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Short note

Some interesting lichens on volcanic rocks in the inland regions of the Iberian Peninsula

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Abstract. We report the first record of *Acarospora insolata, A. irregularis*, *Caloplaca interna, Endocarpon adsurgens,* and *Flavoplaca limonia* in the Iberian Peninsula. The species inhabit volcanic rocks in the Spanish Central Volcanic Region. This finding represents a significant expansion of the distribution range of these five species.

Keywords. Campo de Calatrava, distribution, saxicolous lichens, Spain, volcanic habitat.

Resumen. Se aportan la primera cita de *Acarospora insolata, A. irregularis*, *Caloplaca interna, Endocarpon adsurgens* y *Flavoplaca limonia* en la Península Ibérica. Las especies viven sobre rocas volcánicas en la región volcánica central española. Este descubrimiento amplía significativamente el rango de distribución de estas cinco especies.

Palabras clave. Campo de Calatrava, distribución, España, hábitat volcánico, líquenes saxícolas.

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Title in Spanish: Algunos líquenes interesantes sobre rocas volcánicas del interior de la Península Ibérica.

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Four distinct volcanic regions are well differentiated in the Iberian Peninsula: NE (Girona), Central (Campo de Calatrava), SE (Almería-Murcia), and Levante (Ancochea & al. 2004). These regions exhibit diverse geological characteristics, with a wide range of volcanic rocks (e.g., ultra-potassic, alkaline, calc-alkaline) that are indicative of varying morphological structures, such as cones, domes, and buildings (Ancochea & al. 2004). Therefore, many lichen species in highly diverse communities can be found on volcanic rocks in the Iberian Peninsula (Egea & Llimona 1994; 1997).

The Spanish Central Volcanic Region, also known as Campo de Calatrava, is located in the center of the Ciudad Real province, covering around 5,000 square kilometres, and comprising almost 360 volcanic structures (Becerra-Ramírez & al. 2020). Most of the volcanic formations result from events of low explosivity (Hawaiian and Strombolian eruptions) and are composed of alkaline rocks from the basalt series (Becerra-Ramírez & al. 2020). The landscape of the region is dominated by mountains up to 900 m high, mainly composed of Armorican quartzites (García-Camacho & al. 2004), and the land use is charac-

terized by extensive agricultural, livestock management, or mining activities (Becerra-Ramírez & al. 2020). Consequently, the lichen component will be influenced by the physical and chemical properties of the volcanic rocks, the environmental exposure of the volcanic structures, the different land uses of this zone, and the interaction with the quartzite rocks that cover a substantial portion of the territory.

Previous studies of lichens on volcanic rocks have concentrated in the southeastern (Llimona & Werner 1975; Egea & Llimona 1994**;** 1997) and the northeast (Maheu & Werner 1935; Llop & al. 2013; Llop 2018), while central Spain remains completely unknown. Our note presents five intriguing species discovered on the Iberian Peninsula, which considerably expand their distributional range.

The research was conducted on volcanic rocks situated in the Campo de Calatrava region. The samples were collected from 2021 to 2023 and included in the MACB Herbarium. Species identification was based on the online keys published in ITALIC (Nimis & Martellos 2020) and the following literature: Clauzade & Roux (1982), Breuss & McCune (1994), Vondrák & al. (2009) and Roux & al. (2019). Besides, we have included references containing descriptions, iconography, and ecological preferences, as well as collected materials. We have also explored the relevance of the new locality in relation to its distribution. Figure 1 shows the location of the studied localities. Additionally, images of the species (Fig. 2) have been uploaded to iNaturalist.

Fig. 1. Map with the location of the sampled localities for each of the lichen species reporeted in this study: (1) Castillejos de la Bienvenida (*Acarospora insolata, Flavoplaca limonia*); (2) La Encina (*Acarospora irregularis, Caloplaca interna*); (3) Peñarroya (*Caloplaca interna*); (4) Cerro Gordo (*Caloplaca interna*); (5) Cerro de los Santos (*Endocarpon adsurgens*).

New species records for the Iberian Peninsula

Acarospora insolata H.Magn.—Clauzade & Roux (1982), Nimis (2023). The species grows on the thalli of *Aspiciliella intermutans* (Nyl.) M. Choisy on inclined sunny surfaces of volcanic rocks. According to Clauzade & Roux (1982), the species inhabits non-calcareous rocks and is often parasitic on other lichens. It is a scarce species known from a few localities in north and central Europe (Clauzade & Roux 1982; Vondrak & al. 2022), central Asia (Clauzade & Roux 1982), and the Mediterranean basin, spanning from Sardinia to Turkey (Clauzade & Roux 1982; Oran & Öztürk 2007; Nimis 2023) and Armenia (Harutyunyan & al. 2011). *Acarospora insolata* is similar to *A. impressula* Th.Fr., from which it differs by the presence of an areolate thallus subdivided by a network of fine-medium cracks and slightly wider spores (Clauzade & Roux 1982). According to Westberg et al. (2015), neither of them belong to *Acarospora* s.str.

Specimen examined.—SPAIN. **Ciudad Real**: Bienvenida, Valle de Alcudia, Castillejos de la Bienvenida, 38.65003, -4.52046, 707 m, on volcanic rocks, grass-crop area, 13 Apr. 2023, G. Aragón & al. 1373 (MACB).

Acarospora irregularis H. Magn.—Knudsen & al. (2014). The species grows on volcanic rocks in sunny sites with *Buellia dispersa* A. Massal., *Calogaya arnoldii* (Wedd.) Arup, Frödén & Søchting and *Rinodina teichophila* (Nyl.) Arnold. The species has been reported from central Europe, as well as Greece, Italy, and Turkey (Knudsen & al. 2016; Güllü & al. 2023; Nimis 2023). The nearest records were from Valle d'Aosta (Italian Alps) (Nimis 2023). The species was probably often confused with *A. badiofusca* (Nyl.) Th. Fr., from which it differs by having an algal layer interrupted by hyphal bands (Knudsen et al. 2014).

Specimen examined.—SPAIN. **Ciudad Real**: Aldea del Rey, Campo Volcánico de Calatrava, La Encina, 38.75308, -3.91296, 873 m, on volcanic rocks, crop area, 16 Mar. 2023, G. Aragón & M. Vicente, 1542 (MACB).

Caloplaca interna Poelt & Nimis.—Mouedden & al. (2022), Nimis (2023). The species grows on the thalli of *Aspiciliella intermutans* and *Circinaria caesiocinera*, on sun-exposed volcanic rocks with great roughness and porosity. Its distribution covers throughout the Mediterranean basin, and it has been documented in a few locations in Italy (including Sardinia), on the thalli of *Aspicilia* and *Circinaria* (Nimis 2023); Algeria, on *Circinaria* and *Heteroplacium* (Mouedden & al. 2022); and Turkey, on *Aspicilia* (Breuss & John 2004). Some references require further confirmation concerning the Island of Paros in Greece (Sipman & Raus 1999; Arcadia 2023). These have

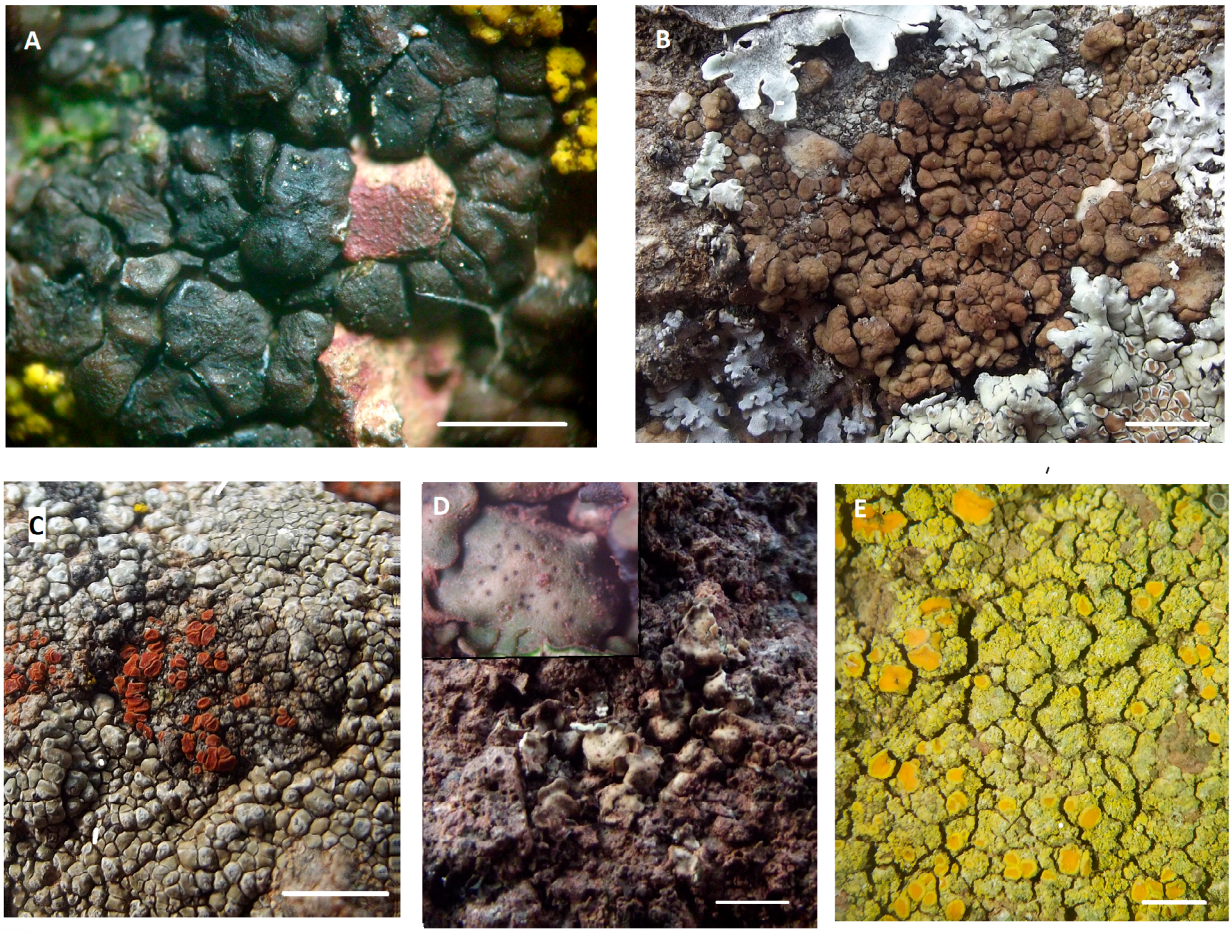

Fig. 2. Field images of the lichen species found in Campo de Calatrava region: **a,** *Acarospora insolata*; **b,** *Acarospora irregularis*; **c,** *Caloplaca interna*; **d,** *Endocarpon adsurgens*; **e,** *Flavoplaca limonia* [scales: a = 1 mm; b, e, = 3 mm; c = 0.5 cm; d = 2 mm].

also been cited in Cape Verde (Sánchez-Pinto & Rodríguez 2005), with the nearest records being from Sardinia Island (Nimis 2023). *Flavoplaca oasis* (A.Massal.) Arup, Frödén & Søchting is a similar parasitic species, but it develops slightly wider spores with a wider equatorial septum, up to 7 µm (Mouedden et al. 2022; Nimis 2023).

Specimens examined.—SPAIN. **Ciudad Real**: Alcolea de Calatrava, Peñarroya, 38.94753, -4.10226, 805 m, on volcanic rocks, grass-crop area, 19 Jan. 2023, G. Aragón & al., nº 1390 (MACB); Aldea del Rey, Campo Volcánico de Calatrava, La Encina, 38.75308, -3.91296, 873 m, on volcanic rocks, crop area, 16-03-2023, G. Aragón & M. Vicente, nº 1432 (MACB); Almagro, Granátula de Calatrava, Cerro Gordo, 38.83107, -3.73973, 785 m, on volcanic rocks, grass-crop area, 16 Mar. 2023, G. Aragón & M. Vicente 1536 (MACB).

Endocarpon adsurgens Vain.—Breuss & McCune (1994), Nimis (2023). It is a terricolous species growing on exposed and hard soils between volcanic rocks. It is a scarce species known from a few localities in north and central Europe, North America (Breuss & McCune 1994; Thell & al. 2014), China (Orange & Chhetri 2022; Zhang & Wei 2023) and Southern Europe (Mayrhofer & al. 2005; 2016; Spribille & al. 2006). The nearest records were from the Alps (Nimis & al. 2018). The species resembles the more common *E. adscendens* (Anzi) Müll.Arg., differing in the dark rhizines and paler spores (Nimis 2023).

Specimen examined.—SPAIN. **Ciudad Real**: Porzuna, Cerro de los Santos, 39.14890, -4.16409, 700 m, on the ground, base of volcanic rocks, grassland area, 8 Jun. 2021, G. Aragón & al. 1168 (MACB).

Flavoplaca limonia (Nimis & Poelt) Arup, Fröden & Sochting—Vondrák & al. (2009), Nimis (2023). The species grows on volcanic rocks, in dry and sun-exposed situations, over gently sloping surfaces, together with *Aspiciliella intermutans* and *Candelariella vitellina* (Hoffm.) Müll.

Arg. *Caloplaca limonia* is a common saxicolous species in the Mediterranean and Black Sea regions (Vondrák & al. 2009), as well as in the UK and Ireland (BLS-https://britishlichensociety.org.uk/). The nearest record was from the French Alps (Roux 2017). Earlier records might probably be under *F. citrina* group (Nimis 2023). *F. limonia* and *F. dichroa* (Arup) Arup, Frödén & Søchting are morphologically similar, although *F. limonia* develops a thicker thallus, dull to bright yellow in color, and coarse soredia. *F. dichroa* has a thinner thallus, yellow to orange in color, and small soredia (Vondrák et al. 2009).

Specimen examined.—SPAIN. **Ciudad Real**: Bienvenida, Valle de Alcudia, Castillejos de la Bienvenida, 38.65003, -4.62046, 707 m, on volcanic rocks, grass-crop area, 13 Apr. 2023, G. Aragón & al. 1250 (MACB).

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AUTHORSHIP CONTRIBUTION STATEMENT

Gregorio Aragón: Conceptualization, Data curation, Investigation, Writing–original draft, Writing–review & editing. Gil Fernando GIMÉNEZ: Data curation, Investigation, Writing–original draft, Writing –review & editing. Valerie NEGRÓN: Data curation, Investigation, Writing–original draft, Writing–review & editing.

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