



First insular population of the critically endangered *Cistus heterophyllus* subsp. *carthaginensis* on Cabrera Archipelago National Park (Balearic Islands, Spain)

Carles Cardona^{1,2} · Miquel Capó^{3,4}

Received: 10 June 2022 / Revised: 18 November 2022 / Accepted: 27 November 2022 /
Published online: 2 December 2022
© The Author(s) 2022

Abstract

Cistus heterophyllus subsp. *carthaginensis* is considered one of the most endangered plants of Spain and has been object to many conservation programs and research projects. Until now, only two small spots were located in Europe: a population of one self-incompatible specimen was found in Valencia and another small population in Cartagena, disturbed by human impact and hybridization with close-relatives. Therefore, the conservation of this taxon has been one of the most defeating issues in the current plant conservation strategies of the Mediterranean workgroups. In this study, we report, describe and cense a new population of this taxon located at the furthest accessible area of the isle of Cabrera Gran in Cabrera Archipelago National Park. The population contains 59 individuals of *C. heterophyllus* subsp. *carthaginensis*, the most abundant known population of this species, with a high representation of young individuals (83%). However, some threats are currently compromising the stability of this population: the presence of *Cistus albidus* in surrounding areas is producing hybrids (*Cistus* × *clausonii*) and the high abundance of rats and rabbits is affecting the population recruitment. For this reason, urgent conservation actions must be designed to protect and enhance this population. Overall, this new finding offers new insights on the distribution and conservation strategies of this species.

Keywords Cistaceae · Insularity · Mediterranean ecosystems · Threatened flora · National Park

Communicated by Daniel Sanchez Mata.

✉ Miquel Capó
miquel.capo@uib.es

¹ Centre Forestal de les Illes Balears (CEFOR-Finca de Menut), Institut Balear de la Natura (IBANAT), C/Gremi de Corredors 10 (Polígon Son Rossinyol), 07009 Palma, Spain

² Grup d'Ecologia Interdisciplinària, Departament de Biologia, Universitat de les Illes Balears, 07122 Palma, Spain

³ Departamento de Sistemas y Recursos Naturales, E.T.S.I. Montes, Universidad Politécnica de Madrid, 28040 Madrid, Spain

⁴ Grup de Recerca en Biologia de les Plantes en Condicions Mediterrànies, Departament de Biologia, Universitat de les Illes Balears, 07122 Palma, Spain

Introduction

The discovery and conservation of *Cistus heterophyllus* in Europe

Cistus heterophyllus Desf. is a species endemic to the Western Mediterranean basin, with two highly threatened populations in the Iberian Peninsula. These European populations have been described under the subspecies *carthaginensis* (Crespo and Mateo 1988; Demoly and Montserrat 1993). This species lives in thermomediterranean scrublands with low annual precipitation regimes (Crespo and Mateo 1988).

At the beginning of the twentieth century, an abundant presence of an unknown rock-rose was cited at the area of Cartagena (Peña del Águila and Sancti Spiritu) for the first time, which was studied by Carlos Pau and identified as *Cistus polymorphus* Willk. (Jiménez 1903). Nevertheless, after the publication of a monograph on the genus *Cistus* (Grosser 1903), Pau decided to describe the material as a new taxon: *Cistus carthaginensis* Pau (1904). Subsequently, this species was ascribed to the North African taxon described as *C. heterophyllus* Desf. (Vicioso 1946; Martín Bolaños and Guinea 1949). In the early 1970s, the taxon was considered extinct from the Iberian Peninsula (Esteve 1973) as no plants were detected anymore, until in 1986 a single individual was found in La Pobla de Vallbona (Valencia) and the subspecies *C. heterophyllus* subsp. *carthaginensis* (Pau) Crespo and Mateo (1988) was formerly proposed. This Valencian specimen did not produce fruits due to self-incompatibility, common in the genus *Cistus* (Boscaiu and Güemes 2001).

In 1993, a small population of 9 individuals was discovered in Murcia near Cartagena (Robledo et al. 1995), but in 1998 the area was devastated by a fire and the species disappeared. The following year, the species germinated from the soil seedbank and 26 individuals successfully colonized the area (Sánchez-Gómez et al. 2018). These individuals presented a certain hybridization with *Cistus albidus*, which is very abundant in the area and raised a significant risk factor for the conservation of this taxon (Navarro-Cano 2018a), being the Valencian plant much genetically purer than the Cartagena plants (Jiménez et al. 2007). These hybrids between *C. albidus* and *C. heterophyllus* are abundant in North Africa and have been described as *Cistus* × *clausonii* (Jiménez et al. 2007; Navarro-Cano et al. 2009). The vigour of these hybrids is indicative of their possible evolutionary relevance (Fernández-Mazuecos and Vargas 2018).

In 2012 the Valencian plant was able to produce an unique fruit due to an uncommon self-pollination event, but only one seed was viable to reproduce (Chenoll et al. 2020). In 2013, the individual fructified again and 142 seeds were obtained, from which several specimens were grown (Ferrer-Gallego et al. 2018). In 2022, the death of the original Valencian specimen was confirmed, but more than 1500 plants and 10,000 seeds were finally obtained (Ruiz 2022). Because the origin of the current population comes from a single individual, a low genetic diversity is expected, compromising the stability of the population in the long-term.

Cistus heterophyllus subsp. *carthaginensis* is listed in the Spanish Catalogue of Threatened Species (Royal Decree 139/2011) in the highest category of threat "En Peligro de Extinción". In 2018 it was considered in critical status (Order TEC/1078/2018) being the unique plant species to be declared in high risk to disappear.

In the Region of Murcia, it is included in the Regional Catalogue of Protected Wild Flora of the Region of Murcia (Decree 50/2003). At the same time, it is included in the Valencian Catalogue of Threatened Flora Species (Decree 70/2009). In both cases, *C. heterophyllus* subsp. *carthaginensis* is categorized as "En Peligro de Extinción". There

are also Recovery Plans approved for the Iberian populations, both in Murcia (Decree 244/2014) and in Valencia (Order 1/2015). Also, as a result of being legally declared in critical situation and in order to optimize and coordinate conservation strategies implemented to this species, a Working Group formed by state administrators and technicians from Murcia and Valencia was created in 2018 and currently ongoing. Since the discovery presented in this study, Balearic technicians have also joined to the Working Group.

The vegetation of Cabrera Archipelago National Park

The Maritime-Terrestrial National Park of Cabrera Archipelago (Parque Nacional Marítimo-terrestre del Archipiélago de Cabrera), located at the south of Mallorca, was officially declared in 1991 and consists of several islands and islets. The largest island is Cabrera Gran, with an area of 11.54 km². It has an annual rainfall range from 330 to 407 mm, an average temperature of 18 °C and a semi-arid thermo-Mediterranean climate. Its highest peak is in Puig de na Picamosques (172 m). The Park's Natural Resources Management Plan (Royal Decree 1431/1992) limits human intervention on the vegetation in order to allow their spontaneous evolution and to provide model communities for the study of the ecological processes linked to them.

The flora of the Cabrera Archipelago was studied by Marcos (1936) for the first time, followed by a review of Palau (1976) including more details of many taxa. In the early 1990s, an exhaustive plant species inventory of all 500×500 m UTM grids of the whole archipelago was carried out, published as part of a monographic work of Cabrera Archipelago (Bibiloni et al. 1993; Rita and Bibiloni 1993). Also based on this data, a guide with an analysis of the biodiversity of the archipelago was published (Bibiloni and Rita 1995). Recently, an update of this monograph has been published with several chapters dedicated to flora and vegetation (Rita et al. 2020; Traveset and Rita, 2020; Seguí et al. 2020) and currently, promoted by the staff of the National Park, there is a proposal to carry out a new update of the flora from the entire archipelago.

Until now, in Balearic Islands, the genus *Cistus* L. was represented by 5 taxa (Demoly and Montserrat 1993): *C. albidus* L., which is present on all islands, *Cistus creticus* L., that lives only on Menorca, *Cistus monspeliensis* L., existing on all islands; *Cistus salvifolius* L., present on all islands except Dragonera and Cabrera, and *Cistus clusii* subsp. *multiflorus* Demoly, present on Mallorca, Ibiza, Formentera and recently extinct from Cabrera (at the coast near the shore of l'Olla).

We present our finding of a new population of the threatened *C. heterophyllus* subsp. *carthaginensis* in the northern part of the island of Cabrera Gran. Therefore, this is the first population established in insular conditions and also under the protection of National Park laws and management. This finding represents an important extension of the distribution of this endangered species (Fig. 1) and new insights to disentangle its phylogeography.

Material and methods

The discovery process of this population is explained below. After this finding, we proceed to explore the surrounding area (radius of ca. 500 m) attempting to expand the area of occupancy of the population. All individuals were geolocated by GPS (distance error of 3 m) and manually marked using the official labels used by the environmental authority to register threatened plant species in Balearic Islands. From each individual, we obtained

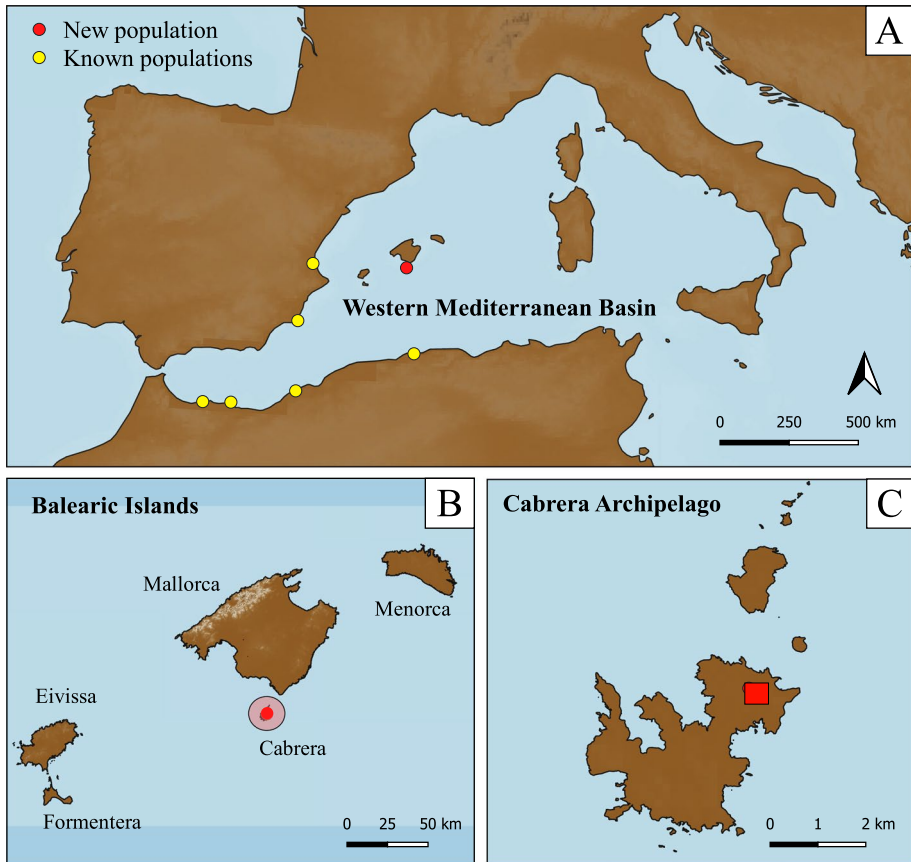


Fig. 1 Distribution map of all known populations of *Cistus heterophyllus* subsp. *carthaginensis* found in the Western Mediterranean Basin (A) and detailed location of the new population found in Balearic Islands (B), concretely in the north-eastern site of the isle of Cabrera Gran (C)

information about their approximate life stage depending on their size and reproductive capacity (seedlings: individuals of less than one year old; juveniles: those of more than one year old but not reproductive yet; and reproductive matures: adult plants that already flowered and fructified). Also, we registered dead individuals and those showing predation signals.

In order to confirm the taxonomic identity of this species, we obtained plant material from the largest individual (in order to minimize sampling impact on the threatened species) and we observed and described all morphological traits necessary to recognise the taxon. Detailed pictures of the most important plant features (e.g., trichomes and seeds) were made using an optical microscope coupled to Canon 90d camera, using WeMacro's automatic rail and the software Helicon focus v8.1.0 stacking software (Helicon Software 2022) to merge stacks into a fully focused images.

After fieldwork, we introduced all geositioned data on KML format in QGIS v3.10. (QGIS Development Team 2020) and they were mapped using Balearic Islands shapefile obtained from the Cartography Service of the Government of the Balearic Islands.

Results and discussion

The discovery of *Cistus heterophyllus* subsp. *carthaginensis* in Cabrera Archipelago

In the early 1990s, Gabriel Servera, a National Park guard, detected the presence of a species of *Cistus* on the island of Cabrera Gran that could not be ascribed to any of the species known in Mallorca, giving the identity of *Cistus* cf. *creticus*. Two decades later, in September 2015, the Forestry Centre of the Balearic Islands collected seeds of this unknown taxon. After observing the specimens, we confirmed that it was not *Cistus creticus* although the definitive identification remained unsolved. We were able to detect some individuals having similar traits to *C. albidus*, which led us to think that the unknown taxa could originate by hybridization. We revisited the island of Cabrera Gran in April 2022, coinciding with the flowering season of the species, favouring its identification as *C. heterophyllus*, mainly due to the yellow macules with white upper part present at the base of the petals, which quickly distinguish it from other pink-flowered *Cistus* species present in the Western Mediterranean Basin (Fig. 2A).

A more detailed analysis allowed us to determine with certainty that the individuals found in Cabrera Gran also presented the morphological traits associated to the subspecies *C. heterophyllus* subsp. *carthaginensis*. In addition, the intermediate individuals coincided with the description of *Cistus* \times *clausonii* (*Cistus albidus* \times *C. heterophyllus*). *Cistus*

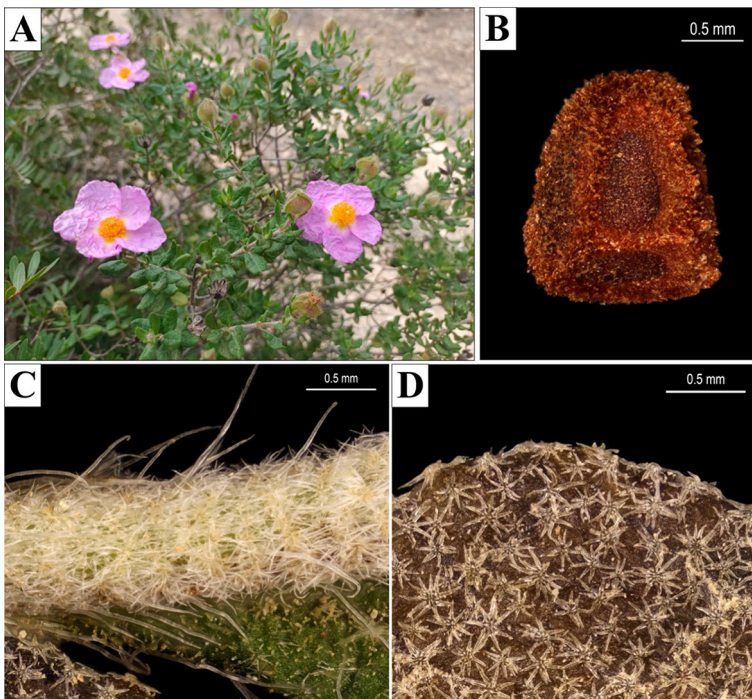


Fig. 2 Discriminatory traits that allow identification of *Cistus heterophyllus* subsp. *carthaginensis*: plant architecture and flower morphology (A), seed morphology (B), indument of branchlets (C) and trichomes disposition at the front side of the leaf (D)

albidus has been cited in different locations of Cabrera Gran (Marcos 1936; Palau 1976), but currently there are only 18 individuals in the entire Cabrera Archipelago, 6 individuals located a few meters away from the population *C. heterophyllus* subsp. *carthaginensis*, and another 12 specimens about 760 m away.

The flowers of the individuals found in Cabrera Gran have external sepals slightly mucronate and internal ones apiculate, of $41.6 \text{ mm} \pm 0.5 \text{ mm}$ in diameter, seeds are spheroidal-tetrahedral (Fig. 2B), with a densely papillose external cover or with alveolate faces and papillose edges, sienna-coloured (Navarro-Cano 2018b). Indumentum of the young branchlets constituted by stellate trichomes (Fig. 2C) and very few simple trichomes (Crespo and Mateo 1988). Also, all stellate trichomes were found addressed to leaves (Fig. 2D). *Cistus albidus* contains many spreading stellate trichomes while *C. x clausonii* present stellate trichomes of intermediate disposition (Navarro-Cano 2018b). Therefore, pure specimens of *C. heterophyllus* subsp. *carthaginensis* can be distinguished in the population. These plant features, combined with the semi-arid thermomediterranean bioclimate where this species exists in other populations of Spain and north-Africa, allow us to confirm that this threatened species was present in Cabrera Gran.

Cistus heterophyllus subsp. *carthaginensis* (Pau) M.B. Crespo & Mateo in Anales Jard. Bot. Madrid 45(1): 168 (1988)

= *Cistus carthaginensis* Pau in Bol. Soc. Aragonesa Ci. Nat. 3: 260 (1904)

Cabrera Gran: Putxet de l'Olla, at Camí del Cap Ventós, 31SDD9634, 100 m, 03-IV-2022.

Cistus heterophyllus subsp. *carthaginensis* plants are found in the northern part of the island of Cabrera Gran, at the furthest point from the port and away from human frequented areas. The central population runs parallel to a forest track, which is not reflected in the 1980 toponymic map of Cabrera by Cosme Aguiló, indicating that it is a modern construction. After a population census, we detected a total of 59 individuals of *C. heterophyllus* subsp. *carthaginensis*. Ten individuals were more than one year old and were reproductive; 41 seedlings were less than one year old, and 8 individuals had hybrid features (*C. x clausonii*). However, the individuals of this species are very difficult to detect if they are not in bloom, since the plants live among other species and get confused in them (e.g., *Cistus monspeliensis* or *Pistacia lentiscus*). Probably, this difficult discrimination of the vegetative parts of the species within the plant mosaic where it is located is the reason why no botanist has detected the presence of this taxon in this area of Cabrera Gran until now.

Current status of the insular population

The population is distributed in a central core, parallel to the forest track, with 9 pure and reproductive individuals, 33 pure seedlings, and 1 hybrid; a small core about 40 m east of the central core, with 1 pure individual, 1 dead individual, and 7 seedlings; and a last core north of the central core, with 7 reproductive hybrid individuals and 1 pure seedling (Fig. 3). This last core composed of 7 hybrids is only 7 m from a small population of *Cistus albidus* consisting of 6 individuals. This proximity explains why all the individuals of this core are morphologically identified as hybrids.

When Cabrera Archipelago National Park was declared, the environmental authority decided to eliminate goats and sheep present on the island, whereas agricultural activities were also abandoned. This land use changes led to a notable increase in woody vegetation of Cabrera Gran (Rita et al. 2020), which could be the reason why *C. heterophyllus* subsp. *carthaginensis* is probably losing its habitat restricted to scrub clearings. In fact, we found

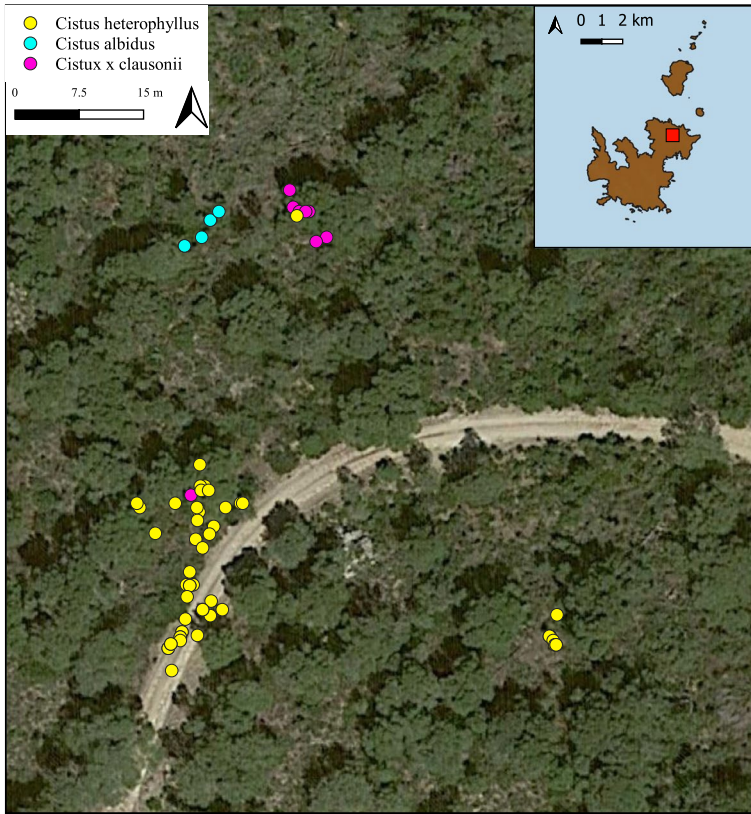


Fig. 3 Distribution of the whole population of *Cistus heterophyllus* subsp. *carthagenensis* (yellow), *Cistus* × *clausonii* (pink) and the coexisting subpopulation of *Cistus albidus* (blue) from the isle of Cabrera Gran

most of the young plants along the open space left by the forest track, revealing a clear preference of this species for sparsely vegetated areas.

This case is not the first endangered rockrose endemic to Western Mediterranean basin that requires conservation actions. *Helianthemum caput-felis* (Cistaceae), which has a similar distributional range -but living at different habitats- than *C. heterophyllus*, is considered Endangered and extinction models predicted a quasi-extinction of 45% in three generations (Sulis et al. 2020). Also, this species have a similar lifespan and plant architecture than *C. heterophyllus* whose population stability rely on short-term population dynamics (Sulis et al. 2018). This case can be used as a model for further conservation strategies on *C. heterophyllus*.

Additionally, future studies should check the degree of hybridization of this new island population and whether this could be detrimental to the conservation of the species. The scarce presence of *C. albidus* on Cabrera Gran offers a very interesting scenario for further research on the phenomenon of hybridization of this species with *C. heterophyllus* subsp. *carthagenensis*. In addition, it remains to be resolved what are the phylogenetic similarities with other populations of this species and the phylogeographic pattern that frames this distribution.

Most of the seedlings showed predation marks, indicating that they suffer from a high herbivory impact. For this reason, it is clear that the presence of rabbits and rats in Cabrera Gran is an important factor compromising the population recruitment and demographic stability of this species. For this reason, it is necessary to rapidly create and develop a recovery plan for this species in the Balearic Islands. Conservation actions must be taken in the near future to protect this new population of the endangered *C. heterophyllus* subsp. *carthaginensis*, which is also the very first insular population found from this species, and must be included as a new taxon from the Balearic Islands flora, a new endangered species to be included in the Red List of Balearic threatened species and to the list of the most threatened Mediterranean islands plants.

Acknowledgements Gabriel Servera, ex-worker of the National Park was the first person to detect an unknown *Cistus* species in the area. Joan Salom, current guard of the National Park, who has preserved the knowledge of the vegetation of Cabrera and the location of the unknown *Cistus* specimens until now. Dr. Eva Moragues, head of conservation at the National Park, Francesca López, director of the National Park, José Romero, deputy director of the National Park and all the members of the National Park staff that have been working to conserve and protect this ecosystem for 30 years.

Author contributions Both authors equally contributed to the design, development and writing of this study.

Funding Open Access funding provided thanks to the CRUE-CSIC agreement with Springer Nature. The authors declare that no funds, grants, or other support were received during the preparation of this manuscript.

Declarations

Competing interests The authors have no relevant financial or non-financial interests to disclose.

Open Access This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by/4.0/>.

References

- Bibiloni G, Alomar G, Rita J (1993) Flora vascular dels illots i addicions a la flora de Cabrera gran. In: Alcover JA, Ballesteros E, Fornós JJ (eds) Història Natural de l'Arxipèlag de Cabrera, 1st edn. CSIC-Editorial Moll, Palma, pp 179–206
- Bibiloni G, Rita J (1995) Anàlisi de la biodiversitat de la Flora vascular del archipièlag de Cabrera. In: Llorens L (ed) Guia de la excursió geobotànica de las XV Jornades de Fitosociologia: datos sobre la vegetació de Cabrera, 1st edn. Universitat de les Illes Balears, Palma, pp 19–49
- Boscaiu M, Güemes J (2001) Breeding system and conservation strategy of the extremely endangered *Cistus carthaginensis* Pau (Cistaceae) of Spain. *Isr J Plant Sci* 49:213–220
- Chenoll J, Bonet A, Ferrer PP (2020) Valoració de la implantació de noves poblacions translocades de l'endemisme ibèric altament amenaçat de la flora espanyola *Cistus heterophyllus* subsp. *carthaginensis* (Cistaceae). *Nemus: Revista De L'ateneu De Natura* 10:124–145
- Crespo MB, Mateo G (1988) Consideraciones acerca de la presencia de *Cistus heterophyllus* Desf. en la Península Ibérica. *Anales Jard. Bot Madrid* 45(1):165–171
- Decree 244/2014, of December 19th, by which Recovery Plans of many plant species are approved. *Boletín Oficial de la Región de Murcia*. Murcia, 29th December, num. 297, pp 47836–47916

- Decree 50/2003, of May 30th, by which the Regional Catalogue of Protected Wild Flora of the Region of Murcia is created and rules for the use of forest species are established. *Boletín Oficial de la Región de Murcia*. Murcia, 10th of June 2003, num. 131, pp 11615–11624
- Decree 70/2009, of May 22nd, that creates and regulates the Valencian Catalogue of Threatened Flora Species and regulates additional conservation measures. *Diario Oficial de la Generalitat Valenciana*. Valencia, 27th of May 2009, num. 6021, pp 1–20
- Demoly JP, Montserrat P (1993) *Cistus* L. In: Castroviejo S et al (eds) *Flora Ibérica, Plumbaginaceae (Partim)-Capparaceae*, vol III. Real Jardín Botánico CSIC, Madrid, pp 319–337
- Fernández-Mazuco M, Vargas P (2018) Especiación en el género *Cistus*. In: Vicente MJ, Martínez-Sánchez JJ (eds) *La Jara de Cartagena (Cistus heterophyllus)*, una especie en peligro. Estado actual de conocimientos, Universidad Politécnica de Cartagena, Murcia, pp 26–30
- Ferrer-Gallego PP, Ferrando-Pardo I, Albert-Llana FJ, Martínez V, Laguna E (2018) Obtención de material de reproducción en la Comunidad Valenciana. In: Vicente MJ, Martínez-Sánchez JJ (eds) *La Jara de Cartagena (Cistus heterophyllus)*, una especie en peligro. Estado actual de conocimientos, Universidad Politécnica de Cartagena, Murcia, pp 102–126
- Grosser W (1903) *Cistaceae*. In: Engler A (ed) *Das Pflanzenreich*, vol 14. Engelmann, Berlin
- Helicon Software (2022) *Helicon Focus*. <https://www.heliconsoft.com/>
- Jiménez FP (1903) *Las plantas de Cartagena*. Memorias De La Real Sociedad Española De Historia Natural 2:63–118
- Jiménez JF, Sánchez-Gómez P, Rosselló JA (2007) Evidencia de introgresión en *Cistus heterophyllus* subsp. *carthaginensis* (Cistaceae) a partir de marcadores moleculares RAPD. *An Biol* 29:95–103
- Marcos A (1936) *Flòrula de Cabrera i dels illots pròxims*. *Cavanillesia* 8:5–52
- Martín-Bolaños M, Guinea E (1949) *Jarales y jaras (Cistografía hispánica)*. Instituto Forestal Investigador y Experimental, Madrid
- Navarro-Cano JA (2018a) Historia de las poblaciones ibéricas de *Cistus heterophyllus*. In: Vicente MJ, Martínez-Sánchez JJ (eds) *La Jara de Cartagena (Cistus heterophyllus)*, una especie en peligro. Estado actual de conocimientos, Universidad Politécnica de Cartagena, Murcia, pp 32–41
- Navarro-Cano JA (2018b) Clave fotográfica-ilustraciones para diferenciar híbridos o reconocer plántulas. In: Vicente MJ, Martínez-Sánchez JJ (eds) *La Jara de Cartagena (Cistus heterophyllus)*, una especie en peligro. Estado actual de conocimientos, Universidad Politécnica de Cartagena, Murcia, pp 218–221
- Navarro-Cano JA, Sánchez-Balibrea J, Barberá GG, Fernández-Sempere M, El-Andalossí M (2009) Siguiendo la huella de la hibridación en poblaciones de *Cistus heterophyllus* del Rif marroquí. *Conservación Vegetal* 13:9–10
- Order 1/2015, of January 8th, by which the Recovery Plans of critically endangered plant species (*Cistus heterophyllus*, *Limonium perplexum* and *Silene hifacensis*) are approved. *Diari Oficial de la Comunitat Valenciana*. Valencia, 27th January 2015, num. 7451, pp 1801–1815
- Order TEC/1078/2018, of September 28th, declaring the critical status of *Cistus heterophyllus* subsp. *carthaginensis*, *Lanius minor*, *Margaritifera auricularia*, *Marmaronetta angustirostris*, *Mustela lutreola*, *Pinna nobilis* and *Tetrao urogallus cantabricus* in Spain, whereas all works and projects related to the recovery of these taxa were declared of general interest. *Boletín Oficial del Estado*. Madrid, 17th October 2018, num. 251, pp 100677–100679
- Palau PC (1976) *Catàleg de la flòrula de l'illa de Cabrera i dels illots que l'envolten*. *Treballs De La Institució Catalana D'història Natural* 7:5–103
- Pau C (1904) Sección bibliográfica: A Engler *Das Pflanzenreich Cistaceae* von W. Grosser *Bol Soc Aragonesa Ci Nat* 3:259–266
- QGIS Development Team (2020) *QGIS Geographic information system*. Open-source geospatial foundation project
- Rita J, Bibiloni G (1993) *La Vegetació*. In: Alcover JA, Ballesteros E, Fornós JJ (eds) *Història Natural de l'Arxipèlag de Cabrera*, 1st edn. CSIC-Editorial Moll, Palma, pp 207–256
- Rita J, Ruiz M, Bibiloni G, Traveset A (2020) *Canvis de la vegetació de l'illa de Cabrera al llarg del temps*. In: Grau AM, Fornós JJ, Mateu G, Oliver PA, Terrasa B (eds) *Arxipèlag de Cabrera: història natural*. Societat d'Història Natural de les Illes Balears, Palma, pp 493–512
- Royal Decree 139/2011, of February 4th, for the development of the List of Wild Species under Special Protection Regime and the Spanish Catalogue of Threatened Species. *Boletín Oficial del Estado*. Madrid, 23 of February 2011, num. 46, pp 20912–20951
- Royal Decree 1431/1992, of November 27th, by which the Natural Resources Management Plan of Cabrera Archipelago National Park is approved. *Boletín Oficial del Estado*. Madrid, 18th February 1993, num. 42, pp 5067–5071
- Ruiz MA (2022) *Muere la abuela de las jaras de Cartagena*. *La Verdad*. <https://www.laverdad.es/lospiesenlatierra/noticias/muere-abuela-jaras-20220303174908-nt.html>

- Sánchez-Gómez P, Martínez JF, Güemes J, Rubio JLC (2018) Taxonomía, filogenia y contexto geobotánico. In: Vicente MJ, Martínez-Sánchez JJ (eds) La Jara de Cartagena (*Cistus heterophyllus*), una especie en peligro. Estado actual de conocimientos, Universidad Politécnica de Cartagena, Murcia, pp 20–25
- Seguí J, Rita J, Traveset A (2020) Les plantes destacables de l'arxipèlag de Cabrera. In: Grau AM, Fornós JJ, Mateu G, Oliver PA, Terrasa B (eds) Arxipèlag de Cabrera: història natural. Societat d'Història Natural de les Illes Balears, Palma, pp 577–590
- Sulis E, Bacchetta G, Cogoni D, Fenu G (2018) Short-term population dynamics of *Helianthemum caput-felis*, a perennial Mediterranean coastal plant: a key element for an effective conservation programme. *Syst Biodivers* 16:774–783. <https://doi.org/10.1080/14772000.2018.1492469>
- Sulis E, Bacchetta G, Cogoni D et al (2020) Assessing the global conservation status of the rock rose *Helianthemum caput-felis*. *Oryx* 54:197–205. <https://doi.org/10.1017/S0030605318001424>
- Traveset A, Rita J (2020) Els illots de l'arxipèlag de Cabrera: Refugis de Biodiversitat. In: Grau AM, Fornós JJ, Mateu G, Oliver PA, Terrasa B (eds) Arxipèlag de Cabrera: història natural. Societat d'Història Natural de les Illes Balears, Palma, pp 513–534
- Vicioso C (1946) Notas sobre la flora española. *Anales Del Jardín Botánico De Madrid* 6(2):55

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.