

## **Cotoneaster Majoricensis L. Sáez & Rosselló (Rosaceae), a New Species from Majorca (Balearic Islands, Spain)**

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Source: Candollea, 67(2) : 243-253

Published By: The Conservatory and Botanical Garden of the City of  
Geneva (CJBG)

URL: <https://doi.org/10.15553/c2012v672a5>

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# Cotoneaster majoricensis L. Sáez & Rosselló (Rosaceae), a new species from Majorca (Balearic Islands, Spain)

Llorenç Sáez & Josep A. Rosselló

## Abstract

SÁEZ, L. & J. A. ROSSELLÓ (2012). *Cotoneaster majoricensis* L. Sáez & Rosselló (Rosaceae), a new species from Majorca (Balearic Islands, Spain). *Candollea* 67: 243-253. In English, English and French abstracts.

A new species from the northern mountains of Mallorca (Balearic Islands), *Cotoneaster majoricensis* L. Sáez & Rosselló (Rosaceae), is described and illustrated. It belongs to section *Cotoneaster* Medik. and is morphologically close to *Cotoneaster tomentosus* (Aiton) Lindl. and *Cotoneaster raboutensis* K. E. Flink & al., differing however by various morphological characters. Data on taxonomic relationships, ecology, and conservation status of this new apparently narrow-ranged endemic species are also provided.

## Key-words

ROSACEAE – *Cotoneaster* – Balearic Islands – Taxonomy – Conservation

## Résumé

SÁEZ, L. & J. A. ROSSELLÓ (2012). *Cotoneaster majoricensis* L. Sáez & Rosselló (Rosaceae), une nouvelle espèce de Majorque (Iles Baléares, Espagne). *Candollea* 67: 243-253. En anglais, résumés anglais et français.

Une nouvelle espèce des montagnes du Nord de Majorque (Iles Baléares), *Cotoneaster majoricensis* L. Sáez & Rosselló (Rosaceae), est décrite et illustrée. Elle appartient à la section *Cotoneaster* Medik. et est morphologiquement proche de *Cotoneaster tomentosus* (Aiton) Lindl. et de *Cotoneaster raboutensis* K. E. Flink & al. dont elle diffère cependant par différents caractères morphologiques. Des données sur les relations taxonomiques, l'écologie et le statut de conservation de cette espèce apparemment endémique à aire de répartition restreinte sont présentées.

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Submitted on April 26, 2011. Accepted on July 24, 2012.

Edited by P. Bungenier

## Introduction

The genus *Cotoneaster* Medik. (*Rosaceae*) belongs to the subfamily *Maloideae* (Small) C. Weber and comprises between 300 and 450 species (deciduous or evergreen shrubs, and rarely small trees) distributed through Europe, North Africa, and Asia, with a marked concentration of species in the Himalaya and western China (GLADKOVA, 1968; HYLMÖ & FRYER, 1999; BARTISH & al., 2001; FRYER & HYLMÖ, 2009).

In *Cotoneaster*, species with apomictic breeding systems are very common, with some species being facultative apomictic or selfing (BARTISH & al., 2001; FRYER & HYLMÖ, 2009). According to HYLMÖ & FRYER (1999), all of the known outbreeding species are diploids, whereas the apomictic species are polyploid (tetraploid or, in a few cases, triploid). These biological features made *Cotoneaster* a complex, and taxonomically difficult, genus. In fact, some of the European species are morphologically very similar and are often difficult to distinguish in vegetative state (BROWICZ, 1968).

The knowledge of the genus in Europe has especially improved during the last decades, mainly due to the studies made by FLINCK & HYLMÖ (1966), FLINCK & al. (1998), HYLMÖ & FRYER (1999) and SENNIKOV (2009). However, some authors consider that these taxonomic treatments are too analytical and suggested a taxonomic lumping for several narrowly distributed species (e.g., DICKORÉ & KASPEREK, 2010). In fact, DICKORÉ & KASPEREK (2010) reduced to seven the number of European native species, in contrast to estimates suggesting as many as 22 autochthonous species (e.g., SENNIKOV, 2009).

The infrageneric division of European *Cotoneaster* has been substantiated on few basic floral features such as petals colour, their position at anthesis, and phenology, i.e., whether or not the flowers open in sequence over a longer period of time (BROWICZ, 1968; BLANCA, 1998; HYLMÖ & FRYER, 1999; FRYER & HYLMÖ, 2009), and two subgenera (*Cotoneaster* and *Chaenopetalum* (Koehne) G. Klotz) are usually recognized.

During field work aimed to increase the floristic knowledge of the mountains of northern Majorca (Balearic Islands), we found two small *Cotoneaster* populations on vertical cliffs of the highest mountains of the island (Puig Major de Son Torrella, and Serra des Teixos). The genus was previously unknown in the flora of the Balearic archipelago. The plants called our attention because they did not match any other species described in a recent revision of the genus in the Iberian Peninsula (BLANCA, 1998). A detailed comparison of the Majorcan populations with European and North African species of *Cotoneaster* revealed constant and conspicuous morphological differences in floral and vegetative features. The taxonomic evaluation of morphological gaps led to the conclusion that they represent an undescribed species restricted, as far known, to the Balearic Islands.

## Material and methods

### *Morphological studies*

Morphological and anatomical observations were undertaken on living plants and herbarium specimens from BC, BCC, BCF, G, LD, MA, MPU and VAL. Pollen grains were stained according to the ALEXANDER (1980) technique and observed under a NIKON eclipse E-400 optic microscope at 600× magnification.

### *Censuses, monitoring and conservation status*

Since the first finding of *Cotoneaster* in Majorca (June 2002) we have carefully explored a number of sites (25 UTM 1 km<sup>2</sup> squares) in the Serra de Tramuntana range in which suitable habitats for the new species were known to occur, mainly cliffs and overhangs. Censuses were performed by direct counting of all mature and non-mature individuals in all those sites at which we found the species. Area of occupancy was calculated using GPS and threat factors were analyzed. The species extinction risk was assessed following the guidelines of the IUCN Red List Categories and Criteria version 3.1 (IUCN, 2001).

### *Plant DNA extraction and rDNA (ITS) sequences*

DNA from *C. integerrimus* Medik. s.l. (including the somewhat recognized segregates *C. scandinavicus* B. Hylmö and *C. pyrenaicus* Gand.), *C. tomentosus* (Aiton) Lindl., *C. granatensis* Boiss., *C. atlanticus* G. Klotz, *C. raboutensis* K. E. Flink & al. and *C. majoricensis* was extracted from herbarium specimens or fresh leaves stored in bags filled with silica gel using the DNeasy Plant Mini Kit (Qiagen) (see Appendix 1). No amplification products were obtained for *C. raboutensis*, due to the low quality (degraded DNA) of the sample. The region including ITS1, 5.8S and ITS2 was amplified from *Cotoneaster* species using the primer pairs ITS-5/ITS-4 or, in the case of herbarium samples, the ITS-5/ITS-2 and ITS-3/ITS-4 (sequences in WHITE & al., 1990). PCR reactions were performed in 50 µl, containing 1× reaction buffer, 0.001% BSA, 2 mM MgCl<sub>2</sub>, 200 µM of each dNTP, 0.6 µM of each primer, approximately 50–100 ng genomic DNA and 3 units of Taq polymerase (NETZYMETM DNA Polymerase; NEED SL, Valencia, Spain). Amplifications comprised an initial cycle at 94°C for 3 min; 40 cycles of 30 s at 94°C, 30 s at 57°C, 1 min at 72°C. A final cycle at 72°C for 5 min was included. The PCR products were separated on 2% agarose gels and purified using the High Pure PCR Product Purification Kit (Roche Diagnostics). Amplifications were carried out on an ABI GeneAmp PCR System 9700 Thermal Cycler (Applied Biosystems, Foster City, California). PCR products were checked for concentration on 2% agarose gels, purified using the High Pure PCR Product Purification Kit (Roche, Germany) and sequenced with an ABI 3100 Genetic Analyser using the ABI BigDyeTM Terminator Cycle Sequencing Ready

Reaction Kit (Applied Biosystems, Foster City, California). Samples were sequenced in both forward and reverse directions. The sequences obtained were compared to the GenBank DNA databases using BLAST (ALTSCHUL & al., 1990) and aligned with ClustalX vs 1.83 (THOMPSON & al., 1997).

## Results

*Cotoneaster majoricensis* L. Sáez & Rosselló, **spec. nova** (Fig. 1).

**Typus:** SPAIN. Balearic Islands, Majorca: Puig Major de Son Torrella, Sa Coma Fosca, couloir nord, 31SDE8206, 1380 m, shady vertical limestone cliffs, 25.VI.2004, L. G. Valle & L. Sáez LS-6177 (holo-: BC [903452]!; iso-: BCB (Herb. L. Sáez)).

*Species* *C. tomentosus* et *C. rabouense proxima*, ab utroque fructo pyriforme, (1-)2 pyrenis praedito, distincta. Ab *C. tomentosus* foliis supra glabrescentibus vel sparse pilosis, petalis albis et antheris minoribus differt. Ab *C. rabouense* differt hypanthio plus minusque piloso et antheris majoribus 0,8-1 mm longis (*C. rabouense*: 0,7-0,8 mm).

*Shrub*, erect or suberect, (0.5-)1-2.7 m high, irregularly branched; young branches sparsely hairy, becoming gray-brown and glabrous. *Leaves* deciduous, alternate, simple; stipules 3-4 × 1-1.5 mm, deciduous, subulate; petiole 4-8 mm; lamina (14-)25-50(-62) × (12)-16-35(-50) mm, broadly elliptic to ovate-elliptic, obtuse, apex obtuse, truncate or emarginate; adaxial surface green, glabrescent, with few hairs, sometimes becoming glabrous; abaxial surface pilose or sparsely tomentose (hairs 0.5-1.5 mm long). *Inflorescences* terminal or axillary, corymbose, 2.1-2.7 × 2.5-3 cm, with 7-14 flowers, with flowers opening in sequence over a longer period of time; bracts c. 7 × 2 mm, lanceolate; peduncle pilose; pedicels sparsely pilose. *Hypanthium* turbinate or campanulate, abaxially subglabrous or sparsely hairy (hairs 0.5-1.2 mm long), adaxially glabrous. *Calyx* lobes 1.2-2 × 1.3-1.9 mm, erect, triangular to broadly triangular, sparsely hairy. *Petals* 3.3-4 × 3.3-4 mm, suborbicular, erect, white, glabrous, imbricate in bud. *Stamens* 12-15, inserted in the mouth of hypanthium; filaments 3-3.5 mm long, subulate, erect, white; anthers 0.8-1 × 0.5 mm, white. *Stigmas* (1-)2 capitate. *Fruit* pyriform (5.5-)6.5-7.5 × (4-)5-6 mm, red to brownish-red, subglabrous or sparsely hairy at base, with persistent, incurved, fleshy calyx lobes; nutlets (1-)2. *Pollen* grains 3-colpate, prolate (37.68 ± 1.16 × 34.13 ± 1.50 µm).

*Phenology*. – Flowering time: (May-)June-August; fruiting time: July-August.

*Taxonomical note*. – *Cotoneaster majoricensis* is morphologically similar to *C. tomentosus* a widespread species in the mountains of Central and Southern Europe, but differs, by its adaxially glabrescent young leaves, white petals, smaller anthers, sparsely hairy hypanthium and calyx lobes, fruit

size and number of nutlets (Table 1). From *C. rabouensis* (restricted to southern and eastern France), the new species differs by its relatively larger anthers, and the higher number of flowers in the inflorescence, adaxially sparsely hairy calyx lobes at the abaxial surface, the fruit shape and the number of nutlets. The low number of nutlets, 1(-2) is a usual feature in sect. *Cotoneaster* Medik., and together with fruit shape are important and useful markers for taxa delimitation (cf. FLINCK & al., 1998; HYLMÖ & FRYER, 1999). *Cotoneaster integerrimus* group seems more distantly related and differs by fewer flowered inflorescences [(1-)2-3(-4) flowers], reflexed pedicels, longer anthers and subglobose fruits.

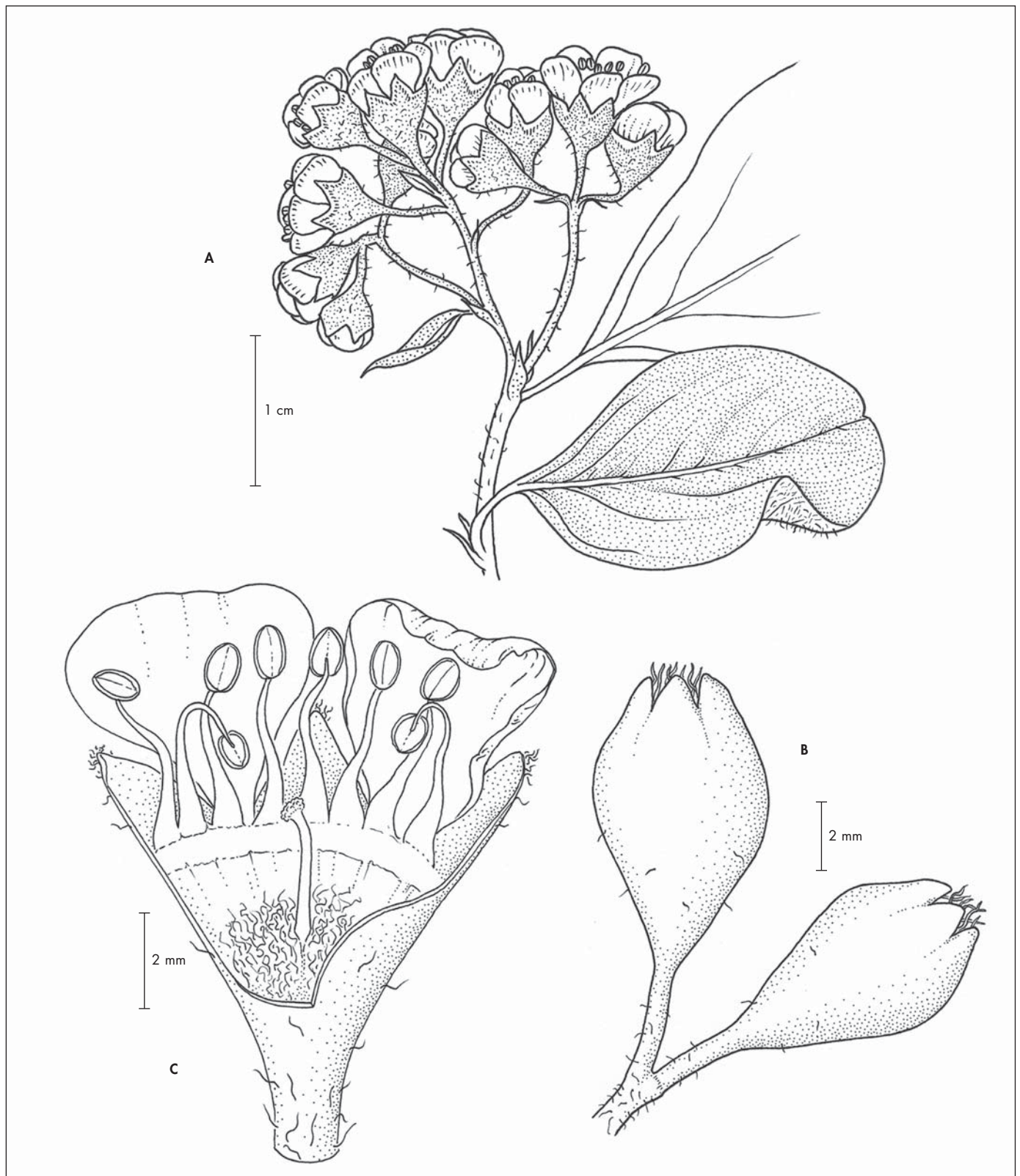
Some 4-colpate pollen grains have been observed in anthers from both populations. The viability of the pollen, according to ALEXANDER (1980) technique, is 47.75 ± 5.63%.

*Key to related species*. – The new species has been added to the key presented by BLANCA (1998). Iberian populations of *C. integerrimus* are considered here as belonging to *C. pyrenaicus*, according to the treatment of SENNIKOV (2009):

1. Petals patent at anthesis, white; fruit glabrous ..... *C. granatensis*
- 1a. Petals erect at anthesis, white, pink or reddish; fruit glabrous or hairy ..... 2
2. Calyx lobes glabrous or hairy only on the margin; fruit reflexed, glabrous; inflorescence (1-)2-3(-4)-flowered ..... *C. pyrenaicus* [*C. integerrimus* group]
- 2a. Calyx lobes hairy or tomentose; fruit erect, hairy; inflorescence 3-14 flowers ..... 3
3. Petals white; leaves adaxially glabrescent; fruit pyriform ..... *C. majoricensis*
- 3a. Petals pink or pale rose (sometimes abaxially reddish); adaxial surface of leaves hairy; fruit globose to subglobose ..... *C. tomentosus*

The features shown by *C. majoricensis* are unique (Table 1) and we failed to provide alternative taxonomic identifications following the key provided by DICKORÉ & KASPEREK (2010). In fact, the new species shows small flowers (3-6 mm diam.) and white petals, contradicting the key statements # 5 and 5'. Moreover, if this key is further followed, we are forced to choose between *C. integerrimus* and *C. tomentosus* (key statements # 25 and 25'). The Balearic plant has only two nutlets, 7-14 flowers per inflorescence, and elliptic to ovate-elliptic leaves, in contrast with *C. integerrimus* features: pyrenes 2-4, inflorescence 1-4-flowered, and leaves ± lanceolate-ovate. Furthermore, it cannot be included within the variation of the alternative choice, *C. tomentosus* characterized by pink or pale petals, nutlets 3-5, inflorescence 2-12-flowered, and leaves ovate or broadly ovate.





**Fig. 1.** – *Cotoneaster majoricensis* L. Sáez & Rosselló. **A.** Detail of flowering stem; **B.** Detail of fruits; **C.** Detail of flower.

[Valle & Sáez LS-6177, BC] [Drawings: L. Sáez]

**Table 1.** – Main morphological distinctive characters between the different studied species of *Cotoneaster* Medik.

|                               | <i>C. majoricensis</i><br>L. Sáez & Rosselló | <i>C. tomentosus</i><br>(Aiton) Lindl.            | <i>C. raboutensis</i><br>K. E. Flink & al. | <i>C. pyrenaicus</i> Gand.<br>[ <i>C. integerrimus</i> group] |
|-------------------------------|----------------------------------------------|---------------------------------------------------|--------------------------------------------|---------------------------------------------------------------|
| Leaves (blade size) [mm]      | (14-)25-50(-62) ×<br>(12-)16-35(-50)         | (20-)30-60 ×<br>20-40                             | 10-45 × 8-25                               | (8-)10-35(-50) ×<br>5-30(-35)                                 |
| Blade, adaxial surface        | green, with few hairs<br>or subglabrous      | greyish-green to green,<br>hairy to densely hairy | greyish-green, glabrous                    | green, glabrous                                               |
| Inflorescence (n° of flowers) | 7-14                                         | 3-7(-12)                                          | 3-8                                        | (1-)2-3(-4)                                                   |
| Hypanthium                    | abaxially subglabrous<br>or sparsely hairy   | abaxially tomentose                               | abaxially glabrous                         | abaxially glabrous<br>or slightly puberulous                  |
| Calyx lobes size [mm]         | 1.2-2 × 1.3-1.9                              | 1-1.8 × 1-1.8                                     | 1.7-2.1 × 1.6-2.1                          | 1.2-2 × 1.3-2.1                                               |
| Petal colour                  | white                                        | pink                                              | white                                      | pink to whitish                                               |
| Anthers length [mm]           | 0.8-1                                        | 1.4-2.3                                           | 0.7-0.8                                    | 1.5-2                                                         |
| Fruit length [mm]             | (5.5-)6.5-7.5                                | (6-)7-8                                           | 6-7.5                                      | (4-)5.9(-10)                                                  |
| Fruit width [mm]              | (4-)5-6                                      | (5.5-)7-8                                         | 6-7.5                                      | (4-)5.9(-9.5)                                                 |
| Fruit shape                   | pyriform                                     | globose to subglobose                             | globose                                    | globose                                                       |
| Fruit colour                  | red or brownish red                          | red                                               | red                                        | red                                                           |
| Nutlets                       | 1-2                                          | (2-)3-5                                           | 3-4                                        | 2-3                                                           |

**Ribosomal ITS sequences.** – The ITS-1 was uniform in length across all accessions (230 bp), whereas the ITS-2 ranged between 213 and 217 bp. The variation in the ITS-2 length was due to three independent indels that were inferred after sequence alignment. Intragenomic polymorphisms (implying the presence of two overlapping bases at the electrophoretograms) occurred at most sites. This ribosomal heterogeneity, apparently indicating a lack of concerted evolution of the ribosomal arrays, precluded the phylogenetic analysis of the ITS sequences. Twenty-two ITS-1 and 15 ITS-2 sites displayed point mutations between accessions. *Cotoneaster majoricensis* showed an unique 1-bp indel (position 253 not found in the other *Cotoneaster* accessions analyzed. Three accessions of *C. integerrimus* (in broad sense) showed an exclusive 2-bp indel (positions 249-250 of the alignment) that was absent from the samples of Montseny (Spain) and Mount Olympus (Greece). The other 2-bp indel (at sites 255-256) was restricted to all *C. integerrimus* samples (including *C. scandinavicus*). Twenty-two ITS-1 and 15 ITS-2 sites showed point mutations between accessions (Table 2), and intragenomic polymorphisms (implying the presence of two overlapping bases at the electrophoretograms) were found at most sites. This ribosomal heterogeneity, due to a lack of concerted evolution of the ribosomal arrays, precluded the phylogenetic analysis of the ITS sequences. However, the inspection of the nucleotide matrix revealed that sequences of *C. majoricensis* showed five unique mutations (including the 1-bp indel) not shared with the other *Cotoneaster* samples. Moreover, five other mutations were shared only with *C. atlanticus* from Jbel Tissouka (Morocco)

to which the ribosomal sequences of *C. majoricensis* appear to be most closely related. Moreover, we refrain to hypothesize an origin of *C. majoricensis* from *C. atlanticus* and *C. tomentosus* or *C. integerrimus*-like ancestors based on sharing specific polymorphic sites. Without cloning the ITS products it is not possible to know the sequences of the ITS copies present in the samples. Furthermore, biased concerted evolution of several sites towards a single parent might have occurred, obscuring the true relationships of the progenitors.

**Habitat and distribution.** – Currently, *C. majoricensis* is known from two mountain peaks of northern Majorca: Puig Major, the highest mountain of the Balearic archipelago, and Serra des Teixos (Fig. 2). It grows in crevices of shady, almost vertical limestone cliffs on northern exposures, in a narrow altitudinal zone between 1180 and 1400 m. On the more exposed sites, the new species was mainly found growing together with several Balearic endemic taxa such as *Agrostis barceloi* L. Sáez & Rosselló, *Crepis triasii* (Cambess.) Nyman, *Galium crespianum* J. J. Rodr., *Galium balearicum* Briq., *Lonicera pyrenaica* subsp. *majoricensis* (Gand.) Gand., and along with more widely distributed species such as *Hieracium amplexicaule* L., *Potentilla caulescens* L., *Sesleria insularis* Sommier subsp. *insularis* and *Pimpinella tragium* L. In more sheltered gullies and rock-bases several temperate trees and shrubs (*Taxus baccata* L., *Ilex aquifolium* L., *Sorbus aria* (L.) Crantz, *Amelanchier ovalis* Medik., and hygrophilous ferns (*Cystopteris fragilis* (L.) Bernh. subsp. *fragilis*, *Polystichum aculeatum* (L.) Roth) were found associated.

**Table 2.** – Polymorphic sites for different studied species of *Cotoneaster* Medik. in the ITS-1 (positions 31 to 214) and ITS-2 (249-432) region of *Cotoneaster* accessions. the base with strongest signal in the electrophoretograms.

|                                                                                                      | 31 | 53   | 56   | 60   | 70   | 80   | 95 | 115  | 118 | 120 | 130  | 131 | 150  | 156  | 168 | 173  | 175  | 179  |
|------------------------------------------------------------------------------------------------------|----|------|------|------|------|------|----|------|-----|-----|------|-----|------|------|-----|------|------|------|
| <i>C. integerrimus</i> Medik. group<br>[ <i>C. pyrenaicus</i> Gand.], Spain:<br>Cuberes (BCB)        | C  | Y[C] | A    | G    | Y[C] | C    | C  | R[G] | C   | C   | Y[T] | T   | G    | Y    | C   | Y    | R[A] | Y    |
| <i>C. integerrimus</i> Medik. group<br>[ <i>C. pyrenaicus</i> Gand.], Spain:<br>Coma d Orient (BCB)  | C  | Y[C] | A    | G    | C    | C    | C  | R    | C   | C   | Y[T] | T   | R[G] | Y    | C   | Y    | A    | Y    |
| <i>C. integerrimus</i> Medik. group<br>[ <i>C. pyrenaicus</i> Gand.], Spain:<br>Teruel (VAL 94401)   | C  | C    | A    | G    | Y[C] | M    | C  | R    | C   | C   | Y    | T   | G    | Y[C] | C   | Y    | A    | Y    |
| <i>C. integerrimus</i> Medik. group<br>[ <i>C. pyrenaicus</i> Gand.], Spain:<br>Montseny (BCB)       | C  | Y[C] | A    | G    | C    | C    | C  | G    | C   | C   | Y    | T   | G    | C    | C   | Y    | R    | Y[C] |
| <i>C. integerrimus</i> Medik. group<br>[ <i>C. pyrenaicus</i> Gand.], Greece:<br>Olympos (BCB)       | C  | Y    | R[A] | G    | Y    | C    | C  | G    | C   | C   | Y    | T   | G    | Y    | C   | Y[C] | R    | C    |
| <i>C. integerrimus</i> Medik. group<br>[ <i>C. scandinavicus</i> B. Hylmö],<br>Sweden (VAL [138524]) | C  | C    | A    | G    | Y[C] | C    | C  | G    | C   | C   | Y    | T   | G    | Y[C] | C   | Y    | R    | Y[C] |
| <i>C. tomentosus</i> (Aiton) Lindl., Spain:<br>Cuenca (VAL 137454)                                   | C  | C    | A    | R    | T    | M[C] | C  | R    | C   | C   | T    | T   | G    | C    | C   | Y[C] | R    | Y[C] |
| <i>C. tomentosus</i> (Aiton) Lindl., Spain:<br>Cuberes (BCB)                                         | Y  | C    | A    | G    | T    | C    | C  | R    | M   | C   | T    | T   | R[G] | C    | C   | C    | R[G] | C    |
| <i>C. granatensis</i> Boiss., Spain:<br>Alacant (VAL [39843])                                        | T  | C    | T    | G    | T    | C    | C  | R[G] | A   | C   | T    | T   | G    | C    | G   | C    | G    | C    |
| <i>C. atlanticus</i> G. Klotz, Morocco:<br>Tizi n'Test (BCB)                                         | C  | C    | S    | R[A] | T    | C    | M  | R    | C   | M   | T    | Y   | R    | C    | C   | C    | G    | C    |
| <i>C. atlanticus</i> G. Klotz, Morocco:<br>Jbel Tissouka (BCB)                                       | C  | C    | C    | G    | T    | C    | C  | G    | C   | C   | T    | C   | G    | C    | C   | C    | G    | C    |
| <i>C. majoricensis</i> L. Sáez & Rosselló,<br>Spain: Balearic Islands, Mallorca (BCB)                | C  | C    | G    | G    | T    | C    | C  | R    | C   | C   | T    | C   | G    | Y    | C   | C    | G    | C    |

**Conservation assessment.** – To date, we have identified two populations of *Cotoneaster majoricensis*, on the Puig Major de Son Torrella and Serra des Teixos (both populations are separated by a distance of 3,9 km). The summit of the Puig Major has been severely altered in the past (RUBÍ & MALAGARRIGA, 1971). The altitude of the mountain was lowered about 15 m for the building of military installations, including a radar station. The concomitant consequence of the permanent anthropic colonization of the mountain was the drastic change or disappearance of many of the north-facing microhabitats at the highest altitudes. Currently, several factors determine the decline of these habitats and their biota, including over-grazing, and damage by climbing activities. The main threat is due to predation by the introduced herbivores (goats and sheeps), likely being responsible for low

local abundance and reduced colonization capacity of this narrow endemic species. In fact, our data indicate that natural recruitment is poor, since only five seedling plants were found in the period 2003-2009. Survival of *C. majoricensis* depends on intrinsic biological factors and stochastic events, as a consequence of its extremely small population size (BARRETT & KOHN, 1991; PRIMACK & ROS, 2002).

The application of IUCN (2001) methodology to evaluate the vulnerability of *C. majoricensis*, produced the following results. The distribution of the species is highly restricted, with extremely low area of occupancy (c. 980 m<sup>2</sup>). At present it is known to exist in 3 UTM 1 km<sup>2</sup> squares. The known populations of *C. majoricensis* are very small and only 94 individuals are known (29 of which in a reproductive state; Table 3). Decline of the population may be inferred by habitat quality

IUPAC ambiguity symbols are used to represent polymorphisms (W = A + T, Y = C + T, R = G + A, K = G + T, M = A + C, S = G + C). Superindices are used as to indicate

| 181 | 188 | 210  | 214 | 249 | 250 | 251  | 252 | 253  | 255 | 256 | 325 | 335 | 337  | 364  | 365 | 392 | 395  | 403  | 413 | 423 | 427 | 432 |
|-----|-----|------|-----|-----|-----|------|-----|------|-----|-----|-----|-----|------|------|-----|-----|------|------|-----|-----|-----|-----|
| G   | T   | K[T] | T   | –   | –   | S    | Y   | T    | –   | –   | G   | C   | G    | T    | G   | C   | Y[C] | C    | T   | A   | A   | T   |
| G   | T   | T    | T   | –   | –   | S    | Y   | K[T] | –   | –   | G   | C   | G    | T    | G   | C   | C    | C    | T   | A   | A   | T   |
| G   | T   | K    | T   | –   | –   | S    | Y   | K[T] | –   | –   | G   | C   | G    | T    | G   | C   | C    | C    | T   | A   | A   | T   |
| G   | T   | K    | T   | C   | C   | G    | Y   | K    | –   | –   | G   | C   | G    | T    | G   | C   | C    | C    | T   | A   | A   | T   |
| G   | T   | K    | T   | C   | C   | G    | Y   | K    | –   | –   | G   | C   | G    | T    | G   | C   | C    | C    | T   | A   | R   | T   |
| G   | T   | K    | T   | C   | C   | S[G] | Y   | K    | –   | –   | G   | C   | G    | T    | G   | C   | C    | C    | T   | A   | A   | T   |
| G   | C   | K    | T   | C   | T   | C    | C   | G    | G   | C   | G   | C   | G    | T    | G   | C   | C    | C    | T   | A   | A   | T   |
| K   | Y   | G    | T   | C   | T   | C    | Y   | G    | G   | C   | G   | C   | G    | T    | G   | A   | C    | Y[T] | K   | A   | A   | Y   |
| T   | C   | G    | T   | C   | T   | C    | T   | G    | G   | C   | G   | C   | G    | T    | G   | A   | C    | T    | G   | A   | A   | C   |
| G   | C   | G    | W   | C   | Y   | C    | M   | G    | G   | C   | R   | C   | G    | T    | G   | A   | C    | T    | T   | A   | A   | T   |
| G   | C   | G    | A   | C   | C   | C    | A   | G    | G   | C   | G   | C   | G    | C    | A   | C   | C    | T    | T   | G   | G   | C   |
| G   | T   | G    | A   | C   | C   | A    | G   | –    | G   | C   | G   | Y   | R[A] | Y[C] | G   | C   | Y[C] | Y[C] | T   | G   | G   | C   |

and we have also registered a decrease of reproductive individuals in Puig Major population (from 19 specimens in 2006 to 14 specimens in 2009). Therefore *C. majoricensis* should be included in the “Critically Endangered” category according to the following criteria and subcriteria: CR C2a(i), D (IUCN, 2001).

*Other specimens studied.* – **SPAIN. Balearic Islands, Majorca:** Puig Major de Son Torrella, 31SDE8206, shady vertical limestone cliffs, 16.VII.2002, *L. Sáez LS-5965* (BCB (herb. L. Sáez)); Puig Major de Son Torrella, 31SDE8206, 1350 m, 24.VII.2002, *L. G. Valle & L. Sáez LS-5975* (BCB (herb. L. Sáez)); Puig Major de Son Torrella, 31SDE8206, 1350 m, 24.V.2003, *L. G. Valle & L. Sáez LS-6106* (BCB (herb. L. Sáez)); Puig Major de Son Torrella, Es Bufador, 31SDE8207, 1300 m, vertical cliffs, 19.VII.2010, *L. Sáez LS-7230* ((BCB (herb. L. Sáez)); Majorca, Serra des Teixos, northern slope, Escorca, 31SDE8606, 1190 m, 13.VI.2006, *L. G. Valle & L. Sáez LS-6433* (BCB (herb. L. Sáez)).

**Table 3.** – Summary of data from 2009 survey.

| Locality                                 | Puig Major | Serra des Teixos |
|------------------------------------------|------------|------------------|
| <b>Vegetative individuals</b>            | 47         | 18               |
| <b>Reproductive individuals</b>          | 14         | 15               |
| <b>Area of occupancy [m<sup>2</sup>]</b> | 30         | 21               |



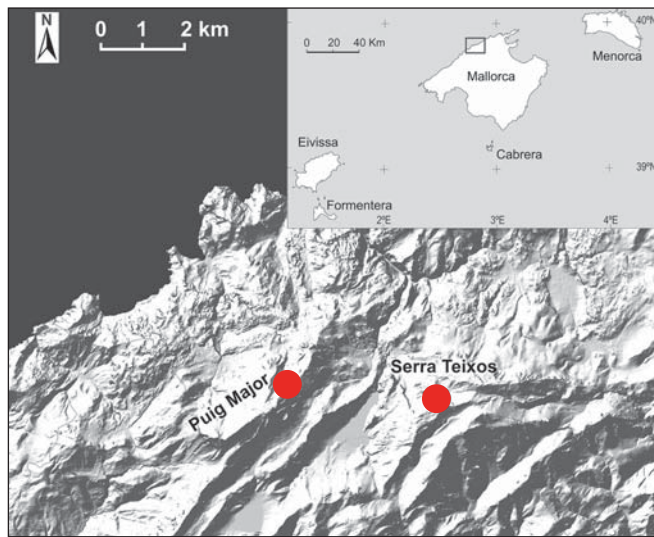


Fig. 2. – Distribution map of *Cotoneaster majoricensis* L. Sáez & Rosselló.

## Discussion

According to Hylmö & Fryer (1999), morphological features such as erect petals at anthesis, longer period of inflorescence opening in sequence, grouping of usually 1-10(-14) flowers per inflorescence, and deciduous leaves, all suggest that *C. majoricensis* should be included within subgenus *Cotoneaster* (= sect. *Orthopetalum* Koehne). The only feature that might relate the new species to subgenus *Chaenopetalum* (= sect. *Chaenopetalum* Koehne) are the entirely white petals. At present, the taxonomy of *Cotoneaster* is difficult and unclear, and this genus is a remarkable case of several contrasting taxonomic proposals that either favor lumping or splitting concepts (BROWICZ, 1968, 1972; HYLMÖ & FRYER, 1999; LINGDI & BRACH, 2003; FRYER & HYLMÖ, 2009; SENNIKOV, 2009; DICKORÉ & KASPEREK, 2010).

Morphological data suggest that *C. majoricensis* should be recognized since it is morphologically distinct and geographically separated (cf. Table 1). Reduced pollen fertility (close to 50%) strongly suggests that the new species may display apomictic reproduction. Nuclear ribosomal ITS sequences, show intragenomic polymorphisms, supporting its polyploidy and a likely hybrid origin.

The recognition and treatment of apomictic lineages is a controversial issue in plant systematics. Lumping versus splitting treatments can be found in many apomictic complexes (e.g., *Limonium* Mill., *Rubus* L., *Hieracium* L., *Taraxacum* L., and *Alchemilla* L.) while species delimitation problems can be circumvented by the use of ancillary taxonomic categories such

as *microspecies* or *aggregate*. Until the nature of polymorphisms exhibited by sexual or apogamous entities of *Cotoneaster*, and the evolutionary patterns sustaining them could be fully understood, a pragmatic approach to manage this diversity should be recommended. Indigenous *Cotoneaster* diversity in Europe is not an acute problem and it was not considered when guidelines for the taxonomic treatment of agamic complexes were debated (LÖVE, 1961; VALENTINE, 1961).

In accordance with the general practice in *Cotoneaster* (e.g. HYLMÖ & FRYER, 1999; FRYER & HYLMÖ, 2009; SENNIKOV, 2009), and on account of more general considerations, we refrain from using intraspecific categories in apomictic lineages and favor the microspecies concept in order to accommodate discrete entities in wider species complexes. Drawing limitations with regard to contents is, however, difficult. Batologists (taxonomists concerned with the extensively micro-differentiated genus *Rubus* in Europe), for instance, have agreed that not all stabilized apomictic biotypes should be formally recognized, but only those more widely distributed (i.e., exceeding an area radius of 50 km) (WEBER, 1996). While this concept seems practical for continental areas, its application to island taxa seems unrealistic, and distribution alone does apparently not help to differentiate the processes that underlie stenochory. Consequently, it would be biologically (and taxonomically) meaningful to know whether the present narrow range of *Cotoneaster majoricensis* derived from a former wider distribution, or if it is related to a likely recent colonization or origin. Unfortunately, the close morphology exhibited by most of the members from section *Cotoneaster* does not allow the analysis of characters showing continuous variation in a phylogenetic (cladistic) context. On theoretical grounds, molecular analysis could bypass this drawback and offer compelling hypotheses on the subject. However, the use of ribosomal ITS sequences did not appear very promising, since a general lack of complete concerted evolution of this multigene family is suggestive of extensive reticular evolution. This also suggests that both, the delimitation of specific entities and recovery of phylogenetic signals in apomict *Cotoneaster* are a great challenge for forthcoming investigations.

Since no other wild *Cotoneaster* species currently occurs on the Balearic Islands it seems most parsimonious to assume that *C. majoricensis* has evolved through somatic mutations from a polyploid ancestor that has colonized the archipelago in the past, rather than to infer «in situ» hybridization from diploid ancestors that subsequently went extinct. However, this last hypothesis should not be completely ruled out since palynological studies have documented the extinction of deciduous trees (*Alnus* Mill., *Fagus* L., *Corylus* L., *Quercus* L.) and a rarefaction of mesophilous elements (e.g. *Buxus* L.) from the Eastern Balearics due to climatic and/or anthropogenic changes during the last 5000 years BP (PÉREZ-OBÍOL, 2007).

## Acknowledgements

We thank J. Vigo for his advice with the latin diagnosis. Our colleagues G. Bosch, B. Company, M. A. Conesa, V. Forteza, J. L. Gradaille, X. Manzano, E. Moragues, M. Mus, C. Roquet and M. Vicens helped with the field work, and A. Molins with the molecular work. We are also indebted to W. Bernhard Dickoré for his suggestions. This research has been partly funded by the CGL2007-60550/BOS project.

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**Appendix 1.** – Additional herbarium material examined.***Cotoneaster atlanticus*** G. Klotz

**ALGERIA:** pente nord du Djebel Toumour, près Batna, 1900 m, 4.VII.1853, *R. Balansa* 1016 (G).

**MOROCCO:** Moyen Atlas, Ari Hebbri, 2000-2100 m, 25.VI.1923, *R. Maire s.n.* (G); Moyen Atlas, Aïn Leuh, 1550 m, 23.V.1924, *Jahandiez* 415 (G); In Atlantis medii montibus prope Immouzer, 1900 m, 29.VI.1927, *R. Maire s.n.* (G); Marrakech, route du Oukaïmeden, 2000-2300 m, 3.VI.1980, *A. Charpin & al. s.n.* (G); High Atlas, near Tizi n'Test, 2200 m, on limestone rocks, 24.VII.2004, *L. Sáez* 6190 (BCB (herb. L. Sáez)); Rif Mountains, Jbel Tissouka, 1800 m, above Xauen, on shady limestone rocks, 1.VII.2007, *M. Alarcón, J. Aldasoro, J. Molero & L. Sáez s.n.* (BCB (herb. L. Sáez)).

***Cotoneaster granatensis*** Boiss.

**SPAIN:** In vallibus Sierra Nevada, 5.000-6.000 m, VII.1837, *Boissier s.n.* (G, type material); Sierra de María, 12.VII.1845, *M. Willkomm s.n.* (G); Sierra Nevada, région alpine, au barranco de Benacalza, 4.VII.1851, *E. Bourgeau* 1167 (G); Trevenque, 1856, *Del Campo s.n.* (G); Almería, Sierra Nevada, Doctor, 1500 m, 2.VII.1981, *A. Segura Zubizarreta* 20833 (G [213535]); Alicante, Benifato (la Marina Baixa), Forata 30SYH3881, 1400 m, 25.VI.1998, *J. Guemes, J. Riera & E. Estrelles s.n.* (VAL [39843]).

***Cotoneaster pyrenaicus*** Gand. [*C. integerrimus* Medik. group]

**FRANCE:** Hautes Pyrénées, Cauterets, 1700-1900 m, 28.VII.1889, *J. J. Neyrant s.n.* (MPU); Ariège, Haut Laurenti, versant E du port de Pailères, 1900-1972 m, 16.VIII.1909, *J. J. Neyrant s.n.* (MPU); Pyrénées Orientales, col de la Perche, vers 1600 m sur les versant Eyne, 3.IX.1910, *J. J. Neyrant s.n.* (MPU); Puy de Dôme, sud, vers 1200 m, 30.V.1987, *A. Charpin s.n.* (G [126771]).

**CZECH REPUBLIC:** Moravica centralis, Brno, in declivibus fruticosus non procul ad urbe Brno, 300 m, 13.V.1925, *J. Suza s.n.* (BC [85844]).

**GREECE:** Macedona occ. eparhia Kastoria montis Kato Arena, 2000-2075 m, 6.VIII.1977, *W. Greuter s.n.* (G [271684]); Florinis, Mt. Boutsis, 1450-1550 m, 10.V.1989, *A. Strid & al.* 29271 (G [457181]); Grevenon, Voïou, Mt. Vourinos, 1500 m, 1.VI.2001, *A. Strid & al.* 52632 (G); Mount Olympos, 1600 m, 15.VII.2007, *C. Roquet & al. s.n.* (BCB (herb. L. Sáez)).

**ROMANIE:** Transsilvania, Hunedoara, montis Cetate proper oppidum Deva, 350 m, 1920, *M. Péterfi s.n.* (G).

**SPAIN:** [Lleida province] supra estany de Cavallers pr. Boí, in rupestribus, 1800 m, 22.VII.1944, *Font Quer s.n.* (BC [94946]); Cara N de la sierra de las Cutas, hacia la fuente del Abé, 30TYN4524, 1800 m, 26.VIII.1970, *P. Montserrat & L. Villar s.n.* (G, VAL [21685]); Vall d'Aran, cap de Baqueria, 2.480 m, 6.VII.1973, *J. Vigo & R. Masalles s.n.* (BC [618574]); Teruel, Cerrada de la Balsa, Valdelinares, 18.VII.1983, *Mateo & Aguilera s.n.* (VAL [1256]); Lérida, lago San Mauricio, 1800 m 21.VII.1983, *O. Bolòs, G. Mateo & al.* 83/828 (VAL [20552], sub *C. nebrodensis*); La Rioja, Viguera, sierra de la Laguna, monte Cerroyera, roquederos, 1350-1380 m, 30TWM3780, 15.V.1994, *B. Fernández de Betoño & J. A. Alejandre s.n.* (VAL [94913]); Zaragoza, Tarazona, macizo del Moncayo, circo de San Miguel, 2010-2030 m, 3.IX.1994, *M. L. Gil & J. A. Alejandre s.n.* (VAL [94911]); Lleida, massís de Boumort, obaga de la coma d'Orient, 31TCG4678, 1650 m, limestone soil, 21.VII.2002, *J. Molero & L. Sáez* 5999 (BCB (herb. L. Sáez)); Lleida province, massís de Boumort, Cuberes, 31TCG4782, 1480 m, limestone soil, 21.VII.2002, *J. Molero & L. Sáez* 6001 (BCB (herb. L. Sáez)); massís de Montseny, vessant N del Turó de l'Home, 31TDG52, 1450 m, siliceous rocks, 24.VI.2006, *L. G. Valle & L. Sáez* 6447 (BCB (herb. L. Sáez)); Lleida province: Llan de Mollet, c. Freixe, CG5090, 1500 m, siliceous rocks, 9.IX.2007, *L. G. Valle & L. Sáez* LS-6794 (BCB (herb. L. Sáez)).

**SWITZERLAND:** Col de Porte, 1560 m, 16.VIII.1969, *G. Guérat* 59a (G); Läggeren, au-dessus de Sahar tenfels, 550 m, 21.V.1978, *D. Aeschmann* 622 (G); Valais, Egga, 1230 m, 2.VI.1982, *J. P. Mermillot & C. Béguin s.n.* (G).

***Cotoneaster rabouensis*** K. E. Flink & al.

**FRANCE:** cultivé à partir de graines récoltes en France, Dauphiné, Bois de Rabou près de Gap, 18.IX.1964, *B. Hylmö* 1245 (LD [05/0250427]).

***Cotoneaster scandinavicus*** B. Hylmö [*C. integerrimus* Medik. group]

**SWEDEN:** Tagen, 1.V.1914, *E. Johanson s.n.* (VAL [138523]); Upplandia, Singö, Ramsan 26.VI.1931, *G. A. Ringselle s.n.* (VAL [138524]).

***Cotoneaster tomentosus*** (Aiton) Lindl.

**AUSTRIA:** Prope St. Pankvaz, 10.VI.1881, *F. Oberleitner* 1092 (MPU).

**FRANCE:** Bois du Mont Ventoux, 24.VI.1877, *A. Jordan s.n.* (MPU); Pariset et St-Nizier, près Grenoble, bois, rochers, 900-1100 m, IX.1882, *Charbonnel-Salle & al. s.n.* (MPU); Hautes Alpes, bois du Devez-de Rabou, 1500 m, 22.VIII.1924, *Faure s.n.* (MPU); Haute Savoie, bords chemin de la chapelle des Evabx, 640 m, 5.VI.1970, *A. Charpin s.n.* (G); Haute Savoie, Le Salève, 500 m, 8.VI.1984, *C. Defferard* 4845 (G).

**GREECE:** Mt. Olympos, E side, 740-780 m, 1974, *A. Strid* & *J. S. Andersen s.n.* (G [274414]); Serron, Sintikis, Mt. Belles (Kerkini) NE of Ano poroia, 1650-1800 m, 2.VIII.1979, *Strid* & *Papanicolau 16064* (G); Mt. Chelmos, N part, near base of Styx waterfall (Idata Stigos), 1750-1800 m, 6.IX.1997, *A. Strid 44840* (G); Mt. Radomir, al S de Belasitsa, 1750 m, 8.VII.2003, *J. González s.n.* (BCB (herb. L. Sáez)).

**SPAIN:** Barcelona, Montserrat, Pla dels Ocells, 1100 m, 6.VII.1950, *A. Bolòs s.n.* (BC [111836]); Tarragona, massís de la Guàrdia, pr. oppidum Prades, 1080 m, 24.V.1953, *A. Bolòs* & *O. Bolòs s.n.* (BC [140322]); Castelló, Vistabella del Maestrat, 1150 m, roques calcàries, 23.V.1963, *J. Vigo s.n.* (BC [372907]); Xodos, Alt Maestrat, 6.VII.1963, *J. Vigo s.n.* (BC [261354]); Vall de Ribes, vers el Roc del Corb, 1500 m, roques calcàries, 20.VIII.1968, *J. Vigo* & *A. Anglada s.n.* (BC [605509]); Tarragona, Montsant d'Albarca hacia la Corbatera, 8.VI.1974, *J. Molero s.n.* (BC [614971]); Huesca, llanos de Lizarra, 30TXN9437, 22.VI.1975, *P. Montserrat s.n.* (G [206725]); Teruel, Mirambel, v.1981, *A. Aguilera s.n.* (VAL [20643]); Fenales de Nocito, YM3187, 1400 m, 3.VII.1982, *P. Montserrat* & *J. M. Montserrat s.n.* (BC [672021]); Valencia, La Puebla de San Miguel, XK63, 1200 m, 18.VI.1985, *R. Figuerola* & *G. Mateo s.n.* (VAL [123439]); Valencia, La Puebla de San Miguel, XK63, 1200 m, 19.VI.1985, *R. Figuerola* & *G. Mateo s.n.* (VAL [20501]); Valencia, Els Serrans, La Yesa, 30SXX71, 1000 m, 27.VII.1991, *J. Güemes, X. Riera* & *C. Fabregat s.n.* (VAL [22646]); Cuenca, Serranía de Cuenca, umbría del monte San Felipe, escarpes calizos, WK9673, 1800 m, 19.VI.1999, *G. Mateo* & *Herrández Viadel 13066-GM* (VAL [107812]); Lleida, massís de Boumort, Cuberes, 31TCG4782, 1480 m, limestone soil, 21.VII.2002, *J. Molero* & *L. Sáez 6000* (BCB (herb. L. Sáez)).

**SWITZERLAND:** Vaud, Bois Badis, 1000 m, 21.VI.1936, *O. Meylan* (G); Valais, Llis, 700 m, 7.VI.1984, *Theurillat 4018* (G [295420]).