occurrence (AOO; panel B) of *Vicia cusnae* at the global level. Panel C represents the EOO of *Vicia cusnae* at Mount Cusna, Italy.

RESULTS

The global Extent of Occurence (EOO) is 9.282 km^2 and the global Area of Occupancy (AOO) is 16 km^2. The total number of mature individuals is unknown, and the Italian population is 360 km away from the nearest French population in a straight line. We identified three locations, the decline is not quantifiable, and no threats are known to currently impacts the populations. It was possible to evaluate *Vicia cusnae* using criteria B and D. Considering the Extent of Occurrence (sub-criterion B1) the species would qualify as Vulnerable, whilst considering the Area of Occupancy (sub-criterion B2), the species would qualify as Endangered. However, the presence of at least two conditions among fragmentation or locations, continuing decline, and extreme fluctuations is not met. In fact, the condition "b" cannot be applied because there are no data about the decline, while condition "c" is not applicable since data on extreme fluctuations are not available. Therefore, we evaluate *Vicia cusnae* as Near Threatened (NT) for both sub-criteria B1 and B2. Since this species has "very small or restricted population", it is possible to use criterion D as well. Based on the AOO < 20 km^2 and the number of locations ≤ 5, we could classify the species in the "Vulnerable" category (D2), but since plausible future threats are not known, we evaluate the species as Near Threatened (NT). Therefore, we conclude that the final global assessment of *Vicia cusnae* is NEAR THREATENED (NT).

It was also possible to make the regional assessment of *Vicia cusnae* (Italy). The number of mature individuals is 64.600 with a single location. The Extent of Occurrence (EOO) is 1.700 km^2 while the Area of Occupancy (AOO) is 4 km^2. *Vicia cusnae* was assessed using criteria B, C and D. Considering the Extent of Occurrence the species would qualify as Endangered, whilst considering the Area of Occupancy, the species would qualify as Critically Endangered. However, the presence of at least two conditions among fragmentation or locations, continuing decline, and extreme fluctuations is not met. Therefore, we evaluate *Vicia cusnae* as Near Threatened (NT) for both sub-criteria B1 and B2. Considering criterion C, it is not possible to include this plant in any threat category, because the number of mature individuals (64.600) exceeds the minimum threshold for the VU category (i.e., 10.000). In addition, *V. cusnae* does not satisfy either sub-criterion C1 or C2, because there are no data about a possible decline of this population, so we classify this species as Least Concern (LC). Since this species is "very small or restricted population", it was possible to use criterion D as well. Since the number of mature individuals (64.600) largely exceeds the minimum threshold for Vulnerable category (VU) it is possible to assess (regionally) *Vicia cusnae* as Least Concern (LC) through sub-criterion D1. Based on the AOO < 20 km^2 and the number of locations ≤ 5, we could classify the species in the "Vulnerable" category (D2), but since plausible future threats are not known we assess the species as Near Threatened (NT). In conclusion, the final national assessment of *Vicia cusnae* classified the species as NEAR THREATENED (NT).

DISCUSSION AND CONCLUSION

The conservation status of *Vicia cusnae* has been assessed at the global and regional levels using the IUCN Red List Categories and Criteria. The global assessment refers to the entire population currently existing, meanwhile the regional assessment concerns the population located on Monte Cusna (Parco Nazionale dell'Appennino Tosco-Emiliano, Emilia Romagna, N-Italy). Based on both the global and the regional assessments, the specie has been categorized as Near Threatened (NT) for the IUCN criteria states: "*a taxon is Near Threatened (NT) when it has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future*".

This is in contrast with the regional assessment of FOGGI *et al.* (2008), when the species was assessed as Vulnerable (VU), despite the same authors could not identify any plausible threats for the species.

The current assessment confirms that the species is not affected by any threat and that there is no data on a possible decline of the population. On the other hand, the deficiency of data regarding these future threats puts *Vicia cusnae* in a delicate position. In fact, the IUCN criterion D2 itself tells us that "restricted area of occupancy or number of locations with a plausible future threat could drive the taxon to CR or EX in a very short time".

Furthermore, the occurrence of *Vicia cusnae* within a national park in Italy may not be enough to maintain the current status of the taxon. For example, an overexploitation of grasslands at M. Cusna, may become a threat in the future and may limit the expansion of the species. The park where the Italian population is located has created educational programs to improve the public awareness. Nevertheless, it is necessary that action is taken towards both the possible threats listed above and potential new ones, like climate change. The ambition is that the specie continues to be monitored to have enough data to better understand the effects of the latter threat and to improve conservation strategies.

Our research provides information about this species' biology, ecology and conservation status. It might be a first step to define the best conservation strategies in the next future.

BIBLIOGRAFY

ABELI T., ROSSI G., GENTILI R., GANDINI M., MONDONI A., & CRISTOFANELLI P., 2012 – Effect of the extreme summer heat waves on isolated populations of two orophitic plants in the north Apennines (Italy). *Nordic Journal of Botany* 30:109-115.

ALESSANDRINI A., FOGGI B., ROSSI G., & TOMASELLI M., 2003 – *La flora di altitudine dell'Appennino Tosco-Emiliano*. Regione Emilia-Romagna.

FENU G., BACCHETTA G., GIANCANELLI V., GARGANO D., MONTAGNANI C., ORSENIGO S., COGONI D., ROSSI G., CONTI F., SANTANGELO A., PINNA M.S., BARTOLUCCI F., DOMINA

G., Oriolo G., Blasi C., Genovesi P., Abeli T., & Ercole S., 2017 – Conserving plant diversity in Europe: outcomes, criticism and perspectives of the Habitats Directive application in Italy. *Biodiversity Conservation* 26:309-328.

Flynn S., Turner R.M., & Stuppy W.H., 2006 – Seed Information Database (release 7.0, Oct. 2006). http://www.kew.org/data/sid.

Foggi B., & Ricceri C., 1989 – Vicia cusnae Foggi et Ricceri, sp. nov. (Leguminosae) nell'Appennino settentrionale. *Webbia*, 43:25-31.

Foggi B., Rossi G., & Gentili R.F., 2008 – *Vicia cusnae* Foggi et Ricceri. *Informatore Botanico Italiano*, 40(S1): 124-126.

IUCN 2012a – Guidelines for Application of IUCN Red List Criteria at Regional and National Levels: Version 4.0. Gland, Switzerland and Cambridge, UK: IUCN. iii + 41pp.

IUCN 2012b – Unified Classification of Direct Threats: Version 3.2. http://s3.amazonaws.com/iucnredlist-newcms/staging/public/attachments/3127/dec_2012_guidance_threats_classification_scheme.pdf.

IUCN 2022 – Guidelines for Using the IUCN Red List Categories and Criteria. Version 15. Prepared by the Standards and Petitions Committee. Downloadable from https://www.iucnredlist.org/documents/RedListGuidelines.pdf.

Myers N., Mittermeier R.A., Mittermeier C.G., da Fonseca G.A.B. & Kent J., 2000 - Biodiversity hotspots for conservation priorities. *Nature*, 403:853-858.

Orsenigo S., Montagnani C., Fenu G., Gargano D., Peruzzi L., Abeli T., Alessandrini A., Bacchetta G., Bartolucci F., Bovio M., Brullo C., Brullo S., Carta A., Castello M., Cogoni D., Conti F., Domina G., Foggi B., Gennai M., Gigante D., Iberite M., Lasen C., Magrini S., Perrino E. V., Prosser F., Santangelo A., Selvaggi A., Stinca A., Vagge I., M., Wagensommer R. P., Wilhalm T., Tartaglini N., Duprè E., Blasi C., & Rossi G., 2018 – Red Listing plants under full national responsibility: Extinction risk and threats in the vascular flora endemic to Italy. *Biological Conservation* 224:213–222.

Orsenigo S., Fenu G., Gargano D., Montagnani C., Abeli T., Alessandrini A., Bacchetta G., Bartolucci F., Carta A., Castello M., Cogoni D., Conti F., Domina G., Foggi B., Gennai M., Gigante D., Iberite M., Peruzzi L., Pinna M.S., Prosser F., Santangelo A., Selvaggi A., Stinca A., Villani M., Wagensommer R.P., Tartaglini N., Duprè E., Blasi C. & Rossi G., 2020 – Red list of threatened vascular plants in Italy. *Plant Biosystems* 155:310-335.

Van Rheede Van Oudshoorn K., & Van Rooyen M.W., 1999 – Dispersal biology of desert plants. Adaptations of desert organism. Spinger-Verlag, Berlin.

Vié J.C., Taylor C.H., & Stuart S.N., 2008 – Wildlife in a Changing World: an analysis of the 2008 IUCN Red List of Threatened Species. IUCN, Gland, Switzerland.