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The genus *Placidiopsis* in the Iberian Peninsula and the Balearic Islands

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Abstract — A taxonomic revision of the genus *Placidiopsis* in the Iberian Peninsula and the Balearic Islands is provided. A total of 500 specimens were studied. A detailed description of the morphology, anatomy, ecology, and distributional rank is presented for each species. Additionally, a key to *Placidiopsis* species is included. The genus is represented by four species in the studied region, with *P. cavicola* and *P. cinereoides* known only from the type localities and *P. cinerascens* and *P. custnani* common in the eastern half of the region. These data expand considerably the ecological and distributional range of these species in the Iberian Peninsula.

Key words — catapyrenioid lichens, distribution, Spain, Portugal, *Verrucariaceae*

Introduction

Placidiopsis Beltr. (*Verrucariaceae*) is a genus of squamulose lichens closely related to *Catapyrenium* s. str., although recent phylogenetic analyses (Gueidan et al. 2007, 2009; Prieto et al. 2010) concluded that both genera were different entities. The two genera are morphologically differentiated by uniseptate ascospores in *Placidiopsis* and simple ascospores in *Catapyrenium* s. str. *Placidiopsis* species are characterized by squamulose thalli attached to the substrate by a rhizohyphal web, a central bundle of rhizohyphae, or rhizines. The upper cortex is either absent or *cinereum*–type (Breuss 1996, 2002; Prieto et al. 2010), the photobiont is a chlorococcoid alga (Breuss 2002), the medulla is proso– or subparaplechtenchymatous, and the lower cortex is (sub)paraplect enchymatous when present. Perithecia are immersed, with or without an apical involucrellum, asci are clavate with an ocular chamber, and pycnidia have never been observed (Breuss 2002).

Members of the group inhabit arid, semiarid, and arctic–alpine regions in the Northern Hemisphere (Breuss 2002). Ecological preferences of the genus

include soil, rock, detritus, or bryophytes occurring in calciferous or acid substrates. *Placidiopsis* comprises 12 species world–wide (Breuss 2010), many of which appear rare and restricted either to their type localities (e.g. *P. cavicola*, *P. cervinula* (Nyl.) Vain., *P. cinereoides*) or to very small areas (e.g. *P. hamadicola* Bredkina, *P. tiroliensis* Breuss).

Breuss (1996), who until now has published the only complete treatment of the genus, reported few specimens for the Iberian Peninsula. Therefore exhaustive collection and more in-depth research of *Placidiopsis* species was necessary in order to establish the true extent of the genus in the Iberian Peninsula and the Balearic Islands. The current research is part of the project Spanish Lichenological Flora.

Materials & methods

This study is mainly based on material collected by the authors in the Iberian Peninsula and the Balearic Islands during 2005–2009. The specimens are deposited in MA herbarium. In addition, collections in Iberia (BCC, BCN, LEB, LISU, MA, MACB, MAF, SANT, VAL, VIT), other European and North American herbaria (ABL, ARIZ, ASU, B, BM, COLO, GB, H, HAL, L, LI, NY, PRM, S, TUR), and personal herbaria (C. Keller, G. Aragón) were revised. Approximately 500 specimens in total were studied.

Observations and measurements were made using a Nikon SMZ–800 dissecting microscope and an Olympus BX 51 microscope. Thallus cross-sections (14–20 µm thick) were made with a Leica CM 1850 UV freezing microtome. Sections were observed and measured in water or occasionally lactophenol cotton blue. For anatomical studies, ten specimens per species were analysed (when available), and ten measurements of each specimen on different squamules were carried out. The limited material of some species and the poor condition of others led to a lower number of measurements in some cases. Measurements are expressed as the mean ± standard deviation (SD) with the extremes within parentheses; length/wide ratios (l/w) were calculated for ascospores. Distributional maps were drawn with ArcView GIS 3.1, based on UTM coordinates (WGS84 Datum).

For each taxon, we cite the basionym, type specimen, and type location, but not previously published synonyms (see Breuss 1996).

Results

Of the four *Placidiopsis* species found in the Iberian Peninsula and the Balearic Islands, two — *P. cavicola, P. cinereoides* — are known only from their type localities and two — *P. cinerascens, P. custnani* — are more common than previously believed and found throughout the studied area.

Key to the known *Placidiopsis* species in the Iberian Peninsula

1. On rocks, squamules up to 0.5 mm ..... *P. cavicola*
1. On soil, squamules up to 2–3 mm 2

2. Rhizohyphae colourless ..... *P. cinerascens*
2. Rhizohyphae dark 3
3. Squamules with down-rolled margins, rhizohyphae attached in a central holdfast (looking like a rhizine), ascospores 15–22 × 5–7 µm ..... *P. custnani*
3. Squamules without downrolled margins, central holdfast absent, ascospores 22–28 × 7–8 µm ..... *P. cinereoides*

Placidiopsis cavicola Etayo & Breuss, Österr. Z. Pilzk. 3: 21 (1994) Figs. 1A, 2A

[type: Spain, Navarra, Larra, Isaba, Añelarra, cave A–50, 5 m depth, on calcareous flagstone, 2154 m, J. Etayo & J.I. Calvo, 19/08/1992 (Herb. Etayo, Holotype; LI 271012, Isotype!).]

Morphology— Thallus squamulose, composed of very small squamules, ≤ 0.5 mm broad, flat, crenulate, adjacent to slightly overlapping. Upper surface green to light brown; lower surface brown, with colourless to brown rhizohyphae.

Anatomy— Thallus 100–150(–250) µm thick, upper cortex 10–20 µm thick, with cells of 4–6 µm diam, epinecral layer lacking. Algal layer distributed over nearly the entire thallus, with algal cells of 5–9 µm; lower cortex not clearly delimited. Rhizohyphae colourless to brownish, ca. 4 µm thick.

Perithecia 150–250 µm wide, with a colourless exciple. Asci clavate, 45–55 × 15–20 µm, ascospores septate, 13–17 × 6–7 µm (Etayo & Breuss 1994). Pycnidia absent.

Ecology & Distribution — *Placidiopsis cavicola* was collected on rock, growing over a thin algal or debris layer in a calcareous cave in the subalpine belt of the Pyrenees, over 2100–2200 m altitude (Etayo & Breuss 1994).

The species is known only from the type locality in Navarra, Spain; it may be more widely distributed, however, as it has probably been overlooked due to its small size.

Comments— *Placidiopsis cavicola* resembles *P. minor* R.C. Harris in that both species have small squamules (no more than 1 mm) and grow on rocks. However, *P. cavicola* has crenulated and non-pruinose squamules, while *P. minor* has roundish to slightly lobed and pruinose squamules; moreover, the spores are bigger in *P. cavicola* (8–10 × 4–5 µm in *P. minor*). *Placidiopsis minor* has not been found until now in the Iberian Peninsula and has previously been known only from North America and Greenland (Breuss 1996).

Placidiopsis cinerascens (Nyl.) Breuss, Plant Syst. Evol. 148: 315 (1985) Figs. 1B, 2A

[type: Gallia merid., Beaucaire, W. Nylander (H–NYL 4021, Holotype!).]

= *Placidiopsis tenella* (Nyl.) Zahlbr., Catal. Lich. Univ. 1: 240 (1921)

[type: Oran, Balansa (H–NYL 3944!, Lectotype, designated by Cl. Roux in herbarium).]

Morphology— Thallus squamulose, squamules up to 3 mm wide, scattered to contiguous, flattened to slightly convex, rounded to lobed or crenate. Upper surface whitish, greenish grey or brownish grey, pruinose or not; lower surface pale with colourless rhizohyphae.

Anatomy— Thallus (110–) 226 ± 48.9 (–320) µm thick, with or without epinecral layer, up to 50 µm when present; upper cortex (5–) 19.1 ± 8.1 (–37.5) µm thick, paraplectenchymatous, with roundish-subangular cells of (4–) 7.1 ± 1.4 (–11) µm diam. Algal layer distributed over almost the entire thallus, 50–175 µm thick, with cells (3–) 6.5 ± 1.7 (–12) µm diam. Medulla not clearly delimited from the algal layer, composed of globular cells (4–) 7.5 ± 1.5 (–11) µm diam; lower cortex lacking. Rhizohyphae colourless, (2.5–) 3.2 ± 0.4 (–4) µm.

Perithecia slightly pyriform to globose, up to 300 µm wide, exciple hyaline to brownish, up to ca. 30 µm thick, darker in the ostiole, with or without a small apical involucrellum. Asci clavate, 55–65 × 11–16 µm (Breuss 1996), with a small ocular chamber; ascospores biseriate, hyaline, septate (occasionally simple), (12–) 16.4 ± 1.9 (–21) × (5–) 6.2 ± 0.5 (–7) µm, l/w ratio (1.7–) 2.6 ± 0.4 (–3.3). Pycnidia absent.

Ecology & Distribution—The species shows preferences for soil and rock ledges on calcareous and gypsiferous substrates. It was found in shrublands with *Buxus sempervirens* L., *Lavandula latifolia* Medik., *Lycium* sp., *Rosmarinus officinalis* L., and *Thymus* sp. in dry and open habitats, but also collected in *Pinus halepensis* Mill., *Juniperus thurifera* L. and *Quercus ilex* subsp. *ballota* (Desf.) Samp. forests. *Placidiopsis cinerascens* has been frequently found together with *Anthracocarpon virescens* (Zahlbr.) Breuss, *Endocarpon pusillum* Hedw., *Placidiopsis custnani,* or *Placidium pilosellum* (Breuss) Breuss. In the studied area, *P. cinerascens* was found between the sea level and 1300(–1800) m altitude.

Until now, *P. cinerascens* was little collected in the Iberian Peninsula and recorded from only 5 southern and eastern provinces of Spain although also known from Portugal (Barreno et al. 1989, Breuss 1996, Etayo & Breuss 1996). There are few records of *P. cinerascens* reported as *P. tenella* in Spain (Boom & Gómez-Bolea 1991, Etayo 1992, Gutierrez & Casares 1994, Guerra et al. 1995); as these specimens could not be examined, their data are not included in the maps.

Our data indicate that *P. cinerascens,* relatively abundant in the Iberian Peninsula, is more common than previously thought. New data extend the known distribution of the species in the Iberian Peninsula, mainly from central, southern and southeastern Spain, with many collections constituting first provincial records. Although present throughout the Iberian Peninsula with

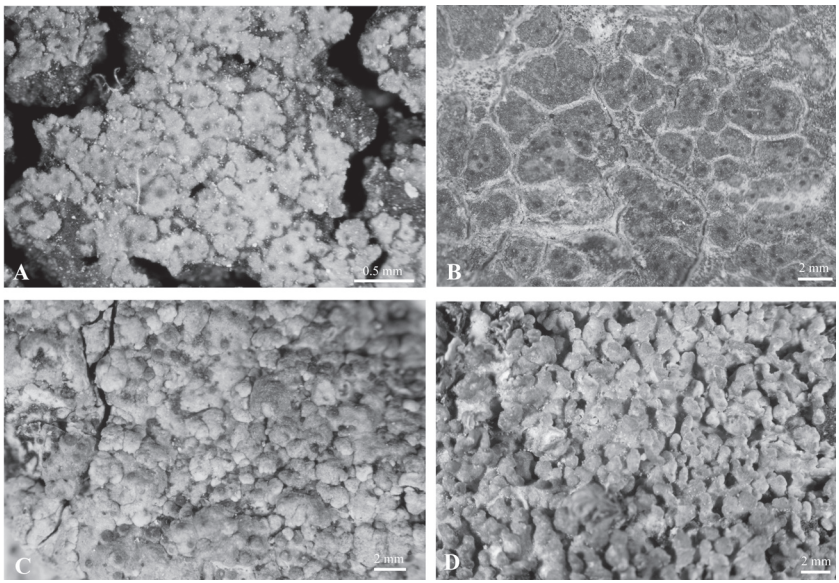

Figure 1. Habit of species of *Placidiopsis*.
A, *P. cavicola*; B, *P. cinerascens*; C, *P. cinereoides*; D, *P. custnani*.

some occurrence in the west, the species is especially prevalent in the eastern half; it is relatively common in the Balearic Islands.

Placidiopsis cinerascens is widely distributed in Mediterranean and arid climates throughout the European mediterranean region as well as in central Asia, Mexico, northern Africa, and SW North America (Breuss 2002).

Comments— *Placidiopsis cinerascens* was synonymized with *P. tenella* based on morphological and genetic similarities (Prieto et al. 2010). The presence of an involucrellum in *P. tenella* is not a valid character state, because it does not appear in all ascomata within the same specimen or even in the same squamule. Therefore, *Placidiopsis tenella* cannot be distinguished from *P. cinerascens* using this character.

Representative specimens — **SPAIN. Albacete**: Riópar, Calar del Mundo, subida por la Fuente de las Raigadas, 549451 E, 4256284 N, 1320 m, G. Aragón, R. Belinchón & M. Prieto, 31/01/2007, M. Prieto 664b. **Alicante**: Orihuela, 680582 E, 4218299 N, suelos calizos, 35 m, M. Prieto, 11/04/2006, M. Prieto 589b. **Almería**: Turrillas, Sierra Alhamilla, 565453 E, 4098680 N, 1300 m, suelos calizos, I. Martínez, M.A.G. Otálora & M. Prieto, 29/11/2005, M. Prieto 515. **Barcelona**: Can Grau, Sierra del Garraf, 403256 E, 4573874 N, 279 m, M. Prieto, 08/07/2004, M. Prieto 1654. **Burgos**: Oña, carretera hacia Villanueva de los Montes, Sierra de Tesla, 466595 E, 4733638 N, repisas calizas, 590 m, I. Martínez & M. Prieto, 23/08/2007, M. Prieto 1166. **Cáceres**: Torrejón El Rubio, castillo de Monfragüe, 244525 E, 4414075 N, sobre mortero de un muro,

661 m, M. Prieto, 14/01/2007, M. Prieto 662 (MA 16302). **Cádiz**: Grazalema, Sierra de Grazalema, carretera hacia Zahara de la Sierra, antes del Puerto de los Acebuches, 287604 E, 4075692 N, 870 m, oquedades de rocas calizas, R. Belinchón, I. Martínez & M. Prieto, 13/06/2008, M. Prieto 1474. **Castellón**: Cabanes, dessert de les Palmes, 248364 E, 4448733 N, fisuras calizas, 290 m, M. Prieto, 14/03/2008, M. Prieto 1410, 1411 (MA 16302). **Cuenca**: Poyatos, 582121 E, 4474336 N; repisas de rocas calizas en pinar, 1046 m, M. Prieto, 05/04/2007, M. Prieto 942. **Granada**: Sierra Nevada, antes de Prado Llano, 460330 E, 4107723 N, suelo calizo, 1880 m, M. Prieto, 26/06/2008, M. Prieto 1523. **La Rioja**: Foncea, 497345 E, 4718904 N, suelo entre rocas calizas, 860 m, I. Martínez & M. Prieto, 27/08/2007, M. Prieto 1154, 1160. **León**: Miñera de Luna, 267275 E, 4751065 N, suelos calizos en sabinar, 1130 m, M. Prieto, 18/05/2006, M. Prieto 617. **Lérida**: Alfés, Timoneda, aeròdrom d´Alfés, 30TCG00, terrícola, 240 m, J. Perez-Redondo, 12/01/1992, BCC 12680. **Madrid**: Patones de Arriba, 459550 E, 4524950 N, 834 m, M. Prieto, 01/05/2008, M. Prieto 1520. **Málaga**: Parauta, Sierra de las Nieves, estribaciones del pinsapar de cerro Alcojona, cerca del pinsapo de la Escalereta, 318103 E, 4060026 N, 1164 m, R. Belinchón, I. Martínez & M. Prieto, 12/06/2008, M. Prieto 1454b. **Mallorca**: Caimari, Sierra de Tramuntana, 681883 E, 4759848 N, fisuras calizas, 500 m, M. Prieto, 15/04/2007, M. Prieto 904 (MA 16304). **Navarra**: Rada, Bárdenas Reales, 616320 E, 4686664 N, suelo calizo, I. Martínez & M. Prieto, 22/08/2007, M. Prieto 1131. **Palencia**: Piedrasluengas, Puerto de Piedrasluengas, 381275 N, 4767675 E, fisuras calizas, 1355 m, G. Aragón, A. García & M. Prieto, 21/07/2005, M. Prieto 108 (MA 16397). **Toledo**: carretera hacia Villacañas, 476725 E, 4378425 N, M. Prieto, 21/01/2007, M Prieto 657. **Valencia**: carretera de Utiel a Estenas, Sierra de Juan Navarro, 659189 N, 4384368 E, suelos calizos en coscojar, 892 m, M. Prieto, 22/02/2008, M. Prieto 1328, 1330. **Zaragoza**: Calcena, 606269 E, 4610745 N, repisas calizas, 890 m, I. Martínez & M. Prieto, 21/08/2007, M. Prieto 1116. **PORTUGAL.** Alvados, Serra de Aire e os Candeiros, grutas, 521231 E, 4376584 N, suelos calizos, 445 m, M.A.G. Otálora & M. Prieto, 27/09/2007, M. Prieto 1257 (MA 16309), 1263, 1266.

Placidiopsis cinereoides Breuss, Österr. Z. Pilzk. 5: 84 (1996) Figs. 1c, 2b

[type: España, Palencia, Pico Curavacas, sobre conglomerado silíceo, 1900–2100 m, M.E. López de Silanes, 09/09/1990 (SANT 7072, Holotype!; LI 271013, Isotype!).]

Morphology— Thallus squamulose, composed of contiguous to slightly overlapping squamules, forming a compact rosette; squamules finely lobulate to crenate, flat to slightly convex, up to 2 mm wide; upper surface whitish to greenish grey-brown; lower surface dark with brown rhizohyphae.

Anatomy— Thallus 200–400 µm thick; upper cortex up to 20 µm thick, with roundish-subangular cells of 5–8 µm diam; with or without epinecral layer, up to 50 µm when present. Algal layer filling almost half of the thallus, with cells (3) 5 ± 1.3 (6) µm diam. Medulla subparaplectenchymatous with globular cells of 8–11 µm diam, brownish in the lower zone; lower cortex paraplectenchymatous, of more densely aggregated cells. Rhizohyphae brown, ca. 4 µm.

Perithecia globose, 200–400 µm wide, exciple colourless to brownish; asci 65–80 × 16–20 µm (Breuss 1996), ascospores biseriate, hyaline, septate (occasionally simple), (20) 22–28 (30) × (6.5) 7–8 (8.5) µm. Pycnidia absent.

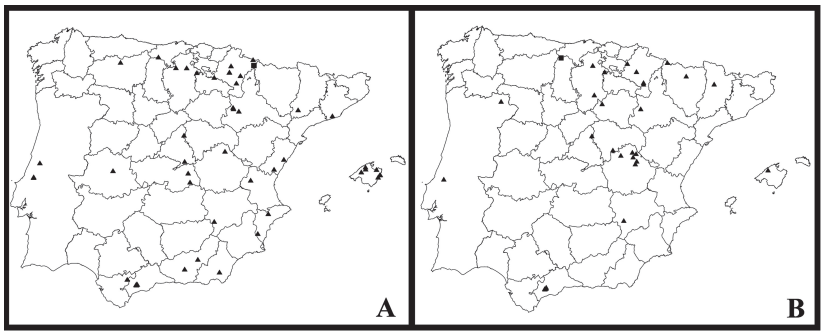

Figure 2. Distribution of *Placidiopsis* species in the Iberian Peninsula and the Balearic Islands. A, *P. cinerascens* (▲) and *P. cavicola* (■); B, *P. custnani* (▲) and *P. cinereoides* (■).

Ecology & Distribution—The species was found growing in a cave over siliceous substrate, in the northern slope, at 1900–2100 m altitude. *Placidiopsis cinereoides* is known only from the type locality in the north half of the Iberian Peninsula.

Comments— The species is well recognized by the presence of larger ascospores and the rosette-like growth.

Placidiopsis custnani (A. Massal.) Körb., Parerga Lichenol. 305 (1863) Figs. 1D, 2B

[type: in opp. Scorgano (Custnano), Verona, A. Massalongo. (A. Massal., Lich exs. Ital. 187, M Lectotype, GE, L, M, W! Isolectotypes).]

Morphology— Thallus squamulose, composed of scattered to contiguous squamules; squamules lobulate to crenate, up to 2(–3) mm wide, with margins ascending and down-rolled; upper surface olive green to brownish or greyish, pruinose or not; lower surface dark brown to black or carbonaceous but pale at margins; attached by a central holdfast of dark rhizohyphae, forming a rhizine-like structure.

Anatomy— Thallus (180) 262.1 ± 51.7 (380) µm thick, upper cortex (7.5) 25.1 ± 9.6 (50) µm thick, paraplectenchymatous, with roundish-subangular cells of (3) 6.4 ± 1.7 (10) µm diam; with or without epinecral layer, up to 50 µm when present. Algal layer 55–175 µm thick, with cells (5) 7.1 ± 1.2 (11) µm diam. Medulla (37.5) 89.5 ± 31.2 (150) µm, composed mainly of globular cells, (4) 6.7 ± 1.3 (10) µm diam; lower cortex not clearly delimited. Rhizohyphae colourless, (3) 3.5 ± 0.5 (4) µm.

Perithecia pyriform to globose, up to ca. 200 µm wide, exciple hyaline to brown or black, darker on the ostiole, up to ca. 20 µm thick; asci clavate, 50–70 × 10–14 µm (Breuss 1996), with a small ocular chamber; ascospores biseriate,

hyaline, septate, (15) 18.2 ± 1.6 (22) × (5) 6.1 ± 0.5 (7.2) µm, l/w ratio (2.3) 3 ± 0.3 (3.8). Pycnidia absent.

Ecology & Distribution — *Placidiopsis custnani* shows preferences for calcareous soils. We have found it mainly in *Pinus halepensis*, *Juniperus thurifera*, and *Quercus ilex* subsp. *ballota* forests; it was found together with *Placidium pilosellum* and sometimes with *Placidiopsis cinerascens*, usually mixed with bryophytes. In the studied area, *P. custnani* was found between 300 and ca. 1500 m altitude.

Placidiopsis custnani has been very infrequently recorded in the Iberian Peninsula. Paz-Bermúdez et al. (2009) reported the second record of the species in the studied region, previously cited from Mallorca (Breuss 1996); this specimen constituted the first record from Portugal. Nevertheless, there are two more records in Spain from 1994 (Hladun & Llimona 2002–07).

Our data considerably extend the known distribution of *P. custnani* in the Iberian Peninsula and the Balearic Islands, with many of the collections constituting first provincial records. The species has been found mainly in central and northern Spain, although there are some localities in southern Spain. In general, the species inhabits colder places than *P. cinerascens.*

Worldwide distribution of *Placidiopsis custnani* includes central Europe reaching northern Europe and the Mediterranean Region (Breuss 1996).

Comments— *Placidiopsis custnani* is easily identified by the presence of ascending squamules with down-rolled margins.

Representative specimens — **SPAIN. Albacete**: Riópar, Sierra de Alcaraz, Calar del Mundo, 555692 E, 426654N, suelo y fisuras calizas, 1530 m, G. Aragón, R. Belinchón y M. Prieto, 01/02/2007, M. Prieto 672, 674. **Burgos**: Contreras, pista hacia Santo Domingo de Silos, Sabinares del Arlanza, 465731 E, 4648768 N, 1276 m, suelo entre musgos, I. Martínez & M. Prieto, 23/08/2007, M. Prieto 1190. Panizares, Sierra de Tesla, 461124 E, 4738773 N, 641 m, suelo entre matorral con boj, I. Martínez & M. Prieto, 23/08/2007, M. Prieto 1168, 1169. **Cuenca**: Las Majadas, Los Callejones, 584688 E, 4459765 N, suelo limoso, 1410 m, M. Prieto, 05/04/2007, M. Prieto 964, 980. **Guadalajara**: Sacedón, carretera hacia Auñón, embalse de Buendía, 521366 E, 4481909 N, 752 m, suelos calizos, M. Prieto, 31/03/2007, M. Prieto 790. **Huesca**: Laguarta, carretera hacia Sabiñánigo, 746634 E, 4706241 N, suelos calizos, 600-700 m, M. Prieto, 04/03/2007, M. Prieto 709 (MA 16303). **La Rioja**: Foncea, 497345 E, 4718904 N, suelos calizos entre matorral con boj, sabina y encinas, 860 m, I. Martínez & M. Prieto, 23/08/2007, M. Prieto 1151 (MA 16310). **Lérida**: Abella de la Conca, Sierra de Carreu, camí Herba-Savina, 832233 E, 4681537 N, suelo entre encinar, 831 m, M. Prieto, 12/08/2008, M. Prieto 1590. **Madrid**: Patones de Arriba, 459550 E, 4524950 N, suelos calizos, 834 m, M. Prieto, 01/05/2008, M. Prieto 1521. **Málaga**: Parauta, Sierra de las Nieves, estribaciones del pinsapar de cerro Alcojona, cerca del pinsapo de la Escalereta, 318103 E, 4060026 N, repisa caliza, 1164 m, I. Martínez & M. Prieto, 12/06/2008, M. Prieto 1452. **Mallorca**: umgebung von Soller, Hohe im Ort, betretener Boden, C. & J. Poelt, 07/04/1964, M. **Navarra**: Bárdenas Reales, hacia el embalse de El Ferial, 616227 E, 4681607 N, suelos yesíferos,

Juniperus phoenicea y *Quercus coccifera*, 362 m, I. Martínez & M. Prieto, 22/08/2007, M. Prieto 1128. **Soria**: Santa María de las Hoyas, monte "Sierra, Jabinada y otros", 489656 E, 4621980 N, suelos calizos en sabinar de *Juniperus thurifera*, 1069 m, R. Belinchón & M. Prieto, 25/05/2006, M. Prieto 633. **Zaragoza**: Oseja, 607653 E, 4606638 N, sustrato yesíferos, suelo entre musgos, 837 m, I. Martínez & M. Prieto, 21/08/2007, M. Prieto 1090. **PORTUGAL**. Bragança, 29TPG799245, rocas básicas, anfibolitas, 955 m, I. Martínez & M. Prieto, 06/09/2006, M. Prieto 838 (MA 16174).

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