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Confirmation of the presence of *Philoscia muscorum* (Scopoli, 1763) (Isopoda: Oniscidea: Philosciidae) in the Iberian Peninsula

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Abstract

The presence of *Philoscia muscorum* (Scopoli, 1763) in the Iberian Peninsula has been questioned by some authors in the past. New data from northern localities in Spain confirmed the species in the Iberian Peninsula. Additionally, new ecological data and sympatry with *Philoscia affinis* Verhoeff, 1908 are reported. Finally, figures on the morphology of *P. muscorum* and *P. affinis* are provided.

Key words: *Philoscia muscorum*, *Philoscia affinis*, Asturias, Lugo, sympatry, habitat diversity

Resumen

La presencia de *Philoscia muscorum* (Scopoli, 1763) en la península ibérica ha sido cuestionada por algunos autores en el pasado. Nuevos datos procedentes de localidades situadas al norte de España permitieron confirmar la especie en la península ibérica. Además, se reportan nuevos datos ecológicos y simpatria con *Philoscia affinis* Verhoeff, 1908. Finalmente, se proporcionan figuras sobre la morfología de *P. muscorum* y *P. affinis*.

Palabras clave: *Philoscia muscorum*, *Philoscia affinis*, Asturias, Lugo, simpatria, diversidad de hábitats

Introduction

Philoscia Latreille, 1804 is a woodlouse genus belonging to the family Philosciidae that originally included almost 200 species (Schmalfuss, 2003; Boyko *et al.*, 2008). Certain species were described attending to minor criteria, many of them later synonymised or transferred to other genera (Leistikow, 2001; Schmalfuss, 2003). Currently, the presence of the genus *Philoscia* is limited to the western Palearctic region and includes nine valid species, all of them present in Europe (Boyko *et al.*, 2008). Most species are endemic in southern regions of Europe, mainly the Italian peninsula, while others often have a wider range of distribution (Schmalfuss, 2003). Only two *Philoscia* species occur in areas of the westernmost part of Europe, *Philoscia muscorum* (Scopoli, 1763) and *Philoscia affinis* Verhoeff, 1908. *Philoscia affinis* usually shows arboricolous habits (Vandel, 1962) and mainly lives in damp forests near watercourses or on waterlogged soils (Vandel, 1962; Boeraeve *et al.*, 2017; Segers *et al.*, 2017; Hughes, 2019; Gregory, 2020). It has been reported from European continental sites in Austria, Belgium, Croatia, France, Germany, Great Britain, Hungary, Ireland, Italy, Slovenia and Spain (Schmalfuss, 2003; Vilisics & Lapanje, 2005; Lefebvre, 2012; Farkas & Vilisics, 2013; Boeraeve *et al.*, 2017; Segers *et al.*, 2018; Hughes, 2019; Gregory, 2020). It is also present in north Africa (Algeria) and the Mediterranean islands, for example Corsica, Mallorca, Malta and Sardinia (Garcia & Cruz, 1996; Schmalfuss, 2003). In the Iberian Peninsula, it has only been recorded from the northern half of Spain, namely in Álava, Asturias, Barcelona, Burgos, Cantabria, Girona, Gipuzkoa, La Rioja, Lugo, Navarra, Tarragona and Vizcaya (Schmölzer, 1955, 1971; Fidalgo & Herrera, 1980; Cifuentes, 1984, 2019; Vivar *et al.*, 1984; Cruz, 1991; Vázquez-Felechosa *et al.*, 2004).

On the contrary, *P. muscorum* is an ubiquitous species that inhabits mountainous environments, deciduous forests on humic soils, damp grasslands, salt marshes and estuarine meadows (Vandel, 1962), especially in damp microhabitats as dead wood, leaf litter or moss, since the species shows negative phototaxis and cannot resist desiccation (Cloudsley-Thompson, 1956; Vandel, 1962). It has been reported from Belgium, Czechoslovakia, Denmark, France, Germany, Great Britain, Greece, Hungary, Ireland, Italy, Netherlands, Norway, Poland, Portugal and Spain (Schmalfuss, 2003), and was introduced into North America (Jass & Klausmeyer, 2000). In the Iberian Peninsula, *P. muscorum* has scarcely been reported, with records from Lisbon (Preudhomme De Borre, 1886; Jackson, 1926) and Gipuzkoa (Dollfus, 1892). It is difficult to assess the real distribution of both species in Europe because some authors did not use accurate diagnostic characters and misidentified species. In most cases, *P. muscorum* can be readily distinguished from *P. affinis* by the colour pattern (Vandel, 1962; Gruner, 1966; Boeraeve *et al.*, 2017; Gregory, 2020), although this character has proven to be quite variable, thus complicating a correct identification when specimens show intermediate patterns. Secondary sexual characters of males are the most reliable to distinguish *P. muscorum* from *P. affinis* (Vandel, 1962; Gruner, 1966; Boeraeve *et al.*, 2017; Gregory, 2020). Identification based on these characters made it possible to report for the first time *P. affinis* in some localities of Belgium (Boeraeve *et al.*, 2017) and Great Britain (Segers *et al.*, 2018) where only *P. muscorum* had been found.

Records of *P. muscorum* in Spain were questioned by Schmalfuss (2003) because only female specimens could be studied. The main goals of this work are to confirm the presence of *P. muscorum* in the Iberian Peninsula and provide new population data from Álava, Asturias, Lugo and Navarra (northern Spain) where only *P. affinis* had previously been reported. Additionally, morphological and ecological remarks are provided and the distribution of *P. muscorum* in the Iberian Peninsula is discussed.

Material & methods

Surveys were carried out in the north-western Iberian Peninsula (Asturias and Lugo, Spain) (Fig. 1) in 2020. Many localities and habitats were visited to collect specimens, mainly under stones, dead wood, moss, leaf litter and humus (Fig. 2A-F). Additionally, unpublished records from Álava, Gipuzkoa and Navarra provided by S. J. Gregory (British Myriapod and Isopod Group) are included. Specimens were hand collected and then fixed and preserved in 96% ethanol. Specimens are kept in the first author's collection. Specimens of *P. muscorum* were photographed *in situ* with a Panasonic Lumix DMC-FZ200 camera equipped with a Raynox DCR-250 macro lens. Specimens of *P. affinis* were photographed by M. Álvarez Fidalgo with a Nikon D5300 camera equipped with Tamron 90 mm macro lens. Works on the morphology of the genus *Philoscia* were consulted to identify species (Sars, 1898; Vandel, 1962; Gruner, 1966; Sutton, 1972; Harding & Sutton, 1985; Hopkin, 1991; Boeraeve *et al.*, 2017; Hughes, 2019; Gregory, 2020). The seventh pereopods of males were dissected and mounted on glass slides using DMHF. A Nikon Coolpix 995 camera coupled to a Levenhuk 7S NG monocular microscope was used to photograph them. Photographs were edited with GIMP 2.8. Maps were generated with ArcGis Desktop 10.8.1.

Results

Philoscia muscorum (Scopoli, 1763)

Material examined: Spain – Álava: Sierra de Peña Gorbeia, Zuia (Álava): 1♂/3♀, 24-IV-2009, 650 m. (30T 0513859 4759129), S. J. Gregory *leg.* Asturias: La Finlandesa, Toleo (Oviedo): 1♂/1♀, 20-VIII-2020, 310 m. (30T 270230 4807557). Yana'l Monte, Turón (Mieres): 1♂/1♀, 28-VIII-2020, 297m (30T 276265 4787617). El Rebollar, Siero (Pola de Siero): 10♀, 03-IX-2020, 239m. (30T 284986 4808039). Entrance of the cave Santiago de Rodiles, Selorio (Villaviciosa): 5♂/6♀, 19-IX-2020, 9 m. (30T 307639

4822585). Forest of Monte Naranco (El Llugarín), Cuyences (Oviedo): 1♂, 20-IX-2020, 303 m. (30T 270443 4809117). Misiego beach, Selorio (Villaviciosa): 2♀, 24-IX-2020, 2m. (30T 307679 4821644). Private garden of Somines (Gurullés): 3♀, 27-IX-2020, 204 m. (29T 742012 4805883). Mofusu forest, Piedracea (Lena): 1♂/2♀, 01-X-2020, 435 m. (30T 267647 4781614). Private garden of Piantón (Vegadeo): 3♂/1♀, 03-X-2020, 28 m. (29T 659488 4813935). Near Islote de la Tortuga, Somió (Gijón): 1♂/3♀, 12-X-2020, 9 m. (30T 288653 4826002). **Lugo:** Reme de Arriba (Ribadeo): 1♀, 12-X-2020, 55 m. (29T 655944 4817704). **Navarra:** Sierra de Aralar, Betelu (Pamplona): 1♂/1♀, 21-IV-2009, 270 m. (30T 0584283 4763710); 2♂, 21-IV-2009, 290 m. (30T 0584772 4763038); 1♂/3♀, 21-IV-2009, 400 m. (30T 0584734 4762172), S. J. Gregory *leg.*

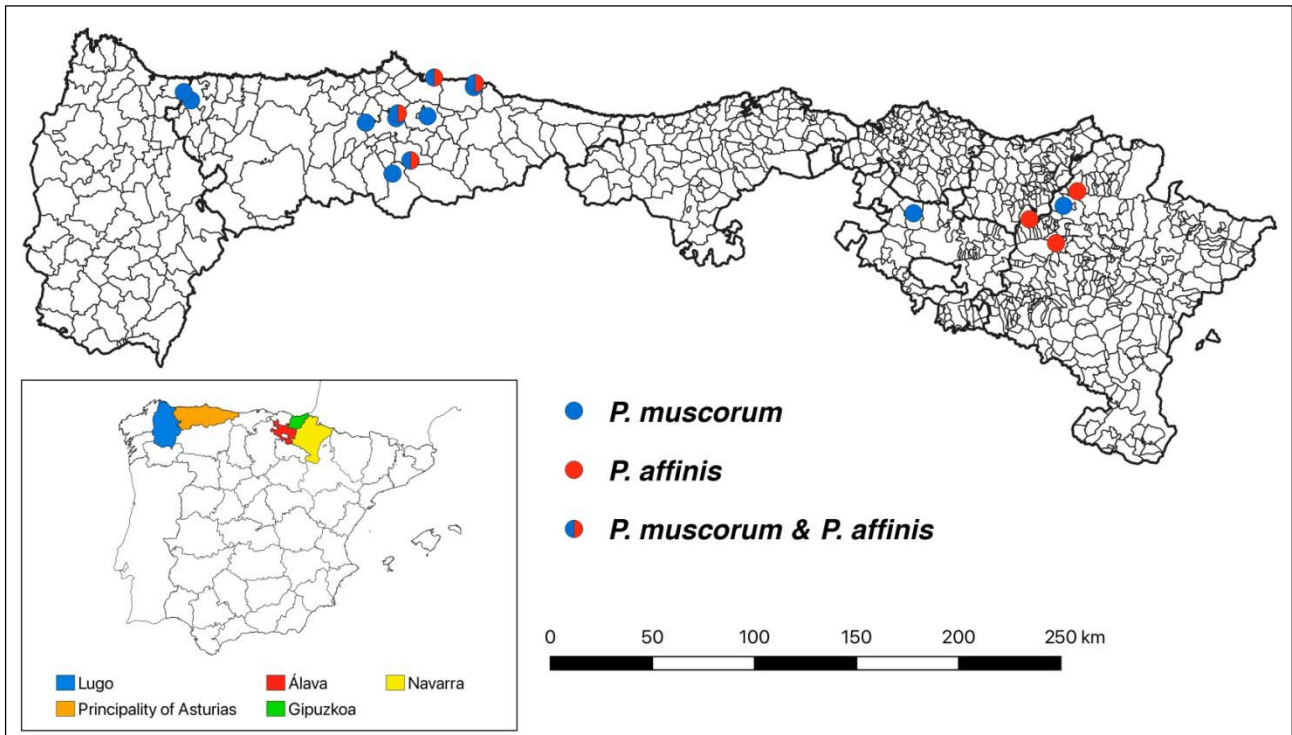


Figure 1. Geographical situation and *Philoscia* populations detected in the northern Iberian Peninsula.

Morphological remarks: Head darker than body, non-mottled and uniformly pigmented with black or other colours, occasionally with a yellow spot on the posterior region. Body with orange/brown and white stripe along the edge of the epimera (Fig. 3A). Only one specimen showed slight variability in the colour pattern. In lateral view, the protuberance of the merus of the seventh pereopods of males appears as a low rounded bump (Fig. 4A-B). Males were detected in 11 of the 15 populations (Fig. 1). The typical *habitus* of *P. muscorum* (Fig. 3A) was found in 54 of the 55 specimens. Only the male from the forest of Monte Naranco (El Llugarín) showed a different *habitus*, similar to *P. affinis*, but male sexual characters corresponded to *P. muscorum*.

Ecological remarks: Specimens were collected under stones and in leaf litter in oak forests (*Quercus robur* L.) (Fig. 2C), beech forests (*Fagus sylvatica* L.), southern blue gum forests (*Eucalyptus globulus* Labill.), laurel forests (*Laurus nobilis* L.) and mixed forests of chestnut (*Castanea sativa* Mill) and hazel (*Corylus avellana* L.) (Fig. 2D). Several specimens were found in dead wood, leaf litter, under the moss on wet walls in rural and urban areas (Fig. 2A-B), under grass on a rocky cliff near a freshwater source (Fig. 2F) and in dune ecosystems (Fig. 2E). Additionally, *P. muscorum* was also found in synanthropic areas as pastures or beside buildings and rubbish. Specimens were found inactive and hidden under moss and bark during the day and active at night walking on moss or grass in damp pastures.



Figure 2. Several habitats of *Philoscia* species. A) Rocky wall with moss in Yana'l Monte (Turón, Mieres). B) Outside wall of the cave Santiago de Rodiles (Selorio, Villaviciosa). C) Oak forest in Monte Naranco - El Lluarín, (Cuyences, Oviedo). D) Mixed forest of oak, hazel and chestnut in Mofusu forest (Piedracea, Lena). E) Salt marsh near Misiego beach (Selorio, Villaviciosa). F) Rocky cliff near a freshwater source, near Islote de la Tortuga (Somió, Gijón).

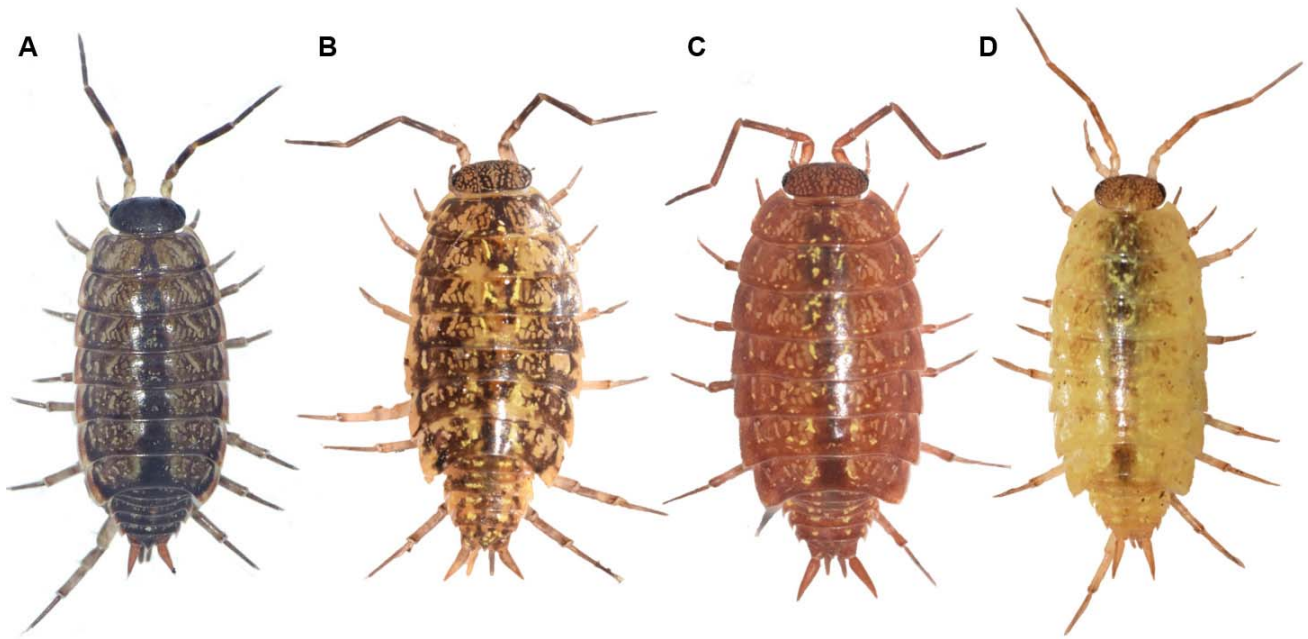


Figure 3: Colour patterns of *Philoscia* specimens collected in Asturias and Lugo. A). Typical layout of *P. muscorum* (Author: D. Cabanillas). B-D). Typical layouts of *P. affinis* showing colour variability (Author: M. Álvarez Fidalgo).

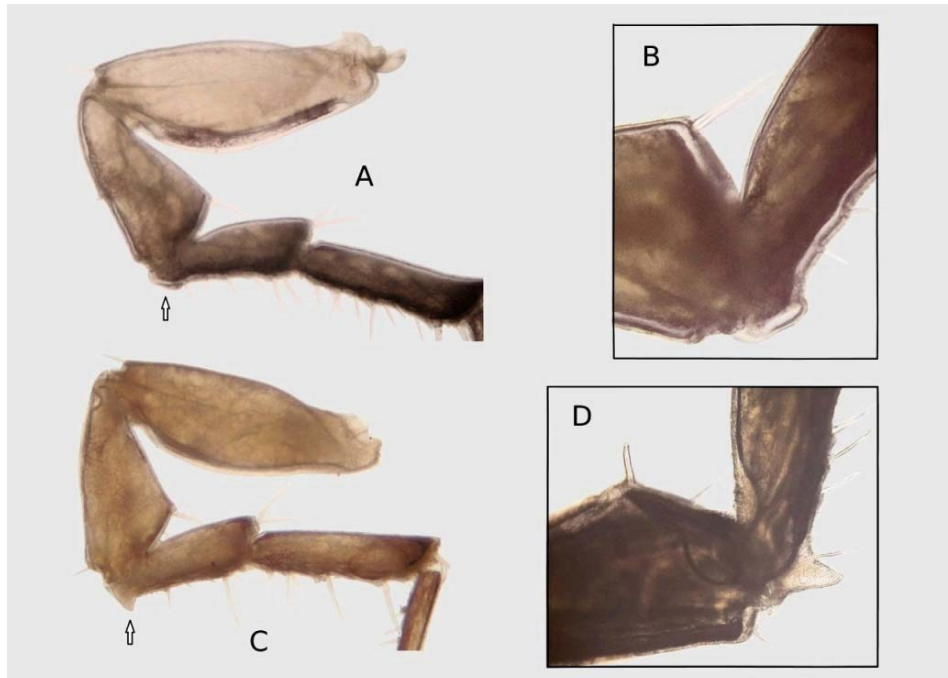


Figure 4: Morphology of the seventh pereopod of *Philoscia* males collected in Asturias, lateral view (arrows indicate the protuberance of the merus). A) Seventh pereopod of *P. muscorum*. B) Small and rounded protuberance in *P. muscorum*. C) Seventh pereopod of *P. affinis*. D) Protruding and triangular protuberance in *P. affinis*.

***Philoscia affinis* Verhoeff, 1908**

Material examined: **Spain – Asturias:** Entrance of the cave Santiago de Rodiles, Selorio (Villaviciosa): 1♂, 19-IX-2020, 9 m. (30T 307639 4822585). Forest of Monte Naranco (El Lluugarín), Cuyences (Oviedo): 1♂/7♀, 20-IX-2020, 303 m. (30T 270443 4809117). Forest near Arroyo de Fayas on Yana'l Monte, Turón (Mieres): 1♂/2♀, 03-X-2020, 319 m. (30T 276315 4787462). Near Islote de la Tortuga, Somió (Gijón): 3♂/6♀, 12-X-2020, 9 m. (30T 288653 4826002). **Gipuzkoa:** Sierra de Aralar, Kaxeta (Goierry): 1♂, 21-IV-2009, 310 m. (30T 0568807 4756507), S. J. Gregory *leg.* **Navarra:** Pico del Aritz, Leitza (Pamplona): 1♂/2♀, 20-IV-2009, 580 m. (30T 0591313 4770031); 1♂, 20-IV-2009, 750 m. (30T 0591994 4770251). Between Sierra de Urbasa and Sierra de Andía, Ergoiena (Pamplona): 2♂/1♀, 22-IV-2009, 950 m. (30T 0580758 4746086), S. J. Gregory *leg.*

Morphological remarks: Generally, head brown with pale yellowish mottling often appearing the same colour as body. No orange/brown and white longitudinal stripes along the edge of the epimera as in *P. muscorum* (Fig. 3B-D). Many specimens showed variability in the colour pattern (Fig. 3B-D). In lateral view, males show a prominent, triangular projection on the merus of the seventh pereopods (Fig. 4C-D). A total of 8 populations were detected, all of them with males and females (Fig. 1). The typical *habitus* of *P. affinis* was found in 28 of the 29 specimens.

Ecological remarks. Specimens were collected in leaf litter and under tree bark in mature oak forests (*Quercus robur* L.) (Fig. 1D) on humic soils, southern blue gum forests (*Eucalyptus globulus* Labill.) and mixed forests of hazel (*Corylus avellana* L.) and chestnut (*Castanea sativa* Mill.) (Fig. 2D). *P. affinis* was also found on wet walls (Fig. 2B) and under grass on a rocky cliff near a freshwater source (Fig. 2F). In addition, *P. affinis* was found in beech pollards, at edge of streams and meadows, mostly beneath stones, logs or moss. At night all specimens were inactive. During the day specimens were hidden under bark and moss, but others were active moving on the bark.

Discussion

The presence of *P. muscorum* in the Iberian Peninsula has always been matter of discussion. Vandel (1962) did not question the validity of the Portuguese records of *P. muscorum* but considered the species introduced. He also noted that *P. muscorum* specimens from Catalonia (Arcangeli, 1924, 1925) were actually *P. affinis*. Schmalzfuss (2003) mentioned that Iberian records of *P. muscorum* (Preudhomme De Borre, 1886; Dollfus, 1892; Jackson, 1926; Schmölzer, 1955, 1971) needed to be reviewed because only female specimens were studied. Cifuentes (2019) reviewed the collection of Schmölzer and reported that specimens identified as *P. muscorum* actually corresponded to *P. affinis*, thus concluding *P. muscorum* does not occur in Galicia. It is difficult to assess the real distribution of *P. muscorum* in the Iberian Peninsula because no morphological or sexual data were provided in reports from Lisbon (Preudhomme De Borre, 1886; Jackson, 1926) and Gipuzkoa (Dollfus, 1892). Consequently, some authors questioned the presence of *P. muscorum* in the Iberian Peninsula until males could be studied. The present study finally confirms the presence of *P. muscorum* in the Iberian Peninsula after examining male specimens. Although former reports suggested that *P. affinis* was the most common species living in the north of the Iberian Peninsula, the possibility exists that *P. muscorum* could also be common in this area since 15 populations were found in several habitats. Lack of exhaustive studies on woodlouse fauna in the north of the Iberian Peninsula could have concealed the presence of *P. muscorum* in this area. Only 8 populations of *P. affinis* were found in northern Spain, suggesting *P. muscorum* could be more widespread than *P. affinis* in northern Iberian regions. More studies will be necessary to know the relative abundance of *Philoscia* species in northern woodlouse communities. *P. muscorum* is apparently an ubiquitous species and more tolerant to diverse ecological conditions than *P. affinis* (Vandel, 1962). Specimens of *P. muscorum* were always found in moist microhabitats, coinciding with previous ecological remarks provided by Cloudsley-Thompson

(1956) and Vandel (1962). Specimens of *P. affinis* were often found in damp forests, coinciding with findings of other authors (Vandel, 1962; Boeraeve *et al.*, 2017; Segers *et al.*, 2018; Hughes, 2019; Gregory, 2020). Coastal records of *P. affinis* are uncommon but sometimes specimens are found in dead wood on beaches, and in pasturelands and forests near the coast (Hughes, 2019; Gregory, 2020). These coastal environments were absent in Islote de la Tortuga, but several specimens were found under grass on a rocky cliff near a freshwater source. In three Asturian sites both species were found in sympatry, coinciding with the observations of Gregory (2020) in Great Britain. When sympatry occurs, it is important to examine secondary sexual characters of males, especially when specimens show intermediate colour patterns. However, *habitus* of both species have been described by many authors. The examined *habitus* of *P. muscorum* fitted the original and later descriptions (Sars, 1898; Gruner, 1966; Sutton, 1972; Hopkin, 1991; Boeraeve *et al.*, 2017; Segers *et al.*, 2017; Hughes, 2019; Gregory, 2020), particularly the non-mottled head and the layout of the epimera. The studied specimens of *P. affinis* showed more variability than *P. muscorum* in colour patterns, also coinciding with previous descriptions (Vandel, 1962; Segers *et al.*, 2017; Boeraeve *et al.*, 2017; Hughes, 2019; Gregory, 2020). Overall, colour patterns appear to be a good way to rapidly distinguish both species when showing typical forms.

In summary, *P. muscorum* is finally confirmed in the Iberian Peninsula and reported for the first time in Spain, thus expanding its known distribution in southern and western Europe and improving ecological and morphological knowledge of *Philoscia* species in the Iberian Peninsula.

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