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ABSTRACT
Brachythecium turgidum (Hartm.) Kindb. is currently known in the Iberian Peninsula only from a few localities in the Pyrenees. In this work a new locality is reported for southern Spain (Granada, Sierra Nevada), that represents an important disjunction of the species in the Iberian Peninsula and Europe. Its ecological behavior is described and some fundamental taxonomical characters for its identification are corroborated and illustrated.

KEY WORDS
Spain, bryophytes, Sierra Nevada, *Brachythecium*, new record.

RÉSUMÉ
Brachythecium turgidum *(Hartm.) Kindb. (Brachytheciaceae) dans l'étage oroméditerranéen de la Sierra Nevada (sud de l'Espagne).*
Brachythecium turgidum (Hartm.) Kindb. n'est actuellement connu dans la péninsule ibérique que par quelques localités dans les Pyrénées. Dans ce travail, une nouvelle localité est signalée dans le sud de l'Espagne (Granada, Sierra Nevada), qui représente une disjonction importante de l'espèce entre la péninsule ibérique et l'Europe. Son comportement écologique est décrit et certains caractères taxonomiques fondamentaux pour son identification sont corroborés et illustrés.

MOTS CLÉS
Espagne, bryophytes, Sierra Nevada, *Brachythecium,* signalement nouveau.

INTRODUCTION

The genus *Brachythecium* Schimp. is one of the most complex and diverse genera in terms of morphological variation in the family Brachytheciaceae. It includes approximately 150 species in the world (Crosby *et al.* 1999; Frey & Stech 2009), distributed mainly in temperate areas. It is mainly characterised by small to large plants, usually concave and plicate, lanceolate to ovate leaves, autoicous or dioicous sexual conditions, rough or smooth setae and a conic operculum. In recent years the taxonomical status of *Brachythecium* has changed notably, since Ignatov & Huttunen (2002) carried out molecular studies in *Brachytheciaceae* using molecular markers. According to these studies, species previously placed in *Brachythecium* are now placed in three different genera: *Brachytheciastrum* Ignatov & Huttunen, *Brachythecium* and *Sciuro-hypnum* (Hampe) Hampe within the Brachytheciaceae. In Europe, 21 species of *Brachythecium* are known (Hodgetts *et al.* 2020), of which 12 species have been cited in the Iberian Peninsula (Orgaz *et al.* 2012, Orgaz 2018). Of all of them, one the least known in this territory, from the point of view of its distribution, is *Brachythecium turgidum* (Hartm.) Kindb., known only from some localities in the Pyrenees.

This paper reports the discovery of *Brachythecium turgidum* in the Sierra Nevada (Granada, southern Spain), a locality that represents an important disjunction of the species in the Iberian Peninsula and Europe.

MATERIAL AND METHODS

The plant material used in this work consisted of a specimen collected during a bryological sampling in Sierra Nevada (Granada, southern Spain), where the authors carried out a study on the habitat and ecological behavior of arctic-alpine bryophyte species that are found in this territory. Microscopic examination and measurements were performed with an Olympus-BH2 optical microscope, while microphotographs were obtained with a Spot insight QE camera mounted on this microscope.

RESULTS

The sample collected in Sierra Nevada (Spain) was identified as *Brachythecium turgidum*, a species not recorded in this mountain system.

Family Brachytheciaceae Schimp.
Genus *Brachythecium* Schimp.

Brachythecium turgidum (Hartm.) Kindb.

Videnskabelige Meddelelser den Naturhistoriske Forening Kjøbenhavn 49: 294 (Kindberg 1888). — *Hypnum salebrosum* var. *turgidum* Hartm., *Handbok i Skandinaviens Flora* (Third edition) 2: 309. 1838 (Hartman 1838).

Material examined. — **Spain** • Granada, Sierra Nevada, Dehesa del Camarate, alrededores de la Piedra de los Soldados y barranco de las Chorreras; 37°09'N, 3°15'W; 2400 m a.s.l.; 22.V.2024; leg. *Guerra*, *Cano*, *Jiménez & Rodríguez*; MUB 63151.

Distribution. — *Brachythecium turgidum* is a Northern Hemisphere species (cf. GBIF 2024), with arctic-alpine distribution. It is found in North America (Ignatov 2014), Asia (Ignatov *et al.* 2006) and Europe (Hodgetts *et al.* 2020). In the Mediterranean Region it grows between 1900 and 2900 m a.s.l. on soils or rocks in humid mountainous areas. From the Pyrenees it is known of France, Andorra and Spain (Lérida and Barcelona provinces) (Orgaz 2018; Brugués *et al.* 2021). The locality that we provide here is probably the southernmost record of the species, both in Europe and in the American continent (Fig. 1).

Taxonomical notes

Brachythecium turgidum can be confused with some other species of the genus that exist in the Iberian Peninsula. The closest species is *B. glareosum* (Bruch *ex* Spruce) Schimp., from which it is differentiated by the orbicular-shaped, obtuse, sometimes short-apiculate pseudoparaphyllia and the alar cells of the leaves with slightly thickened walls in the old leaves. *Brachythecium glareosum* has markedly triangular, long-apiculate pseudoparaphyllia, and even in old leaves the walls of the alar cells are thin. *Brachythecium turgidum* is autoicous and *B. glareosum* is dioicous. The samples collected in Sierra Nevada are autoicous. Furthermore, the habitats of both species are very different, since *B. turgidum* is grows in high montane areas, while *B. glareosum* is common in forested areas at lower altitudes.

Brachythecium turgidum can also be confused with *B. salebrosum* (Hoffm. ex F.Weber & D.Mohr) Schimp., since the shape of the leaves is quite similar. The most relevant difference between both species is the following, *Brachythecium salebrosum* has triangular to lanceolate pseudoparaphyllia, while *B. turgidum* has orbicular, obtuse or short-apiculate pseudoparaphyllia (Orgaz *et al.* 2012). Additionally *Brachythecium turgidum* has entire leaf margins, sometimes with some scattered teeth at the apex, and alar cells clearly ascending up along the leaf margins. *Brachythecium salebrosum* has leaves with more or less denticulate leaf margins, especially towards the apex, and the alar cells forming a small group, scarcely ascending up along the leaf margins. (Fig. 2).

Habitat

Brachythecium turgidum has been found in the Oromediterranean belt of Sierra Nevada, which corresponds to those areas that have average annual temperatures between 8°C and 4°C, typical of the highest mountains of the Iberian Peninsula, always above 1600 m a.s.l. The vegetation of this belt in Sierra Nevada is characterized by the absence of trees and a thicket of junipers (*Juniperus sabina* L., *Juniperus communis* subsp. *alpina* (Suter) Čelak.), barberry (*Berberis hispanica* Boiss. & Reut.) and genisteae (*Cytisus galianoi* Talavera & P.E.Gibbs, *Genista versicolor* Boiss.) predominate (Fig. 3, top).

Fig. 1. — Known distribution of *Brachythecium turgidum* (Hartm.) Kindb. in the Iberian Peninsula. The star indicates the new Spanish record reported.

In the bottoms of glacial cirques, hygrophytic grasslands appear, known locally as "borreguiles", very rich in endemic species such as *Armeria splendens* Webb, *Carex camposii* Boiss. & Reut., *Gentiana sierrae* Briq., *Pinguicola nevadensis* (H.Lindb.) Casper, *Plantago nivalis* Boiss., *Veronica nevadensis* (Pau) Pau, etc. (Blanca 2001). These grasslands are crossed by streams, with numerous species of bryophytes growing on their banks; it is in these places where *B. turgidum* has been found, accompanied by *Bartramia ithyphylla* Brid., *Brachytheciastrum collinum* (Schleich. *ex* Müll.Hal.) Ignatov & Huttunen, *Brachythecium rivulare* Schimp., *Campylium stellatum* (Hedw.) Lange & C.E.O.Jensen, *Jungermannia hyalina* Lyell, *Rhizomnium punctatum* (Hedw.) T.J.Kop., *Scapania undulata* (L.) Dumort. and *Tortula hoppeana* (Schultz) Ochyra (Fig. 3, arrow).

Brachythecium turgidum joins an important number of arctic-alpine bryophytes present in the Sierra Nevada, such as *Amphidium lapponicum* (Hedw.) Schimp., *Bryum schleicheri* DC., *Bryum weigelii* Spreng., *Hymenoloma mulahaceni* (Hohn.) Ochyra, *Oncophorus virens* (Hedw.) Brid., *Pohlia bolanderi* (Lesq.) Broth., *Pohlia greenii* Brid., *Polytrichastrum alpinum* (Hedw.) G.L.Sm., *Schistidium agassizii* Sull. & Lesq., etc. (Rams *et al.* 2001; Guerra 2019, 2021). The causes for the unusual number of these species present in this mountain system probably began at the end of the Tertiary Era, almost 1.7 million years ago. The climate in all of Europe suffered a progressive cooling that allowed plant species from northern and arctic latitudes to progressively advance towards southern Europe and occupy a large part of the interior and high areas of the Iberian Peninsula. The end of the Würm Glaciation and the arrival of the Holocene period marked the beginning of a progressive increase in temperatures, and these species adapted to cold climates found refuge in the heights of the Sierra Nevada, progressively adapting to the characteristics of the climate of the area, especially to its summer droughts.

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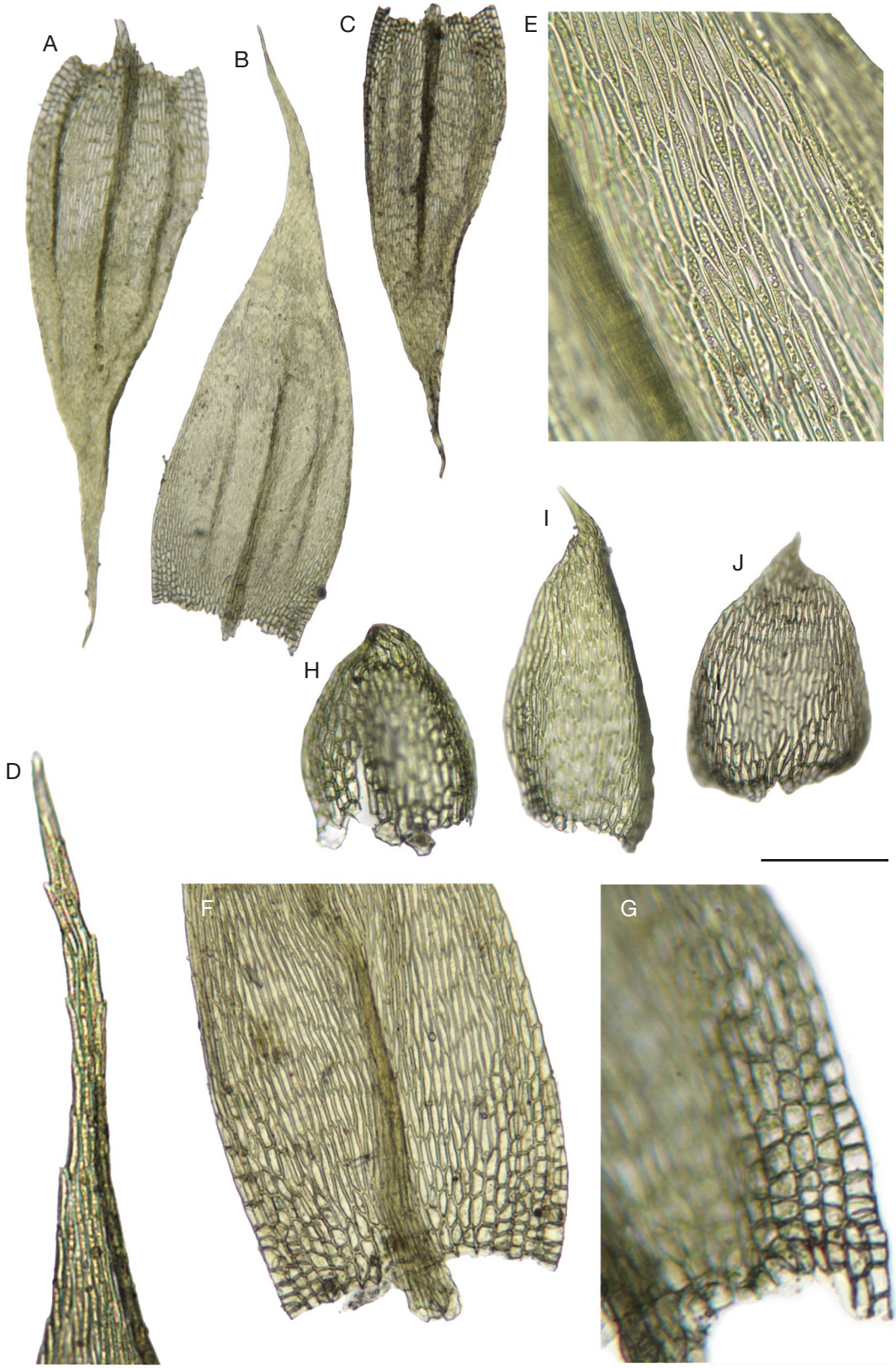

Fig. 2. — Light microscope images of *Brachythecium turgidum* (Hartm.) Kindb. (from MUB 63151): **A-C**, leaves; **D**, apex of leaf; **E**, laminal cells in mid-leaf; **F**, leaf base with alar cells; **G**, alar cells; **H-J**, pseudoparaphyllia. Scale bar: **A-C**, 0.25 mm; **D**, 75 µm; **E**, 40 µm; **F**, 100 µm; **G**, 80 µm; **H-J**, 80 µm.

Fig. 3. — Habitat (arrow) of *Brachythecium turgidum* (Hartm.) Kindb. in Sierra Nevada (Spain). Photo credits: O. Rodríguez.

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