

Delphinium fissum subsp. *sordidum* (Ranunculaceae) in Portugal: distribution and conservation status

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Abstract

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Delphinium fissum subsp. *sordidum* has been found in calcareous and schistaceous slopes on the Mines of Santo Adrião, Trás-os-Montes region—close to Bragança, northeastern Portugal—. It is the first record of this taxon in Portugal and the westernmost locality of its general distribution area. Its conservation status, according to the most recent IUCN categories and criteria, should be “Critically Endangered” in Portugal.

Keywords: Critically Endangered, *Delphinium*, IUCN, Mines of Santo Adrião, Ranunculaceae, Trás-os-Montes.

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INTRODUCTION

The genus *Delphinium* L. —Ranunculaceae— is distributed throughout the temperate and cold zones of the northern hemisphere. Its primary centre of differentiation ranges from the eastern Himalaya to the southwestern China, which includes the highest number of species within—about 150 species— (Blanché, 1990; Jabbour & Renner, 2012), as well as the most primitive perennial species as pointed out by Wang (1962) and Malyutin (1973). The larger sets of species, all perennial, are found in Asia and North America. Only a few annual, biennial or perennial species, with Mediterranean affinities, occur in the Iberian Peninsula. According to Blanché & Molero (1986), 11 taxa—species and subspecies— of *Delphinium* occur in Spain. More recently, the following 2 taxa have been reported for Spain: *D. mansanetianum* Pitarch, Peris & Santis (Pitarch García, 2002) and *D. pentagynum* subsp. *formenteranum* N. Torres, L. Sáez, Rosselló & C. Blanché (Torres & al., 2000). Likewise, *D. fissum* subsp. *fontqueri* Ascaso & Pedrol was described by Ascaso & Pedrol (1991), but later cytogenetic data (Simon & al., 1995) revealed that it is *D. bolosii*

Resumen

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Se ha encontrado *Delphinium fissum* subsp. *sordidum* en laderas calcáreas y esquistosas en las Minas de Santo Adrião, en la región de Trás-os-Montes—cerca de Bragança, en el noreste de Portugal—. Es la primera cita de este taxon para Portugal y la localidad más occidental de su área general de distribución. Su estado de conservación, según las categorías y criterios de la UICN más recientes, debería ser de “En Peligro Crítico” en Portugal.

Palabras clave: *Delphinium*, En Peligro Crítico, Minas de Santo Adrião, Ranunculaceae, Trás-os-Montes, UICN.

C. Blanché & Molero. In Portugal, 6 taxa—species and subspecies— occur, and only *D. pentagynum* Lam. is perennial (cf. Sequeira & al., 2011).

Delphinium fissum subsp. *sordidum* (Cuatrec.) Amich, E. Rico & J. Sánchez (*D. sordidum* Cuatrec., basion.) belongs to a group of species and subspecies with oriental origin—*D.* (subgen. *Oligophyllon* Dimitrova) ser. *Fissa* B. Pawl.—, which ranges throughout the Mediterranean region, being the Iberian Peninsula one of the extremes of its area of distribution (Blanché, 1991). This taxon is close to *D. fissum* Waldst. & Kit. subsp. *fissum*—southeastern France— and *D. bolosii*—northeastern Spain, with only 6 known populations up to now (cf. López-Pujol & al., 2014)—. The genetic diversity studies carried out by Orellana & al. (2007) reinforce the hypothesis of Blanché (1991) about an expansion of *D. fissum* subsp. *fissum*—or an ancestor— from the Alps to the Iberian Peninsula.

Delphinium fissum subsp. *sordidum* was until now considered as an endemic taxon of Spain (Blanché & Molero, 1986), where it is catalogued under the category of “Endangered”—EN B2ab(v)c(iv);C2b—in

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the *Lista roja 2008 de la flora vascular española* and its *Addendum* (Bañares & al., 2008, 2010), respectively. Its occurrence in Portugal increases its distribution range to the western Iberian Peninsula; its implications, from a phytogeographical and conservational point of view, will be discussed below.

MATERIAL AND METHODS

The specimens of *D. fissum* subsp. *sordidum* were collected during field trips in the municipality of Caçarelhos —Vimioso, Bragança, northeastern Portugal— on 14 June 2010 and 14 June 2016. For the identification of the species, morphological characteristics were checked and compared to those given by Blanché & Molero (1986) —perennial species, with linear-lanceolate leaf lobes, dense inflorescences, and densely pubescent flowers usually closed—; all specimens were *D. fissum* subsp. *sordidum*. The reference material was deposited in the herbaria of the University of Salamanca —SALA— and the Royal Botanic Garden of Madrid —MA.

We carried out a direct counting of reproductive individuals in the population. Nonetheless, we established a counting error of 15% because there are small forested areas at higher elevations where it is difficult to distinguish individual plants since they grow up in clumps and inaccessible places.

The International Union for Conservation of Nature assessment follows the latest guidelines of the IUCN (2017) and, specifically the IUCN regional guidelines (IUCN, 2012). Species conservation status was evaluated using B, C, and D criteria. The area of occupancy —AOO— was calculated with ArcGIS 10.3.1 —ESRI, Redlands, California, USA—, creating a polygon which included the population area.

Herbarium specimens

PORTUGAL. **Trás-os-Montes:** Bragança, Vimioso, Caçarelhos, Minas de Santo Adrião, 29TQG1000, contact between schist and limestones, holm-oak forest, shrubs and grassland, 538 m a.s.l. *R. Morales & al. RM 2345*, 14 June 2010, (MA 864924); *ibidem*, 29TQG1000, calcareous and schist slopes, 590 m a.s.l., *F. Amich & R. Ramírez-Rodríguez s.n.*, 14 June 2016 (SALA 158950).

RESULTS

Delphinium fissum subsp. *sordidum* has been found on the Mines of Santo Adrião, in the region of Trás-os-Montes (Fig. 1). The specimens collected on 14 June 2010 and 14 June 2016 were in bloom —early stage— (Fig. 2a). On 22 July 2016, the population was visited again, and fructifying specimens were seen and collected (Fig. 2b). The blooming period seems to be quite short, since it lasts about 4 weeks —from mid-June to mid-July.

The taxon is found on a very small area close to the Mines of Santo Adrião, which corresponds to the largest calcareous area in the northern Portugal. It lives in a holm-oak forest —*Quercus ilex* subsp. *ballota* (Desf.) Samp.— in a good state of conservation, and is mainly found in bottoms and south-facing slopes. On the slate and granites zones that surround the limestone area, an extensive cork oak forest —*Quercus suber* L.— grows. *Delphinium fissum* subsp. *sordidum* is located on slopes orientated to the southwest, within cleared holm oak forests, at an altitude of 590 m a.s.l., occupying an approximate area of 735 m²—0.07 ha; 0.0007 km²— where 353 reproductive individuals were counted, with a rough error of the 15% in the direct counting. With *D. fissum* subsp. *sordidum* the following species could also be seen: *Quercus ilex* subsp. *ballota*, *Phillyrea*

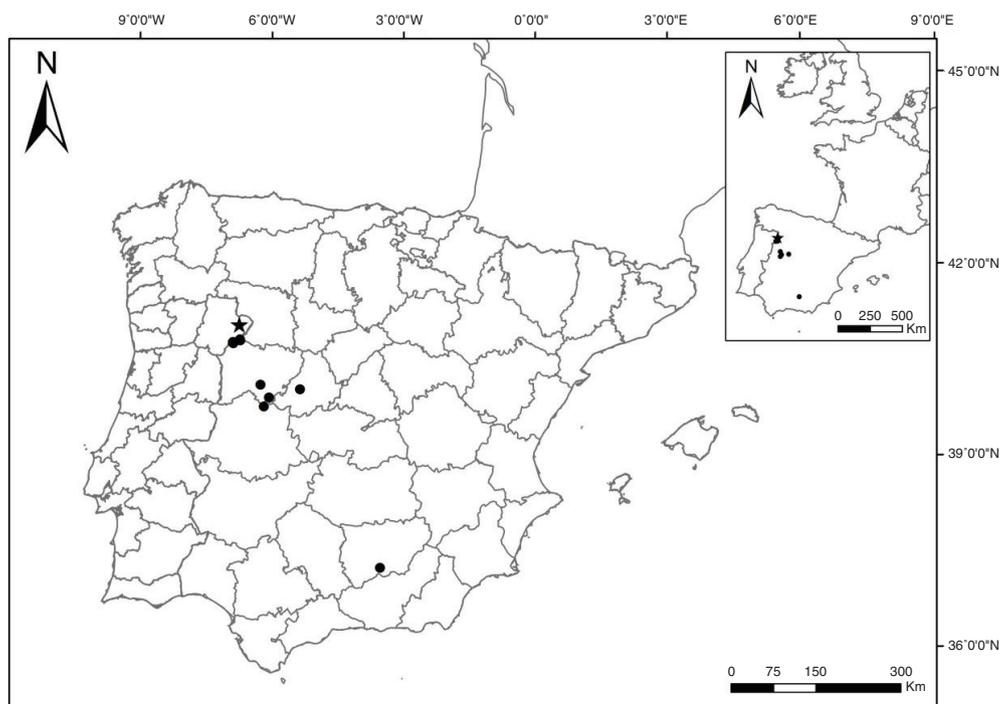


Fig. 1. Distribution of *Delphinium fissum* subsp. *sordidum* in the Iberian Peninsula and location of the first citation in Portugal —star symbol.



Fig. 2. *Delphinium fissum* subsp. *sordidum*: a, inflorescence; b, infructescence (Mines of Santo Adrião; photos 14 Jun 2016).

angustifolia L., *Cytisus scoparius* (L.) Link, *Ruscus aculeatus* L., *Thymus mastichina* (L.) L., *Asparagus acutifolius* L., *Jasminum fruticans* L., *Vincetoxicum nigrum* (L.) Moench, *Ruta montana* (L.) L., *Melica ciliata* L., *Tamus communis* L., *Galium glaucum* L., *Allium sphaerocephalon* L., *Phagnalon saxatile* (L.) Cass., *Sedum sediforme* (Jacq.) Pau, *Euphorbia falcata* L., *Reseda barrelieri* Bertol. ex Müll. Arg., *Ornithogalum pyrenaicum* L., *Briza maxima* L., *Hypericum perforatum* L., and *Helichrysum stoechas* (L.) Moench.

Although the Mines of Santo Adrião are integrated into Natura 2000 network as a Site of Community Importance—SCI— and Special Protection Areas for birds—SPA—, the area is nonetheless subject to different threats, v.gr., fire and, possibly, collecting due to its showy flowers. Due to its restricted area of occupancy and extent of occurrence, the small number of mature individuals, which might have inter-annual variation due to environmental fluctuations and its unique biology as occurs in other studied populations and the identified threats that it faces, *D. fissum* subsp. *sordidum* is to be considered “Critically Endangered”—CR B1ab(v)c(iv) + 2ab(v)c(iv);C2a(i,ii)b;D2— in Portugal.

Applying the regional criteria, the population is found approximately 30 km away from the closest population, and this does not make possible the genetic flow, pollination or seed dispersal events. Thus, the category was not moved up or down. Likewise, the current status of *D. fissum* subsp. *sordidum* in the Iberian Peninsula does not vary in relation to the previously given for Spain—EN B2ab(v)c(iv);C2b.

DISCUSSION

Delphinium ser. *Fissa* is a group with oriental affinities. Several migration patterns can be recognized in the Iberian Peninsula according to Bocquet & al. (1978) during the

Messinian period. *Delphinium bolosii* may have appeared by some biogeographical barrier—v.gr., Ebro River, allopatric speciation— or by variation in chromosomes—sympatric speciation— (Orellana & al., 2007). Some populations of *D. fissum* subsp. *fissum* could have continued expanding to the western Peninsula and become differentiated as *D. fissum* subsp. *sordidum*. The Portuguese population increases its current distribution range to the western Iberian Peninsula (Fig. 1).

With *D. fissum* subsp. *sordidum*, the number of recognized taxa—species and subspecies— of the genus in Portugal increases to 7, with only 2 perennial taxa, *D. pentagynum* and *D. fissum* subsp. *sordidum*. In Spain, the main habitat of the taxon is constituted by formations of *Castanea sativa* Mill. —Hervás, Cáceres province— and *Quercus pyrenaica* Willd. —Linares de Riofrío, Salamanca province—, mainly on acidic soils. In the isolated population of Sierra Mágina—Jaén province—, it lives in communities dominated by thorny and spiky deciduous shrubs. Likewise, in Portugal, the population appears on the calcareous soils of a holm-oak forest.

The new population size, 353 reproductive individuals, implies that demographic stochasticity may not be relevant— $n > 50$ — (Menges, 1991; Lande, 1998). Environmental stochasticity should be taken into account, especially in studies related to pollination biology and reproductive success, because the closest population is approximately 30 km away, implying that the new population is, in fact, isolated. According to Ellstrand (1992), “most of the xenogamous threatened species that are separated by more than 10 km are not linked genetically through pollen flow”. On the other hand, the area has a high risk of being affected by wild fires, which might reduce the population size and deteriorate the habitat

quality, creating functional barriers that could limit the availability of the pollinators that ensure outcrossing (Pisanu & al., 2009).

The migration pattern of *D. series Fissa*, together with the small size of the populations, explain the low genetic diversity of the taxon, which can be considered depauperated (Orellana & al., 2007). It would be advisable to clarify the taxonomy of the Iberian populations of this series —*D. bolosii*, *D. mansanetianum*, and *D. fissum* subsp. *sordidum*— using ETS/ITS markers (López-Pujol & al., 2014).

Plant species survival can also be affected by anthropogenic threats. The collection of plants, especially of the remarkable or rare species, is a potential threat for all them. However, botanists have generally been careful with collecting activities, and these botanical tasks have had very positive results for species conservation, providing timely and accurate information (Aedo & al., 2015). Moreover, we have not found evidences of herbivores, but we have observed it in other populations —v.gr., Linares de Riofrío and Sierra Mágina—. Fire is the main threat to consider, because it occurs frequently in Mediterranean ecosystems. For instance, in Villarino de los Aires —Salamanca province, Spain—, we have evidences that fire affected negatively the population during the summer of 2006 (Ramírez-Rodríguez & al., unpubl.). We have not observed that an increase of the weed had a negative effect on recruitment. On the contrary, the low recruitment of this species can be explained by its low survival rate of seedlings and samplings (Ramírez-Rodríguez & al., unpubl.).

Habitat fragmentation has been shown as a critical factor for the loss of plant diversity, since it influences movement and dispersal of organisms, gene flow rates, and invasion by exotic plants, among many other factors (Heywood & Iriondo, 2003). Considering that it represents the only population currently known in Portugal, and its threat category is high, we propose to carry out intensive searches in the limestone environment of the Mines of Santo Adrião and the annual monitoring of the population, to make germination studies and apply conservation measures to avoid its extinction. We believe that a detailed study of the biology of *D. fissum* subsp. *sordidum* is necessary in order to implement a recovery plan in Portugal, as well as for the populations of Castile and Leon (Ramírez-Rodríguez & Amich, 2014). Likewise, it is interesting to continue the fieldwork directed to find new populations in the Iberian Peninsula.

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