

Chorological novelties of the genus *Cladonia* in Toledo province (Spain)

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Abstract. *Cladonia gracilis* subsp. *gracilis* and *Cladonia uncialis* subsp. *biuncialis* are newly recorded to Toledo province. Furthermore, the distribution of *C. macilenta* and *C. diversa* is extended in this province. The habitats and distribution of these species in the Iberian Peninsula are discussed.

Keywords: Lichens, Iberian Peninsula, Castilla-La Mancha.

[es] Novedades corológicas del género *Cladonia* en la provincia de Toledo (España)

Resumen. Se citan por primera vez *Cladonia gracilis* subsp. *gracilis* y *Cladonia uncialis* subsp. *biuncialis* en la provincia de Toledo. Además, se amplía la distribución de *Cladonia macilenta* y *C. diversa* en la provincia. Se discuten los hábitats y la distribución de estas especies en la Península Ibérica

Palabras clave: Líquenes, Península Ibérica, Castilla-La Mancha.

Introduction

The genus *Cladonia* is one of the most relevant genera of terricolous macrolichens. The diversity and distribution in the Iberian Peninsula of the species within this genus is well studied (Burgaz & Ahti 1991, 1994, 2009; Burgaz et al. 1999). However, new species have been recently reported (Pino-Bodas et al. 2013, 2014) and the distribution of others has become spread (Burgaz et al. 2020). Up to date 73 species of *Cladonia* are known to grow in the Iberian Peninsula. Most of the diversity concentrates in the Eurosiberian region; as regards the Mediterranean region, the supramediterranean belt, along with some humid enclaves with a submediterranean climate, harbour most of the genus diversity.

Spain's Toledo province has an area of 15.368 km², the northern limit is the Sierra de San Vicente, while the Montes de Toledo range form the southern border, with the highest summit at Rocigalgo (1441 m). In the easternmost third of the province, sedimentary soils of basic pH prevail, whether calcareous or gypsiferous; in the western zone paleozoic siliceous rocks prevail. The lichenized mycota of Toledo province has been relatively well studied (Martínez et al. 1993; Vázquez & Burgaz 1996; Aragón & Martínez 1997; Aragón et al. 2001, 2006), especially the epiphytic lichen forming fungi. Sixteen species of the

genus *Cladonia* have been reported. The eastern massifs of Montes de Toledo range, namely Rocigalgo and Chorito, are the most studied in detail. The western sector, where Sevilleja and Altamira ranges lie, has been less explored. In some humid enclaves of the Sierra de Sevilleja, a few patches of relict forests from the Tertiary are preserved, with *Taxus baccata* L. and *Prunus lusitanica* L., while the Sierra de Altamira still retains some well preserved *Quercus pyrenaica* Willd. oakwoods.

The aim of this paper is to provide new and interesting reports of the genus *Cladonia* in Toledo province on the occasion of several field surveys in the mountain ranges known as Sierra de Altamira and Sierra de Sevilleja.

Material and methods

Specimens were collected by the first author in different localities of Toledo province. The specimens were studied morphologically under Olympus SZX9 stereomicroscope. The secondary metabolites of each specimen were analysed by thin layer chromatography (TLC) according to standardized procedures (White and James 1985; Orange et al. 2001), using the solvents A and C. All the new collections were deposited at MACB herbarium in Madrid.

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Results and discussion

Cladonia diversa Asperges ex S. Stenroos

Primary thallus persistent, squamules slightly divided. Podetia green to yellowish, scyphose, simple or with proliferations on the margin of scyphi. Surface covered by corticate granules and microsquamules at base. The specimens studied contain usnic acid and zeorin.

It is the commonest species of the Erythrocarpae clade in the Mediterranean region (Burgaz et al. 2020). Found in several provinces of the Iberian Peninsula: Ávila, Burgos, Cáceres, Cantabria, Ciudad Real, Gerona, Guadalajara, Huesca, Jaén, León, La Rioja, Málaga, Madrid, Orense, Palencia, Pontevedra, Salamanca, Segovia, Soria, Teruel, Toledo, Zamora and Zaragoza (Burgaz 2009; Burgaz & Ahti 2009; Burgaz et al. 2020). It usually grows on acid soils typical of holm oak forests, beech forests, oak groves, pine groves and heaths, though some records exist from limestone substrates (Burgaz 2015). It has not been much collected in Toledo province, though it is not a rare species. It probably has gone unnoticed due to the absence of apothecia. In the course of this work it has been found in three localities, always on mossy, shaded rocks or in the depths of pine forests. It is widely distributed in Europe and in the Macaronesian region (Ahti & Stenroos 2013); some specimens have been found in Japan and China (Ahti & Stenroos 2012). The presence of the species in North America is uncertain (Ahti & Stenroos 2012).

It can be mistaken for *Cladonia coccifera* (L.) Willd., though this one is scarcer in the Mediterranean region. Both species contain the same secondary metabolites, but they can easily be told apart by the slimmer podetia of *C. diversa* and by the presence of microsquamules on the podetia of the latter.

Specimens examined. Toledo: Montes de Toledo, Altamira mountains, Pto de San Vicente, pathway near the pass, 39°30'54.0"N 5°06'43.4"W, 881 m, *Castanea sativa*, *Pinus pinaster* and *Arbutus unedo*, quartzite rocks, 21 Oct 2020, Pino-Bodas s.n. (MACB 113894); Las Hunfrías, north side of Sevilleja mountains, Natural Reserve "Garganta de las Lanchas", 39°34'43.9"N 4°53'42.9", 736 m, quartzite rocks on forest of *Quercus pyrenaica* with *Q. ilex* subsp. *ballota* and *Prunus lusitanica*, 6 Sep 2020, Pino-Bodas s.n. (MACB 113904); Aldeanueva de Barbarroya, 480 m, 21 Nov 2020, Pino-Bodas s.n. (MACB 113905).

Cladonia gracilis (L.) Willd. subsp. *gracilis*

Primary thallus evanescent. Podetia slender, greenish to dark brown, unbranched or slightly branched, young podetia subulate, later with scyphi. Scyphi narrow and regular, with marginal proliferations. Surface corticate, smooth, sometimes areolate, with

discontinuous algal layer. The specimens studied contain fumarprotocetraric acid complex.

Cladonia furcata (Huds.) Schrad. is other species occurring in the territory that could be mistaken for *C. gracilis*. But the podetia of the former are more branched, thicker; it never produces any scyphus and whenever it develops apothecia the podetia tips split longitudinally.

Cladonia gracilis subsp. *gracilis* is broadly distributed, present in Europe, Asia, North and South America, though it is more abundant in temperate and boreal regions (Ahti 1980; Ahti & Stenroos 2013). In the Iberian Peninsula it is restricted mainly to pine groves, *Quercus pyrenaica* oakwoods, beechwoods, heaths and pasturages, in several mountain ranges (Burgaz & Ahti 2009). It was previously found in Asturias, Ávila, Burgos, Cáceres, Cádiz, Cantabria, La Coruña, Gerona, Guadalajara, Huesca, Jaén, León, Lugo, Madrid, Navarra, Orense, Palencia, La Rioja, Salamanca, Segovia, Teruel, Zamora and Zaragoza provinces (Burgaz & Ahti 2009; Burgaz et al. 2020). Only in Galicia and northern Portugal the species has been found at low altitudes probably due to oceanic influence. In the Iberian Peninsula, the southernmost locality where the species is cited lies on Sierra de Grazalema, Cádiz, (Rowe & Egea 1988), a mountain range that stands out for its heavy rainfall. Here it is newly reported to Toledo province from two localities, one in Sierra de Sevilleja, another in Sierra de Altamira. The Sierra de Sevilleja locality is placed in the meso-mediterranean belt, in a sheltered, humid area that enjoys a high thermic stability (average annual temperature, 14–15 °C; average annual rainfall, 600–700 mm), on Ordovician quartzite rocks (Muñoz-Jiménez 1976). The Sierra de Altamira population is placed near the summits, where fogs are frequent. In both localities the specimens have been found on rocky outcrops or on mossy rocks. In Puerto de San Vicente, some mats of this species were found intermingled with *C. uncialis* subsp. *biuncialis* (Hoffm.) M. Choisy.

Specimens examined. Toledo: Montes de Toledo, Altamira mountains, Pto de San Vicente, pathway near the pass, 39°30'54.0"N 5°06'43.4"W, 881 m, *Castanea sativa*, *Pinus pinaster* and *Arbutus unedo*, quartzite rocks, 21 Oct 2020, Pino-Bodas s.n. (MACB 113895); Las Hunfrías, north side of Sevilleja mountains, Natural Reserve "Garganta de las Lanchas", 39°34'43.9"N 4°53'42.9", 736 m, quartzite rocks on forest of *Quercus pyrenaica* with *Q. ilex* subsp. *ballota* and *Prunus lusitanica*, 6 Sep 2020, Pino-Bodas s.n. (MACB 113896).

Cladonia macilenta Hoffm.

Primary thallus persistent, squamules greenish on the upper side, white below, sometimes with yellow tinge on the lower surface. Podetia greenish to greyish, simple or rarely slightly branched near the tips,

subulate. Surface completely covered by farinose sores and frequently with microsquamules at the base. The specimen studied contains barbatic and thamnolic acids.

It can be mistaken for *Cladonia coniocraea* (Flörke) Spreng, which also has subulate and sore-diate podetia, and is much more common. However, *C. coniocraea* contains fumarprotocetraric acid. The specimens with apothecia are unmistakable, since in *C. macilenta* they are red, while those of *C. coniocraea* are brownish.

Cladonia macilenta is a widely distributed species, known from Europe, Asia, North America and South America, where it is less frequent. Its worldwide distribution shows certain oceanic trends (Stenroos 1986; Hammer 1995; Ahti & Stenroos 2013). It is not rare in the Mediterranean region, but more common in the Eurosiberian one (Burgaz et al. 2020). In the Iberian Peninsula, it has been found in the following provinces: Álava, Asturias, Ávila, Barcelona, Cáceres, Cádiz, Cantabria, Ciudad Real, Cuenca, Gerona, Guadalajara, Guipúzcoa, Huesca, Jaén, La Coruña, La Rioja, León, Lugo, Madrid, Navarra, Orense, Pontevedra, Salamanca, Segovia, Soria, Teruel, Toledo and Vizcaya (Burgaz & Ahti 2009). It grows on stumps, tree bases, mosses and rock outcrops. The newly reported population was found on mossy rocks placed in shaded areas. Up to date, a unique report of this species is known for Toledo province, namely in Sierra de San Vicente range, locality of Navamorcuende, near the border with Ávila (Vázquez & Burgaz 1996). It is likely a rare species in Toledo province, though it might have gone unnoticed, or mistaken for *C. coniocraea*.

Specimens examined. Toledo: Montes de Toledo, Altamira mountains, Pto de San Vicente, pathway near the pass, 39°30'54.0"N5°06'43.4"W, 881 m, *Castanea sativa*, *Pinus pinaster* and *Arbutus unedo*, quartzite rocks, 21 Oct 2020, Pino-Bodas s.n. (MACB 113899).

***Cladonia uncialis* subsp. *biuncialis* (Hoffm.) M. Choisy**

Primary thallus evanescent, podetia moderate branched, predominantly dichotomous, yellowish and corticate surface, with a thin and smooth cortex. The presence of usnic and squamatic acids were confirmed by TLC.

The only species present in the territory that could be mistaken for *C. uncialis* (L.) Weber ex F.H. Wigg. are *C. gracilis* (L.) Willd., *C. furcata* and *C. rangiformis* Hoffm. But none of these species contain usnic acid and consequently their podetia are not yellowish. Besides, *C. furcata* and *C. rangiformis* are usually more branched and frequently show podetia with some squamules, while *C. uncialis* never develops squamules and *C. gracilis* produces scyphi.

Cladonia uncialis is a species rare in the Mediterranean region. In Spain the subsp. *biuncialis* has been found in Asturias, Ávila, Burgos, Cáceres, Cantabria, La Coruña, Guadalajara, Huesca, León, Lugo, Madrid, Navarra, Orense, Palencia, La Rioja, Salamanca, Segovia, Soria and Zamora provinces, while the subsp. *uncialis* has been found in Asturias, Cantabria, La Coruña, Huesca, Guadalajara, León, Lugo, Orense, Palencia, Pontevedra, La Rioja, Soria, Salamanca and Zamora (Burgaz & Ahti 2009; Burgaz et al. 2020). It is new to Toledo. Both subspecies usually grow above 1.000 m in altitude in Spanish Mediterranean region but the Toledo population grows under 1.000 m. In Tunisia and Greece, however, they have been found at sea level (Burgaz et al. 2020; El Mokni et al. 2015). Within the Mediterranean region this species grows in less continental habitats, where fogs are abundant (Burgaz & Martínez 2008). The population in Puerto de San Vicente was found in humid and shaded slopes covered with bryophytes, on the north face and near the summits, where fogs often occur. Anyway the species is not abundant and usually appears accompanied by *Cladonia gracilis*, *C. fimbriata* (L.) Fr., *C. diversa*, *C. furcata* and *C. scabriuscula* (Delise) Nyl., though most of these species are commoner and not restricted to the summits, as happens with *Cladonia uncialis*. The population in Puerto de San Vicente has climatic and geologic characteristics similar to those in the Villuercas, where other populations of this species have been reported (Burgaz 2015).

A second population was previously found in Toledo province, about 30 km further north, in Aldeanueva de Barbarroya locality, on huge granite rocks scattered across an open holm-oak wood, in the vicinity of the Huso river. This population amounted to some 10 thalli on a granite crag facing north, a rock that stayed damp most of the year. Unfortunately this population disappeared last summer because of a fire, though a collection is kept in K-M. It is likely that other populations of *C. uncialis* exist in areas near the Montes de Toledo summits.

Specimens examined. Toledo: Montes de Toledo, Altamira mountains, Pto de San Vicente, pathway near the pass, 39°30'54.0"N5°06'43.4"W, 881 m, *Castanea sativa*, *Pinus pinaster* and *Arbutus unedo*, quartzite rocks, 21 Oct 2020, Pino-Bodas s.n. (MACB 113898); Aldeanueva de Barbarroya, open forest of *Quercus ilex* subsp. *ballota* with granitic rocks, 39°44'46"N 5°02'00.0"W, 480 m, 7 Feb 2020, Pino-Bodas s.n. (K-M).

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