ARTICLES

Mediterranean Botany
ISSNe 2603-9109

EDICIONES COMPLUTENSE

http://dx.doi.org/10.5209/MBOT.60080

New data on the southern Iberian serpentinophyte flora (Andalusia, Spain)

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Received: 18 September 2017 / Accepted: 20 April 2018 / Published online: 29 june 2018

Abstract. This work updates the existing list of obligate endemic serpentinophytes of the southern Iberian Peninsula. Serpentine ecosystems are developed on ultramafic outcrops which, although rare, have a worldwide distribution. The highly evolved and specialized flora that manages to inhabit these harsh ecosystems includes a very specialized and highly evolved group of plants known as serpentinophytes. Serpentinophytes are linked exclusively or almost exclusively to serpentine ecosystems. The existing list of obligate serpentinophytes (obligate endemics) which exist in the serpentine ecosystems of the southern Iberian Peninsula (Spain) consists of 22 taxa. New fieldwork has been done resulting in the description of new soil endemics and the discovery of new populations of this specialized flora. Consequently, bibliographical sources, databases such as the Global Biodiversity Information Facility (GBIF), and existing herbarium sheets have been revised. *Crepis bermejana* and *Galatella malacitana* have been added to the list and are proposed to be evaluated as threatened. *Teucrium reverchonii* has been excluded from the list. *Euphorbia flavicoma* subsp. *bermejense* and *Armeria villosa* subsp. *serpentinicola* required changes in nomenclature. These nomenclatural changes imply changes in population allocations. The revised list is composed of 23 obligate serpentinophyte taxa. Future conservation measures may include a complete Iberian (including Portugal) serpentinophytes checklist and corresponding revisions of States' legislation and Red Lists.
Keywords: Serpentinophytes; Peridotites; Sierras Bermejas; Iberian Peninsula; Conservation.

Novedades sobre serpentinófitos sud-ibéricos (Andalucía, España)

Resumen. Los ecosistemas serpentínicos se desarrollan sobre afloramientos ultramáficos y constituyen una rareza a nivel mundial. La flora que consigue habitar estos ecosistemas incluye un grupo de plantas muy especializado y evolucionado denominadas serpentinófitos, ligados exclusivamente, o casi, a ellos. El primer listado de serpentinófitos obligados (endémicos) de los ecosistemas serpentínicos del sur de la Península Ibérica (España) estaba compuesto por 22 taxa. Con este trabajo se pretende actualizar dicho listado, ya que desde entonces nuevos edafismos han sido descritos y nuevas poblaciones han sido descubiertas. Para ello se han consultado fuentes bibliográficas, bases de datos, fundamentalmente GBIF, y pliegos de herbario, así como se han hecho trabajos de campo. Como principal resultado se han añadido al listado *Crepis bermejana* y *Galatella malacitana*, propuestas como amenazadas y para ser evaluadas. *Teucrium reverchonii* ha sido excluido. *Euphorbia flavicoma* subsp. *bermejense* y *Armeria villosa* subsp. *serpentinicola* presentan cambios nomenclaturales que han implicado cambios en asignación de poblaciones. La lista actual queda compuesta por 23 serpentinófitos obligados.
Palabras clave: Serpentinófitos; Peridotitas; Sierras Bermejas; Península Ibérica; Conservación.

Introduction

Serpentine ecosystems are centres for plant endemism that, due to their island configurations and their special substrates (peridotites, ultramafic rocks), have generated a considerable number of endemic species (Anacker, 2014), linked to some degree to certain substrates, called serpentinophytes (Pérez Latorre & *al*., 2013).

Ultramafic outcrops are distributed worldwide including the Mediterranean region (Brooks, 1987). Within the Mediterranean region lies the southern Iberian Peninsula, whose most recent checklist of serpentinophytes dates from 2013 (Pérez-Latorre & *al*., 2013). The 2013 list established three categories of serpentinophyte: obligate serpentinophyte (22 taxa), preferential serpentinophyte (two taxa) and sub-serpentinophyte (three taxa). Since then, new taxa have been described and new populations of serpentinophytes have been located, which require an update of the list of such plants. Maintaining an up-to-date list of the taxa linked to serpentine substrates, including data on their abundance, distribution and threat status is critical for plant conservation in these Spanish ecosystems.

The main objectives of this study are:

1. Update the former list of obligate serpentinophytes in the southern area of the Iberian Peninsula, solving taxonomic and chorological issues.
2. Propose an initial evaluation of the degree of threat of newly described serpentinophytes.

Study area and Methods

The ultramafic outcrops which comprise the study area are located in Andalusia (Spain; Figure 1) and primarily correspond with those in the provinces of Malaga (Sierras Bermejas in a broad sense), Granada (Pico del Almirez) and Almería (Lubrín) as described in Pérez Latorre &

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al. (2013). In this work, the Seville outcrop (Guillena-El Ronquillo) and other minor outcrops are added, which are found in the middle areas of the Sierra Nevada and of the Sierra de los Filabres (Granada-Almeria; Geological and Mining Institute of Spain – IGME, 1978). The largest outcrop is located in the province of Malaga and is divided into four main outcrops: Bermeja (Sierras Bermeja, Palmitera, Real and Parda), Alpujata (Sierras Alpujata and Mijas), Aguas (Sierra de Aguas-La Robla) and Guadalhorce Valley (Sierra Mota, Sierra Gorda and Sierra de Cártama).

Phytogeographically, these outcrops are in large measure included in the Baetic province of the Western Mediterranean subregion in the following sectors: a/ Bermejense, with the Sierras Bermeja, Palmitera, Real, Alpujata and Mijas included in the Bermejense subsector and Sierra de Aguas, La Robla and Alozaina in the Carratracense subsector; b/ Malacitano-Axarquiense, with the outcrops of the Guadalhorce Valley and c/ Nevadense, including those of Cerro del Almirez and Lubrín. The outcrop located in Guillena-El Ronquillo is included in the Luso-Extremadurense province (Pérez-Latorre & Cabezudo, 2002; Rivas-Martínez, 2007).

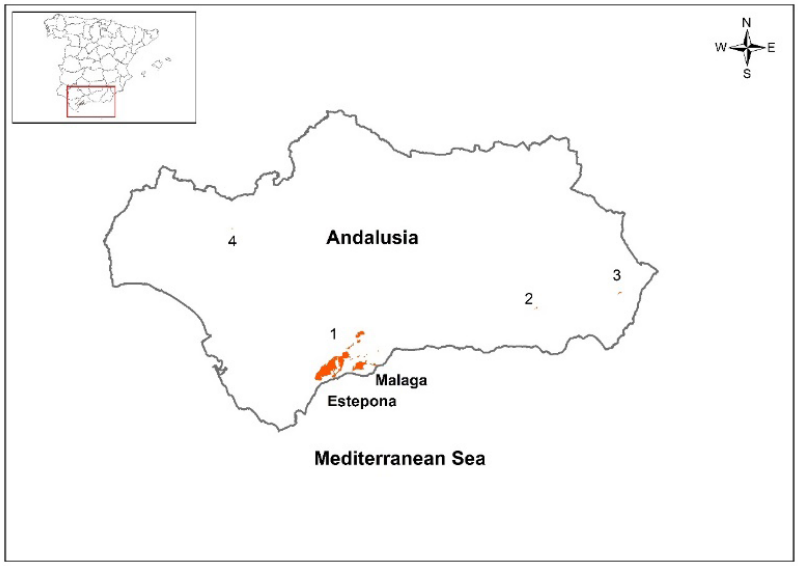

Figure 1. Ultramafic outcrops in the southern Iberian Peninsula (Andalusia) and their corresponding areas. 1: Sierras Bermejas (Malaga, 434.5 km^2). 2: Pico del Almirez (Sierra Nevada, Granada, 3 km^2). 3: Lubrín (Almeria, 3 km^2). 4: El Ronquillo (Seville, 1 km^2).

For this work, we studied the obligate serpentinophytes (Pérez-Latorre & *al*., 2013), which are those serpentinophytes whose entire populations inhabit serpentines exclusively. The identification of serpentinophytes was obtained according to the criteria specified in Pérez-Latorre & *al*. (2013). For newly described taxa, we consulted these criteria for each serpentinophyte: biological type, soils, bioclimatic belt (thermotype), altitudinal range, ombrotype, vegetation (syntaxon in which it appears), type of endemism following the classification of Pérez-Latorre & *al*. (2013) and outcrops in which it appears. For the rest of obligate serpentinophytes, only new data with respect to those contributed by Pérez Latorre & *al*. (2013) are provided where appropriate (i.e. remarks on taxonomic status, chorology, etc.).

Results

New additions

Crepis bermejana M. Talavera, C. Sánchez Casimiro-Soriguer & S. Talavera

Scapiform hemicryptophyte. Slopes and stony areas. Thermo-mesomediterranean (528-980 m asl). Dry-sub-humid. Perennial pastures and shrublands (possibly *Andryalo-Crambion filiformis* and *Staehelino baeticae-Ulicion baetici*). Local endemism (serpentines of Malaga province). Bermeja and Aguas outcrops. Flowering: (IV) V-VI (VII).

Species described in 2013 (Talavera & *al*., 2013). According to these authors, it is very close to another possible serpentinophyte taxon of the northwestern Iberian Peninsula: *C. novoana* Ortiz, Soñora & Rodr. Ubiña. In the original description there is no proposal of degree of threat. The number of populations / localities reach only two and its area of occupation (AOO) is less than 10 km^2, which leads to propose this taxon as threatened and worthy of a complete evaluation under UICN criteria (UICN, 2012).

Galatella malacitana Blanca, Gavira & Suár.-Sant.

Scapiform hemicryptophyte. Peridotite soils. Thermomediterranean (400-700 m asl). Subhumid. Open shrublands. (*Staehelino baeticae-Ulicion baetici* and *Andryalo-Crambion filiformis*). Local endemism (serpentines of Malaga province), glacier relict. Bermeja, Alpujata and Aguas outcrops. Flowering: X-XI.

Species described in 2015 (Blanca & *al*., 2015). In the original description there is no proposal of degree of threat. The number of populations / localities reach

only three and its AOO is less than 10 km^2, which leads to propose this taxon as threatened and worthy of a complete evaluation under UICN criteria (UICN, 2012).

Nomenclatural news

Armeria villosa Girard subsp. ***serpentinicola*** Cabezudo, Pérez Lat. & Casimiro-Soriguer Solanas

(*A. villosa* Girard subsp. *carratracensis* (Bernis) Nieto Fel.)

Scapiform hemicryptophyte. Crevices, cliffs and slopes. Mesomediterranean (around 800 m asl). Subhumid. Perennial pastures and open scrublands (*Andryalo-Crambion filiformis* and *Staehelino baeticae-Ulicion baetici*). Local endemism (serpentines of Malaga province). Aguas outcrop. Flowering: IV-VI.

The case of this subspecies has to do not only with a nomenclatural change (Cabezudo & *al*., 2015), but also with the number and location of populations, so that it is necessary to discard it from the outcrops of Bermeja and Alpujata, being exclusive to Aguas. It was proposed by its authors as CR B1ab(ii,iv); C2a(i), and to be included in the Andalusian legislation.

Euphorbia flavicoma DC. subsp. ***bermejense*** Hidalgo Triana, Pérez Lat. & Cabezudo

Amphiphyte (chamaephyte and cryptophyte). Rocky slopes (harzburguites). Thermomediterranean (500-600 m asl). Humid. Open shrublands. (*Andryalo-Crambion filiformis*). Local endemism (serpentines of Malaga province). Bermeja outcrop. Flowering: V-VI.

Species described in 2016 (Hidalgo-Triana & *al*., 2016). The populations of this subspecies had been formerly assigned to *E. flavicoma* subsp. *giselae* Simon Pall. (Pérez-Latorre & *al*. 2013), which is restricted to the SE of France. The threat status proposed by the authors of the taxon is maintained (CR).

Linum carratracense (Rivas Goday & Rivas Mart.) Mart. Labarga & Muñoz Garm.

(*Linum suffruticosum* L. var. *carratracense* (Rivas Goday & Rivas Mart.) G. López)

There has been a change in the taxonomic status of this serpentinophyte since in the previous review (Pérez-Latorre & *al*., 2013) it was considered as a variety.

News on chorology

Alyssum serpyllifolium Desf. subsp. ***malacitanum*** Rivas Goday

Almería: Laujar de Andarax, Sierra Nevada, Cerro del Almirez, 30SWG0823604481, 2326 m asl, 09.07.2013, *A.V. Pérez-Latorre & N. Hidalgo-Triana*, MGC 77895.
The specimen MGC 77895 (*A. serpyllifolium* subsp. *serpyllifolium*) from the peridotites of Cerro del Almirez (Laujar de Andarax, Sierra Nevada, Almeria) has some morphological characteristics of the subspecies *malacitanum*, which would require a deeper study of this population. In any case, it is a new record for *Alyssum serpyllifolium s. l.* in the Nevada-Filabres natural area of Vascular Flora of Eastern Andalusia (Blanca & *al*., 2011).

Asplenium adiantum-nigrum L. var. ***corunnense*** H. Christ

Almería: Laujar de Andarax, Sierra Nevada, Cerro del Almirez, 30SWG0794604207, 2318 m asl, 09.07.2013, Glera, Metaperidotitas, *A.V. Pérez-Latorre & N. Hidalgo-Triana*, MGC 77904.

It is the first south Iberian serpentinophyte that has been located outside the ultramafic complex of Malaga, since it is found in the peridotites of Cerro del Almirez.

Bupleurum acutifolium Boiss.

Málaga: entre Coín y Mijas, 36.63/-4.73, 15.07.1976, *A. Asensi & B. Díez-Garretas*, MGC 3765; entre Coín y Mijas, 36.63/-4.73, 13.07.1976, *A. Asensi & B. Díez-Garretas*, MGC 3796.

It has been confirmed inhabiting the outcrop of Sierra de Alpujata in a burned area (Hidalgo-Triana, 2016). The data of Pérez-Latorre & *al*. (2013) on its presence in the outcrop of Guadalhorce has to be extended to circumscribe Alpujata range, taking into account the localities provided by the vouchers MGC 3765 and 3796. The Portuguese populations which appear in some bibliographies as belonging to *B. acutifolium* have to be included in a different species (Neves, 2003).

Cephalaria baetica Boiss.

It has been recently located in the outcrop of Sierra de Alpujata in a burned area (Hidalgo-Triana, 2016). This new locality does not modify the previous threatening status (EN) established by the Andalusian Red List (Cabezudo & *al*., 2005).

Silene inaperta L. subsp. ***serpentinicola*** Talavera

It has been located for the first time in the outcrop of Sierra de Aguas; as it is an annual plant, it could not be properly collected during field work.

Taxonomic commentaries

Allium rouyi Gaut.

Pastor (2011) and Aedo (2013) decided to include *A. chrysonemum* Stearn and *A. reconditum* Pastor, Valdés & Muñoz (which do not develop on peridotites following GBIF data) in *Allium rouyi*. Aedo's observations on Malaga populations, which would be less hairy and smaller than those of a broad *A. chrysonemum*, are consistent with the possibility of serpentinomorphoses: glabrescence and nanism (Pichi-Sermolli, 1948).

Klasea baetica (Boiss.) Holub

With respect to the Riphaean record of this species in Blanca & *al*. (2011), an herbarium sheet from Morocco (*K. baetica,* G-127573) has been reviewed and identified as *K. alcalae* (Coss.) Holub. *K. baetica* is also mentioned with uncertainty in the natural area of Axarquia (Blanca & *al*., op. cit.), a reference that may refer to some of the small serpentine outcrops that exist there (Alora, Coín, Cártama). It has also been cited (with uncertainty) in Granada, a province where no herbarium sheets exist according to GBIF.

Rejected taxa

***Teucrium reverchonii* Willk.**

A taxonomic revision of all MGC herbarium sheets assigned to *T. reverchonii* collected on peridotites has led *T. reverchonii* to be identified as *T. haenseleri* Boiss. This fact implies that *T. reverchonii* has to be excluded from the obligate serpentinophyte category.

Conclusions

With these results, the new checklist of obligate serpentinophytes is formed by 23 taxa. Regarding the previous list (Pérez Latorre & *al*., 2013), *Crepis bermejana* and *Galatella malacitana* are added while *Teucrium reverchonii* is excluded. *Linum carratracense* shows a change of taxonomic status from variety to species which increases its importance. *Armeria villosa* subsp. *serpentinicola* and *Euphorbia flavicoma* subsp. *bermejense* undergo important changes in their nomenclature and in their attributed populations, but this fact does not influence the total number of serpentinophytes.

Regarding their threat status, *Crepis bermejana*, *Galatella malacitana*, *Armeria villosa* subsp. *serpentinicola* and *Euphorbia flavicoma* subsp. *bermejense* require thorough monitoring of their currently known populations. The management of this type of specialized and highly localized flora requires the implementation of measures in the protected natural areas where it lives (ZEC, Natural Protected Areas) in order to effectively protect outcrops as large as Sierra Alpujata. Including the taxa with fewer populations in the lists of legally protected species, as is the case for the four recently described, may also contribute to their conservation. On the other hand, a complete Iberian (including Portugal) serpentinophytes checklist may be considered as a future need for their corresponding revisions of States legislations and Red Lists.

Acknowledgements

To Federico Casimiro-Soriguer Solanas for identification of species in genus *Teucrium*. Study carried out with contributions of research contracts (CI-17-301) through the University of Malaga (Spain). It was also supported by ULTRAFOREST (CSO2013-47713-P) Project of the Spanish State. Thanks to Joe Burns who improved English of the manuscript.

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