

### *Sphagnum lindbergii* Schimp.: a new peat moss species to the Iberian Flora

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# ***Sphagnum lindbergii* Schimp.: a new peat moss species to the Iberian Flora**

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## **ABSTRACT**

*Sphagnum lindbergii* Schimp., a moss species of circumpolar distribution, is reported for the first time in Spain and in the Iberian Peninsula. This discovery, made in the chalybeate springs in the Chistau Valley (Central Pyrenees), adds to the only Pyrenean population currently known, limited to the French Rioumajou Valley. The Spanish population comprises four small patches occupying an estimated 5 m<sup>2</sup>. We describe its morphology, emphasizing diagnostic traits, and its habitat, characterized by iron-rich flushes in acidic, sub-alpine environments. The population faces significant threats, including livestock trampling and climate change, prompting its classification as Critically Endangered (CR) following IUCN criteria. Conservation measures are urgently recommended given its extreme rarity in the Pyrenees.

## **KEY WORDS**

Mires,  
peatlands,  
Spain,  
Pyrenees,  
Bryophyta,  
new record.

## RÉSUMÉ

*Sphagnum lindbergii* Schimp. : une nouvelle espèce de sphaigne pour la flore ibérique.

*Sphagnum lindbergii* Schimp., une espèce de mousse à distribution circumpolaire, est recensée pour la première fois en Espagne et dans la péninsule ibérique. Cette découverte, réalisée dans les sources d'eau ferrugineuse de la vallée de Chistau (Pyrénées centrales), s'ajoute à la seule population pyrénéenne actuellement connue, limitée à la vallée française du Rioumajou. La population espagnole comprend quatre petites parcelles couvrant une surface estimée à 5 m<sup>2</sup>. Nous décrivons sa morphologie, en mettant l'accent sur les caractères diagnostiques, et son habitat, caractérisé par des eaux riches en fer dans des environnements subalpins acides. La population est confrontée à des menaces importantes, notamment le piétinement du bétail et le changement climatique, ce qui a conduit à la classer dans la catégorie « en danger critique d'extinction » (CR) selon les critères de l'UICN. La mise en place de mesures de conservation sont fortement recommandées étant donné son extrême rareté dans les Pyrénées.

## MOTS CLÉS

Bas-marais,  
tourbières,  
Espagne,  
Pyrénées,  
Bryophyta,  
nouveau signalement.

## INTRODUCTION

Peat mosses, i.e. mosses belonging to the genus *Sphagnum* L., are key ecosystem engineers in mires. In addition to ombrotrophic bogs, they grow extensively in minerotrophic acid fens and flushes, often determining the vegetation composition of both vascular plants and bryophytes (Rydin & Jeglum 2013; Piatkowski *et al.* 2021). The vegetation of fens and flushes, primarily belonging to the phytosociological class Scheuchzerio palustris-Caricetea fuscae Tx 1937, includes sphagnum-rich carpets in mineral-poor waters (Pérez-Haase & Ninot 2017; López Sáez *et al.* 2023). Regarding vegetation composition, microhabitat suitability and narrow ecological niche preferences make *Sphagnum* species important ecological indicators in mire habitats. Furthermore, mires are among the most threatened ecosystems in Southern Europe (Tanneberger *et al.* 2021), where they are distributed over small and scattered areas in a rugged landscape. Additionally, several *Sphagnum* species reach their southernmost limit in Iberian mires (Daniels & Eddy 1990).

Beyond their ecological significance, *Sphagnum* is a cosmopolitan and highly diverse genus of mosses, comprising approximately 300 species (Michaelis 2019). Of these, 29 species are found in the Pyrenees (FLORAPYR 2019). Among them, *Sphagnum lindbergii* Schimp. is notable for its scarcity and biogeographical uniqueness. This circumpolar species thrives in cold, wet ecosystems from the Arctic to boreal zones but becomes much rarer in alpine mountain ranges (Daniels & Eddy 1990; Gauthier & Pujos 1999). In the Pyrenees, it was only reported from a small area in the Rioumajou Valley (municipality of Tramezaines), located in the French department of Hautes-Pyrénées. In fact, this is the only known station of the species in France, and it was previously unrecorded in the Iberian Peninsula (Gauthier & Pujos 1999; Heras Pérez & Infante Sánchez 2019). Schimper named *Sphagnum lindbergii* in honour of the Swedish botanist Sextus Otto Lindberg, who described the subgenus Cuspidata, to which *S. lindbergii* belongs. This subgenus is a widespread cosmopolitan taxon that reaches its highest diversity in sub-arctic and cool-temperate zones. Brugués *et al.* (2004) documented that, in the Iberian Peninsula, this subgenus includes seven of the 16 species found across Europe (Hodgetts *et al.* 2020).

In this article, we aim to report the occurrence of *Sphagnum lindbergii* in Spain.

## MATERIAL AND METHODS

The fieldwork was designed to sample mire vegetation and *Sphagnum* species in springs, flushes, and fens influenced by chalybeate waters in the Culfreda-Bachimala area, Chistau Valley, Huesca province, Central Pyrenees. After analysing the available orthoimages, we identified the Montarruegos pastures as particularly notable due to the prevalence of chalybeate springs that stain rivulets and rills red. Considering the proximity of *S. lindbergii* populations in France, we included this species in our list of potential occurrences in the area.

To ensure the identity of the species, *Sphagnum* samples were collected, air-dried, and stored in the herbarium of the University of Barcelona (voucher codes BCN-bryo 4338 and BCN-bryo 4339). Specimens were identified using the keys of Daniels & Eddy (1990) and Smith (2004).

Given the species' extreme regional rarity, we assessed potential conservation threats following IUCN methodology (2024).

## RESULTS AND DISCUSSION

### NEW POPULATION

On September 28, 2024, we found a new population of *Sphagnum lindbergii* in the Spanish Central Pyrenees, specifically in Huesca, Chistau Valley, Montarruegos pastures (Fig. 1), at elevations between 2145 and 2160 m a.s.l. We identified the species in the field and spent additional time searching for further patches. Our efforts led to the discovery of only four small patches in the Montarruegos area. Three patches were located near the coordinates 42°40'3"N, 0°18'29"E, and the fourth patch was at 42°40'14"N, 0°18'59"E (respectively ED50 UTM MGRS 31TBH72 and 31TBH82). In total, the species occupied an estimated area of only 5 m<sup>2</sup>, with the largest patch occupying approximately 3 m<sup>2</sup>. The maximum lineal distance between patches was 750 m. We conducted an exhaustive survey only of the Montarruegos valley, visiting all wet patches suitable for *S. lindbergii* (above the Sallena hut),

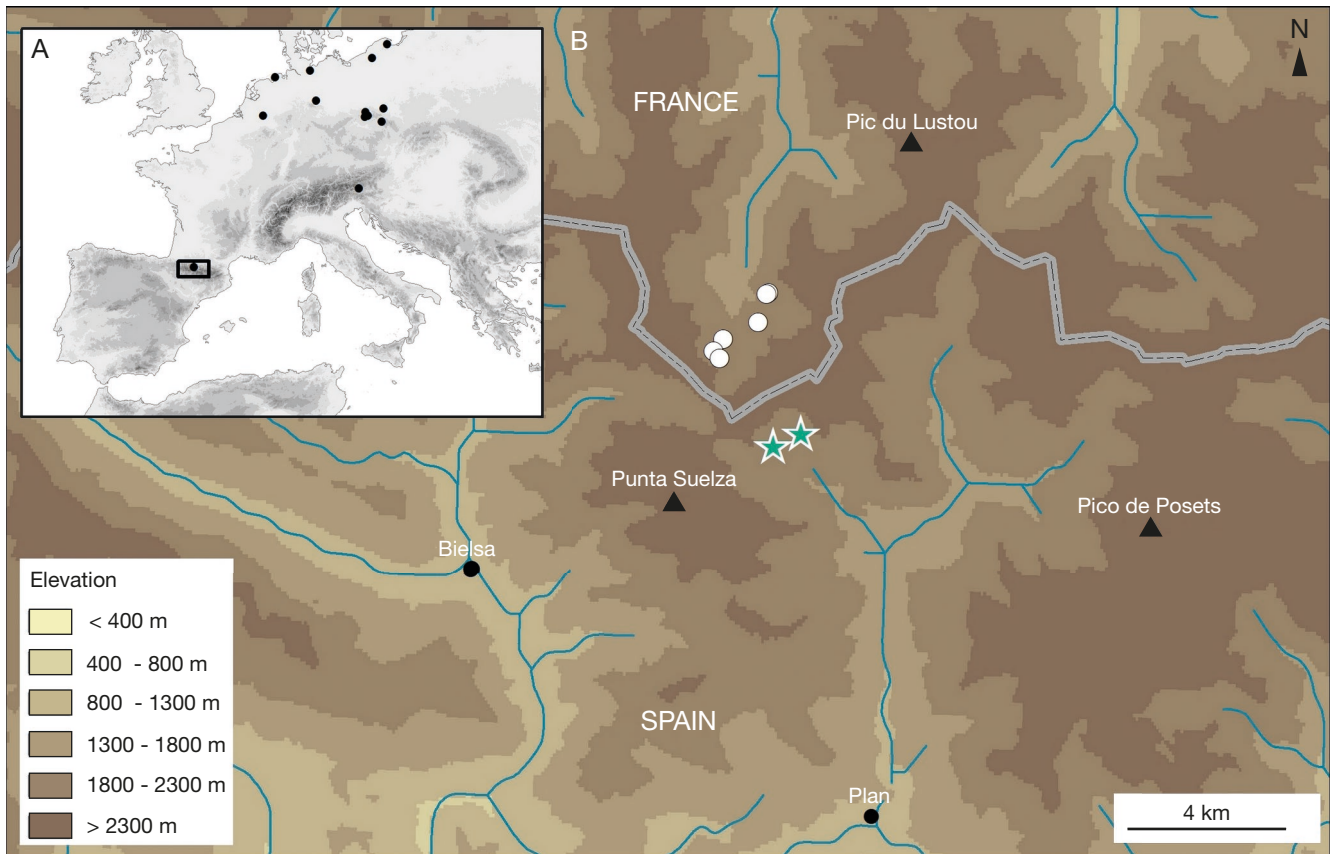


FIG. 1. — Distribution of *Sphagnum lindbergii* Schimp. in: **A**, Western Europe; **B**, the Pyrenees. **Green stars** represent the new stations of the species; **white dots**, the French stations based on Gauthier & Pujos (1999) and own data (pers. obs. 18/09/2020).

where the species proved to be extremely scarce. However, we did not survey the nearby Tabernés area, where the species might also occur, although the available habitats there are smaller and more scattered.

This represents the first report of *S. lindbergii* in Spain and the Iberian Peninsula, and the second report for the Pyrenees, 32 years after Robert Gauthier and José Pujos found the first and only known French population (Gauthier & Pujos 1999). The lineal distance between the French (las Honts, Rioumajou) and Spanish populations is approximately 2.8 km, so they might constitute a metapopulation complex, the only one known in the Pyrenees. In addition, this is the southernmost population in Europe (Fig. 1). Besides the Pyrenean French population, the southernmost location is in the Austrian Alps, at a latitude of 47°N. Moreover, this is the only known population in the Alps, where the species is also extremely scarce. As can be derived from the above information, the species is absent from southern areas of Europe, including the Balkan and Italian peninsulas.

#### MORPHOLOGY

*Sphagnum lindbergii* is a well-established species with no significant taxonomic problems. It is readily identifiable as the only species in the subgenus *Cuspidata* that combines dark brown stems with large stem leaves (approximately 1 mm wide), which are broader near the fringed, tattered apex (Daniels &

Eddy 1990; Smith 2004). These characteristics can easily be checked in the field with a hand lens (Atherton *et al.* 2010). Nevertheless, it is advisable to examine transverse sections of branch leaves under a microscope. The chlorocyst exposure is wider in the abaxial than the adaxial side, a feature common to all species in the *Cuspidata* subgenus. Our samples from Montarruegos exhibited all typical characteristics of the species (Fig. 2), and their variation aligned with descriptions in the referenced literature (Daniels & Eddy 1990; Smith 2004; Flora of North America 2024). We did not observe any fertile shoots.

#### ECOLOGY AND HABITATS

The new patches of *S. lindbergii* were located in the sub-alpine zone, avoiding south-facing slopes. In the area, sloping pastures on Ordovician schists formed the landscape matrix. There, *S. lindbergii* grew as dense moss clumps in flushes influenced by small rivulets flowing from iron-rich springs. The patches were found on steep, moss-covered slopes, sometimes even on vertical walls of the tiered mountainsides (Figs 2F; 3). This is of particular interest, as the species typically thrives in flat areas within boreal zones. Its occurrence here on steep slopes, avoiding southern exposure, may be related to increased shading and the resulting temperature-buffering effect. Although in Montarruegos similar habitats are present on nearby south-facing slopes, *S. lindbergii* is absent there. However, due to the



FIG. 2. — Plate showing the main features of *Sphagnum lindbergii* Schimp.: **A**, divergent branch leaf section; **B**, stem leaf; **C**, divergent branch leaf; **D**, cells at middle of divergent branch leaf; **E**, shoots with capitula; **F**, moss clump on a vertical wall. Scale bars: A, D, 25  $\mu$ m; B, 500  $\mu$ m; C, 1000  $\mu$ m.



FIG. 3. — Picture showing a chalybeate source in Montarruegos Valley. *Sphagnum lindbergii* Schimp. occurs on the wet margins of the denuded area. Photo-credits: Nil Escolà.

extreme scarcity of the species, it is difficult to draw definitive conclusions. Furthermore, in French Pyrenean sites, the species has been observed both in flat areas and on steep slopes (Gauthier & Pujos 1999; pers. obs. 18/09/2020). As for co-

occurring species, the most common we found were *Sphagnum* species, particularly *S. russowii* Warnst., *S. tenellum* (Brid.) Bory and *S. fallax* (H.Klinggr.) H.Klinggr. Other common accompanying species included *Carex nigra* (L.) Reichard

subsp. *intricata* (Tineo ex Guss.) Rivas Mart., *Eriophorum angustifolium* Honck., *Molinia caerulea* (L.) Moench, and *Polytrichum commune* Hedw. The groundwater pH in the *S. lindbergii* patches was notably acidic, with a mean value of 4.1. The species displayed variable behaviour concerning water levels, thriving in conditions ranging from constantly wet vertical moss walls to waterlogged flushes. This matches the ecological conditions previously reported by Gauthier & Pujos (1999) for the French Pyrenees and Daniels & Eddy (1990) for the Scottish Highlands.

#### CONSERVATION STATUS

In the Pyrenees, *S. lindbergii* is confined to two valleys, one in France and one in Spain. In France, *S. lindbergii* is found in several patches in the Rioumajou Valley, where it is more widespread than in Montarruegos Valley (Gauthier & Pujos 1999; pers. obs. 18/09/2020). However, there it remains extremely scarce and is therefore classified as critically endangered (CR) according to IUCN criteria (Infante Sánchez *et al.* 2015; IUCN Standards and Petitions Committee 2024). Applying the same criteria, we consider *S. lindbergii* to be critically endangered (CR) in Spain and recommend its inclusion in the regional and national lists of threatened species. The species in Spain meets the following criteria: an extent of occurrence of less than 100 km<sup>2</sup> (B1), an area of occupancy of less than 10 km<sup>2</sup> (B2), and a population size of fewer than 50 individuals (D), resulting in a conservation status of CR B(1+2)ab(iii)D1. According to Garilleti & Albertos (2012), we considered each discrete differentiable unit as an individual. We might consider these two close French and Spanish populations as part of a single metapopulation. However, it is not clear whether a migration of propagules from French to Spanish side (i.e. a rescue effect) could occur, as the sporophytes are absent (FLORAPYR 2019) and consequently it should disperse vegetatively.

In addition to climate change, a primary threat to *S. lindbergii* in Montarruegos is livestock grazing, and indeed, we found severe trampling in some mire areas. This could potentially affect flushes where *S. lindbergii* is present, and therefore, land managers should take steps to mitigate this threat. Unfortunately, the Montarruegos Valley lies just outside the boundaries of the Posets-Maladeta Natural Park and is also just outside the Natura 2000 Sites of Community Interest, which may hinder effective monitoring and conservation measures for the species in Spain.

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#### Authorship contribution

AP-H: Conception, design, fieldwork, analysis and interpretation of the data, writing; NE: Conception, design, fieldwork, analysis and interpretation of the data, composition of the photographic plate; EP-I: Conception, design, fieldwork,

analysis and interpretation of the data; JMB-M: Fieldwork, analysis and interpretation of the data; VM-A: Fieldwork, analysis and interpretation of the data, drawing up the distribution map. All authors contributed to the critical revision of the text and approved the final version.

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