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Straminergon and *Calliergon* (*Calliergonaceae*, Bryopsida) in the Iberian Peninsula

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Abstract: Oliván, G., Fuertes, E. & Acón, M. *Straminergon and Calliergon (Calliergonaceae, Bryopsida) in the Iberian Peninsula. Lazaroa 26: 17-33 (2005).*

The genera *Straminergon* Hedenäs and *Calliergon* (Sull.) Kindb. are revised for the Iberian Peninsula, based mainly on herbarium specimens kept in PC and the main Iberian herbaria. The occurrence of *Straminergon stramineum* (Dicks. ex Brid.) Hedenäs, *Calliergon cordifolium* (Hedw.) Kindb. and *C. giganteum* (Schimp.) Kindb. in the studied area is confirmed. *S. stramineum* grows mainly in fens in the mountainous areas of the northern half of the Iberian Peninsula and Sierra Nevada. *C. cordifolium* is restricted to fens or wet meadows in the alpine regions of the northern third of the peninsula (Pyrenees, Cantabrian Range and north-western part of the Iberian Range), while the localities in the Central Range, previously recorded in the bibliography, are excluded after this study from its distribution area. *C. giganteum* has been collected only in fens in the Eurosiberian Region, in one locality in the Pyrenees and four in the Cantabrian Range. Keys, descriptions, illustrations, SEM photographs and distribution maps of the species of *Straminergon* and *Calliergon* in the Iberian Peninsula are provided.

Resumen: Oliván, G., Fuertes, E. & Acón, M. *Straminergon y Calliergon (Calliergonaceae, Bryopsida) en la Península Ibérica. Lazaroa 26: 17-33 (2005).*

Se ha llevado a cabo la revisión de los géneros *Straminergon* Hedenäs y *Calliergon* (Sull.) Kindb. en la Península Ibérica, basada principalmente en material de herbario procedente de PC y de los más importantes herbarios ibéricos. Se confirma la presencia de *Straminergon stramineum* (Dicks. ex Brid.) Hedenäs, *Calliergon cordifolium* (Hedw.) Kindb. y *C. giganteum* (Schimp.) Kindb. en el área de estudio. *S. stramineum* crece principalmente en turberas de las áreas montañosas de la mitad norte de la Península Ibérica y Sierra Nevada. *C. cordifolium* queda restringida a turberas y prados húmedos de la alta montaña del tercio norte de la Península Ibérica (Pirineos, Cordillera Cantábrica y noroeste del Sistema Ibérico), mientras que quedan excluidas de su área de distribución las localidades del Sistema Central citadas previamente en la bibliografía. *C. giganteum* se ha recolectado únicamente en turberas de la Región Eurosiberiana, en una única localidad en Pirineos y en cuatro más en la Cordillera Cantábrica. Se proporciona clave, descripciones, ilustraciones, fotografías de SEM y mapas de distribución para las especies de *Straminergon* y *Calliergon* en la Península Ibérica.

INTRODUCTION

TAXONOMIC HISTORY OF *STRAMINERGON* AND *CALLIERGON*

The genus *Calliergon* (Sull.) Kindb., including *Straminergon stramineum* (Dicks. ex Brid.) Hedenäs, has been traditionally placed in the family *Amblystegiaceae* G.Roth (e.g. CRUM & ANDERSON, 1981; NYHOLM, 1965; KARCZMARZ, 1971; KANDA, 1976; SMITH, 1978). As many phylogenetic works have demonstrated (e.g. HEDENÄS, 1995, 1998; VANDERPOORTEN *& al.,* 2001, 2002a), the family *Amblystegiaceae,* as traditionally circumscribed, is polyphyletic, although some monophyletic groups have been found within it. TUOMIKOSKI & KOPONEN (1979) differentiated the natural group *Calliergon-Warnstorfia*, result that was later supported by HEDENÄS (1993), HEDENÄS & KOOIJMAN (1996) and more recently by VANDERPOORTEN *& al.* (2001, 2002a) and HEDENÄS *& al.* (2005).

Based on previous phylogenetic works, VANDERPOORTEN *& al.* (2002b) described a new family, the *Calliergonaceae* (Kanda) Vanderpoorten et al., containing *Calliergon*, *Hamatocaulis*, *Loeskypnum*, *Straminergon* and *Warnstorfia*. The relationships among the species belonging to these genera, as well as with *Scorpidium* species and *Hygrohypnum ochraceum*, which appeared to be closely related with

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the *Calliergonaceae* family in the preceding analyses, have been further studied in a recent work (HEDENÄS *& al*., 2005), showing that there are two big well supported clades within the family *Calliergonaceae*, one with *Hamatocaulis* and *Scorpidium*, and the other one with *Calliergon*, *Loeskypnum*, *Straminergon* and *Warnstorfia*. The inclusion of *Hygrohypnum ochraceum* in the *Calliergonaceae* is questioned, and further analyses including the rest of *Hygrohypnum* species are currently being undertaken.

The genus *Straminergon* was described by HEDENÄS (1993) to place *S. stramineum*, which up to then had been traditionally placed in *Calliergon* (Sull.) Kindb. (e.g. CRUM & ANDERSON, 1981; NYHOLM, 1965; KARCZMARZ, 1971; KANDA, 1976; TUOMIKOSKI & KOPONEN, 1979). The decision to describe a new genus to place *S. stramineum* was based on the autoapomorphies present in this species and in the lack of synapomorphic morphological characters joining *S. stramineum* with the rest of species considered to belong to *Calliergon*. The placement of *S. stramineum* in a distinct genus has been later supported by phylogenetic studies based on morphological, anatomical and ecological data (HEDENÄS & KOOIJMAN, 1996; HEDENÄS, 1998), on molecular data (VANDERPOORTEN *& al*., 2001), and on morphological and molecular data (VANDERPOORTEN *& al*., 2002a; HEDENÄS *& al*., 2005). Nowadays it is mainly accepted in modern floras that *Straminergon* is a separate and monotypic genus (e.g. IGNATOV & IGNATOVA, 2004; SMITH, 2004; HEDENÄS, 2003a, 2003b).

Calliergon was a very heterogeneous and artificial genus, containing many unrelated species (check KARCZMARZ (1971) for details about the taxonomic history of the genus), until TUOMIKOSKI & KOPONEN (1979) re-circumscribed it on the basis of morphological features that had so far escaped the attention of taxonomists. They kept *C. cordifolium* (Hedw.) Kindb., *C. giganteum* (Schimp.) Kindb., *C. megalophyllum* Mikut., *C. richardsonii* (Mitt.) Kindb. and *Straminergon stramineum* (as *Calliergon stramineum*) in the genus, although pointing out the differences between the latter and the rest of the species, and suggesting its possible placement in a subgenus. This circumscription of the genus *Calliergon* was later supported by HEDENÄS (1993), except for *S. stramineum,* which, as explained above, was left out. Currently it is widely accepted that Calliergon includes four species: *C. cordifolium*, *C. giganteum*, *C. megalophyllum* and *C. richardsonii* (Mitt.) Kindb. However, recent results based on morphological and molecular evidence (HEDENÄS *& al*., 2005) question the monophyly of the genus, since *C. megalophyllum* appears, in some of the analyses, out of the well supported clade containing the other three *Calliergon* species, and within a poorly supported clade as sister of the Warnstorfia-Straminergon-Loeskypnum group. More phylogenetic analyses seem to be necessary to decide whether *C. megalophyllum* belongs to *Calliergon* or not.

HISTORY OF *STRAMINERGON* AND *CALLIERGON* IN THE IBERIAN PENINSULA

Straminergon stramineum was first reported in the Iberian Peninsula by JEANBERNAT (1864), who collected it in the Spanish Pyrenees. Machado gathered it for the first time in Portugal, in Serra da Estrela (Central Range) (MACHADO, 1917). Since then *S. stramineum* has been reported mainly in the Cantabrian Range, Iberic System and Central Range.

The first record for *Calliergon cordifolium* in the Iberian Peninsula was provided by ALLORGE (1928), who collected it in the Cantabrian Range. Later there have only been a few more records for this species in the Pyrenees (CASAS, 1986), Central Range (ELÍAS-RIVAS, 1988) and Iberian Range (CASAS & *al*., 1984; GARCÍA-ÁLVARO & *al*., 2001).

Calliergon giganteum has been reported in the French Pyrenees since the end of the nineteenth century (BOULAY, 1884; JEANBERNAT & RENAULD, 1885). However, it was not cited in the Spanish Pyrenees until one century later (BRUGUÉS & *al*., 1999). Besides this record, it was also reported in the Cantabrian Range (SIMÓ & *al*., 1978).

The main goals of the present study have been: Firstly, to assess the taxonomic status of the Iberian specimens of *Straminergon* and *Calliergon* in the light of modern taxonomic works. Secondly, to determine the current distribution and ecology of *Straminergon* and *Calliergon* species in the Iberian Peninsula, and finally to provide descriptions and iconography specific for the Iberian specimens of *Straminergon* and *Calliergon*, since there is not a complete Iberian bryophyte flora.

The present work is part of a general revision of the genera traditionally placed under *Amblystegiaceae s.l.* in the Iberian Peninsula.

MATERIAL AND METHODS

This revision is based mainly on herbarium material from PC and the main Iberian herbaria (BCB, FCO, GDAC, LISU, MA, MACB, MAF, MUB, PAMP, SALA, VAB, VIT, Herb. Martínez-Abaigar). Many specimens have also been collected by the authors in the studied area during this study; these are now deposited in MACB.

About 100 specimens were checked. 110 morphological and anatomical characters have been studied (Appendix 2). The descriptions of the gametophytic characters and sexual branches, as well as the habitat descriptions, illustrations and SEM photographs are based on Iberian specimens. The sporophytic characters of *Calliergon cordifolium* and *C. giganteum* are also based on Iberian specimens, while those of *Straminergon stramineum* were described from non-Iberian specimens kept at S and BM during the visits of one of the authors to these institutions, since there were no sporophytes in any of the studied Iberian specimens belonging to this species. The type specimens kept at S and BM were checked.

Nomenclature follows CROSBY *& al.* (1999) and HEDENÄS (1993). Names of authors are abbreviated according to BRUMMIT & POWELL (1992).

RESULTS

KEY AND DESCRIPTIONS OF *STRAMINERGON* AND *CALLIERGON* IN THE IBERIAN PENINSULA

Stem leaves ovate, elongate-ovate or lingulate; alar groups ovate or rectangular along basal leaf margin, reaching up to 50% of distance from leaf margin to costa. Axilary hairs scarce and small (1-2 hyaline apical cells) .....*Straminergon*

Stem leaves broadly ovate to broadly ovate-cordate; alar groups triangular, reaching the costa or at least 75% of distance from leaf margin to costa. Axilary hairs abundant and large (2-5 hyaline apical cells) .....*Calliergon*

Straminergon Hedenäs, J. Bryol. 17: 462. 1993.
Type: *Straminergon stramineum* (Dicks. ex Brid.) Hedenäs, J. Bryol. 17: 463. 1993 (*Hypnum stramineum* Dicks. ex Brid., Muscol. Recent. 2(2): 172. 1801 (basionym).
Calliergon sect. *Straminea* C.E.O. Jensen, Danmarks Mosser 2: 88. 1923 (*Calliergon* subgen. *Straminea* (C.E.O. Jensen) Tuom. & T.J. Kop. Ann. Bot. Fenn.16: 223. 1979. *Type*: *Straminergon stramineum* (Dicks. ex Brid.) Hedenäs, J. Bryol. 17: 463. 1993 (*Hypnum stramineum* Dicks. ex Brid., Muscol. Recent. 2(2): 172. 1801 (basionym).

Plants forming loose tufts, pale yellow, greenish-yellow, medium-sized. Stem erect, usually unbranched or with very few short branches; stem transverse section round-oval, with central strand, large and thin-walled medullar cells and 1-2 rows of yellowish thick-walled cells, without hyalodermis; axillary hairs scarce, small, with 1-2 hyaline apical cells and 1-2 quadrate and brownish basal cells; pseudoparaphyllia foliose, broad; paraphyllia absent. Rhizoids on back of leaves or scattered on stem, brown, scarcely branched, smooth, frequent. Stem leaves straight, concave, ovate, elongate-ovate or lingulate; ± erect and imbricate, sometimes spreading; margin plane, slightly recurved at base, entire; apex rounded or obtuse, cucullate; costa long and single (up to 80% of length leaf); median lamina cells linear, slightly incrassate, porose; marginal cells similar or narrower than adjacent median lamina cells; alar cells rectangular, shortly rectangular or quadrate, hyaline, ± inflated, ± thick-walled, forming a well delimited ovate or rectangular group along basal leaf margin, decurrent; initial cells of rhizoids abundant near apex or beside nerve in upper part of leaves, rhomboidal and hyaline. Branch leaves similar to stem ones. Dioicous. Perigonia lateral on lower part of stem, perigonial leaves ovate, abruptly and shortly acuminate, margin entire, ecostate. Perichaetia lateral on stem; inner perichaetial leaves straight, not plicate, ovate-lanceolate, erect, margin entire or irregularly denticulate near apex, apex shortly acuminate, sometimes rounded or obtuse, costa single, usually rudimentary, cells fusiform, porose and smooth; vaginula naked. Seta long (4-5 cm), brownish, ± twisted, smooth. Capsule inclined to horizontal, cylindrical, curved, brownish, smooth. Exothecial cells shortly rectangular, quadrate to rounded, thick-walled; stomata numerous in base of capsule, phaneropore. Separating annulus absent. Peristome well developed; exostome yellowish, lower outside ornamentation dotted (reticulate at high magnification), upper outside ornamentation papillose, border broad; endostome hyaline to yellowish, basal membrane high, 40-45% of endostome height, segments narrowly perforated, papillose, strongly papillose in upper part, cilia 2-3, long, nodose. Lid conical. Calyptra cucullate, naked. Spores 15.0-22.5 µm, finely papillose.

Straminergon includes one species, *S. stramineum*.

Straminergon stramineum (Dicks. ex Brid.) Hedenäs, J. Bryol. 17: 463. 1993.

Hypnum stramineum Dicks. ex Brid., Muscol. Recent. 2(2): 172. 1801 (basionym) (*Hypnum sarmentosum* var. *stramineum* (Dicks. ex Brid.) Sommerf. Suppl. Fl. Lapponicae 67. 1826 (*Amblystegium stramineum* (Dicks. ex Brid.) De Not., Atti Reale Univ. Genova 1: 137. 1869 (*Calliergon stramineum* (Dicks. ex Brid.) Kindb. Canad. Rec. Sci. 6(2): 72. 1894 (*Acrocladium stramineum* (Dicks. ex Brid.) P.W. Richards & E.C. Wallace, Trans. Brit. Bryol. Soc. 1(4): xxv. 1950. *Lectotype*: BM! (in Dickson herbarium): BM000851585.

Plants forming loose tufts (Figure 1), sometimes solitary shoots mixed with other mosses, pale yellow, greenish-yellow, medium-sized (5-10(12) cm). Stem erect, usually unbranched or with very few short branches (0.5-1.5 cm); stem transverse section round-oval, with central strand, large and thin-walled medullar cells and 1-2 rows of yellowish thick-walled cells, without hyalodermis; axillary hairs scarce (1-2 per leaf axil), with 1-2 hyaline apical cells; pseudoparaphyllia foliose, broadly triangular, lingulate or irregular. Rhizoids in tufts on back of leaves, specially at leaf apices, brown, scarcely branched, smooth, frequent. Stem leaves straight, concave, ovate, elongate-ovate or lingulate, 0.5-0.8 mm wide x 1.0-1.8 mm long; attitude upon the stem ± erect and imbricate, sometimes spreading; margin plane, slightly recurved at base, entire; apex rounded or obtuse, usually cucullate; costa long and single (up to 80% of length leaf); median lamina cells linear, 4.0-6.0 µm wide (45.0-87.5 µm long, slightly incrassate, porose, becoming shorter and wider towards apex and base; marginal cells similar or narrower than adjacent median lamina cells; alar cells rectangular, shortly rectangular or quadrate, hyaline, ± inflated, ± thick-walled, forming a well delimited group, ovate or rectangular, consisting of 3-4 rows of cells along basal leaf margin, upper cells of group less inflated and smaller, usually quadrate or rectangular, alar group decurrent; initial cells of rhizoids abundant near apex or beside nerve in upper part of leaves, rhomboidal and hyaline. Dioicous. Perichaetia as described for the genus. Sporophyte as described for the genus. Sporophytes not known from Iberian specimens.

Habitat: *Sphagnum* bogs, fens, rarer on irrigated rocks and beside streams. Sometimes submerged.

General distribution: Widespread in artic and temperate areas in the Northern Hemisphere, rarer in Southern Hemisphere (HEDENÄS, 2003a, 2003b).

Distribution in the Iberian Peninsula (Figure 2): *Straminergon stramineum* is widespread in the mountainous areas of the northern half of the Iberian Peninsula, while in the southern half this species is restricted to Sierra Nevada. In the Eurosiberian Region *S. stramineum* grows in the Cantabrian Range (Lugo, Asturias, León, Zamora, Palencia, Cantabria and Vasque Country) from the low montane to alpine belts (90-2000 m a.s.l.), and in the Pyrenees (Navarra, Huesca, Andorra, Lérida and Gerona), where it can be found at higher altitudes (1300-2450 m a.s.l.). In the Mediterranean Region it grows in the oromediterranean belts of the high mountains (1800-2225 m a.s.l.) in the Central Range (Madrid, Ávila, Segovia, Salamanca and Beira Alta), Iberian Range (Burgos, La Rioja, Soria, Zaragoza) and Penibetic Range (Sierra Nevada in Granada).

Specimens examined: Appendix 1.

Calliergon (Sull.) Kindb., Canad. Rec. Sci. 6(2): 72. 1894.

Hypnum sect. *Calliergon* Sull., Manual (ed. 2) 672. 1856 (basionym) (*Amblystegium* subgen. *Calliergon* (Sull.) Lindb. Musci Scand. 34. 1879 — *Hypnum* subgen. *Calliergon* (Sull.) Lesq. & James, Man. Mosses N. America 318, 402. 1884 — *Amblystegium* sect. *Calliergon* (Sull.) Braithw., Brit. Moss Fl. 3: 17. 1896. *Type*: *Calliergon cordifolium* (Hedw.) Kindb., Can. Rec. Sci. 6(2): 72. 1894 — *Hypnum cordifolium* Hedw., Sp. Musc. Frond. 254. 1801 (basionym).

Amblystegium sect. *Obtusifolia* De Not., Atti Reale Univ. Genova 1: 129. 1869. *Type*: *Amblystegium cordifolium* (Hedw.) De Not., *Cronac. Briol. Ital.* 2: 23. 1867 — *Hypnum cordifolium* Hedw., Sp. Musc. Frond. 254. 1801 (basionym).

Calliergon sect. *Cordifolia* C.E.O. Jensen, Danmarks Mosser 2: 88. 1923. *Type*: *Calliergon cordifolium* (Hedw.) Kindb., *Canad. Rec. Sci.* 6(2): 72. 1894 — *Hypnum cordifolium* Hedw., Sp. Musc. Frond. 254. 1801 (basionym).

Plants forming loose tufts, green, pale green, green, yellowish-green to brownish, never reddish (outside the Iberian Peninsula sometimes pinkish), medium-sized to large and robust (outside the Iberian Peninsula very large). Stem usually erect, radially branched, pinnately or irregularly branched; stem cross section round-oval, with central strand, large and thin-walled medullar cells and cortex of yellowish thick-walled cells, without hyalodermis; axillary hairs abundant, large, with 2-5 hyaline apical cells (outside de Iberian Peninsula to 10) and 1-2 quadrate to shortly rectangular and brownish basal cells; pseudoparaphyllia foliose, broad; paraphyllia absent. Rhizoids on back of leaves or sparse on stem,

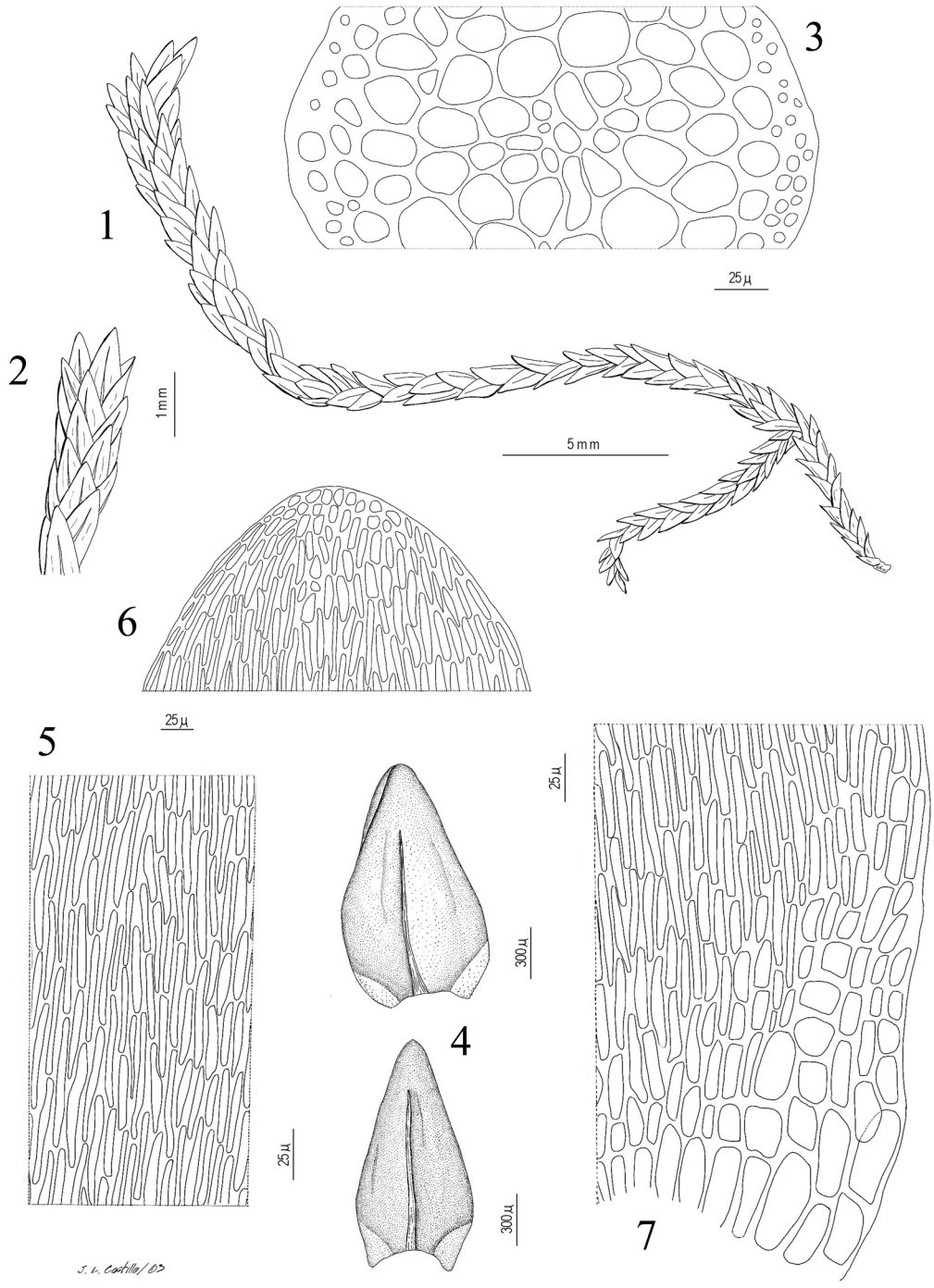

Figure 1.— *Straminergon stramineum*. 1, shoot; 2, shoot apex; 3, stem transverse section; 4 stem leaves; 5, median lamina cells; 6, apical cells; 7, alar cells.

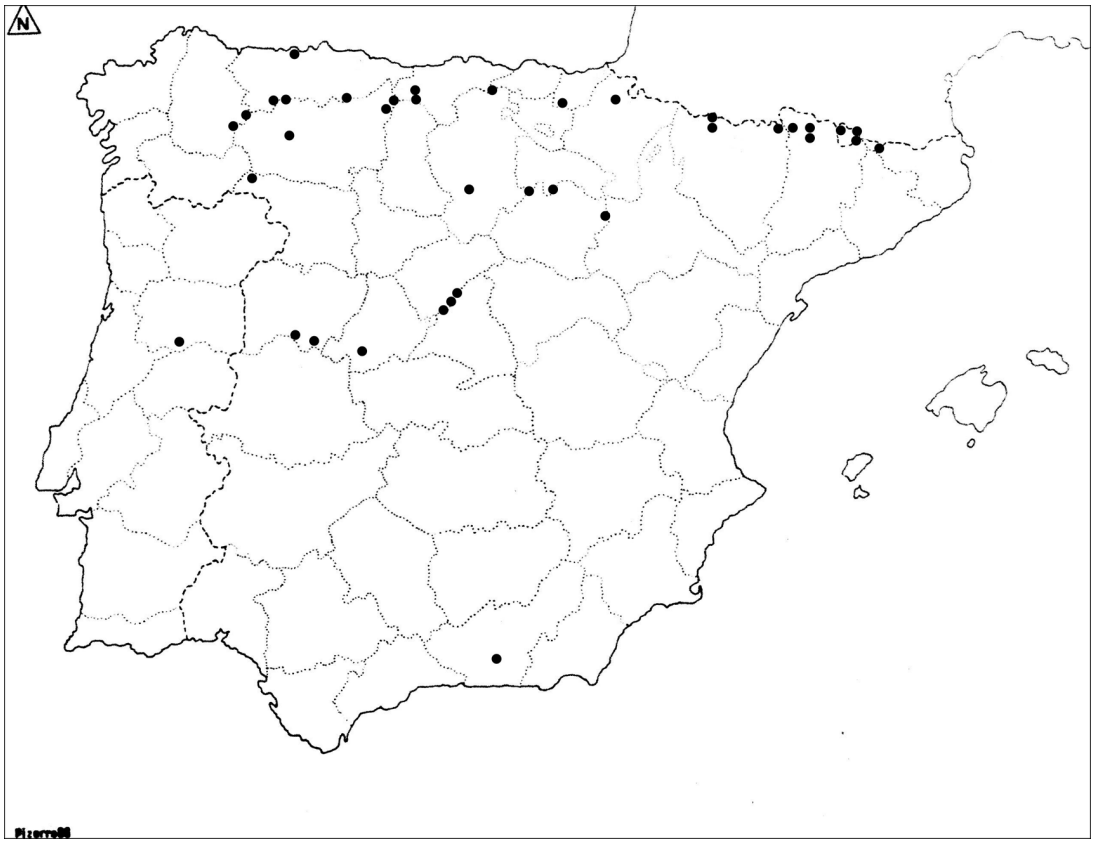

Figure 2.— Distribution map of *Straminergon stramineum* in the Iberian Peninsula. ● confirmed occurrence (10 x 10 Km square).

brown-reddish, scarcely branched, smooth. Stem leaves straight, concave, ± broadly ovate, ovate-cordate (outside the Iberian Peninsula also rounded-ovate or broadly rounded-ovated); attitude upon the stem erect to spreading; margin plane, entire or slightly sinuate; apex rounded or obtuse; costa single, almost reaching the apex (outside the Iberian Peninsula also branched, up to 80% of length leaf); median lamina cells linear, smooth, becoming wider and shorter towards apex and base; marginal cells narrower; alar cells rectangular, hyaline, inflated, thin-walled, forming a triangular group (outside the Iberian Peninsula also oval-rounded), reaching or not the costa, sometimes excavate, broadly decurrent, transition from alar cells to adjacent basal cells gradual or abrupt; initial cells of rhizoids very common near leaf apex and beside costa, rhomboidal and hyaline. Branch leaves smaller and narrower (or only smaller outside the Iberian Peninsula). Autoicous or dioicous. Perigonia lateral on lower part of stem, below perichaetia in autoicous species, perigonial leaves ovate to ovate-oblong, abruptly and shortly acuminate or apiculate, margin entire, ecostate. Perichaetia lateral on stem; inner perichaetial leaves straight, not plicate, ovate-lanceolate, erect, margin entire or slightly sinuate, apex abruptly and shortly to longly acuminate, costa long and single, almost reaching the apex, cells linear, thin-walled, smooth, sometimes initial cells of rhizoids present in upper part of perichaetial leaves; vaginula naked. Seta long (4-5 cm), reddish, slightly twisted, smooth. Capsule horinzontal, cylindrical, brownish, smooth. Exothecial cells shortly-rectangular, quadrate to rounded, thick-walled, smooth; stomata at base of capsule, phaneropore kind. Separating annulus absent. Peristome well developed; exostome yellowish, lower outside ornamentation dotted (reticulate at high magnification), upper outside ornamentation papillose, border broad; endostome hyaline, basal membrane high, 40-45% of endostome height, segments narrowly perforated,

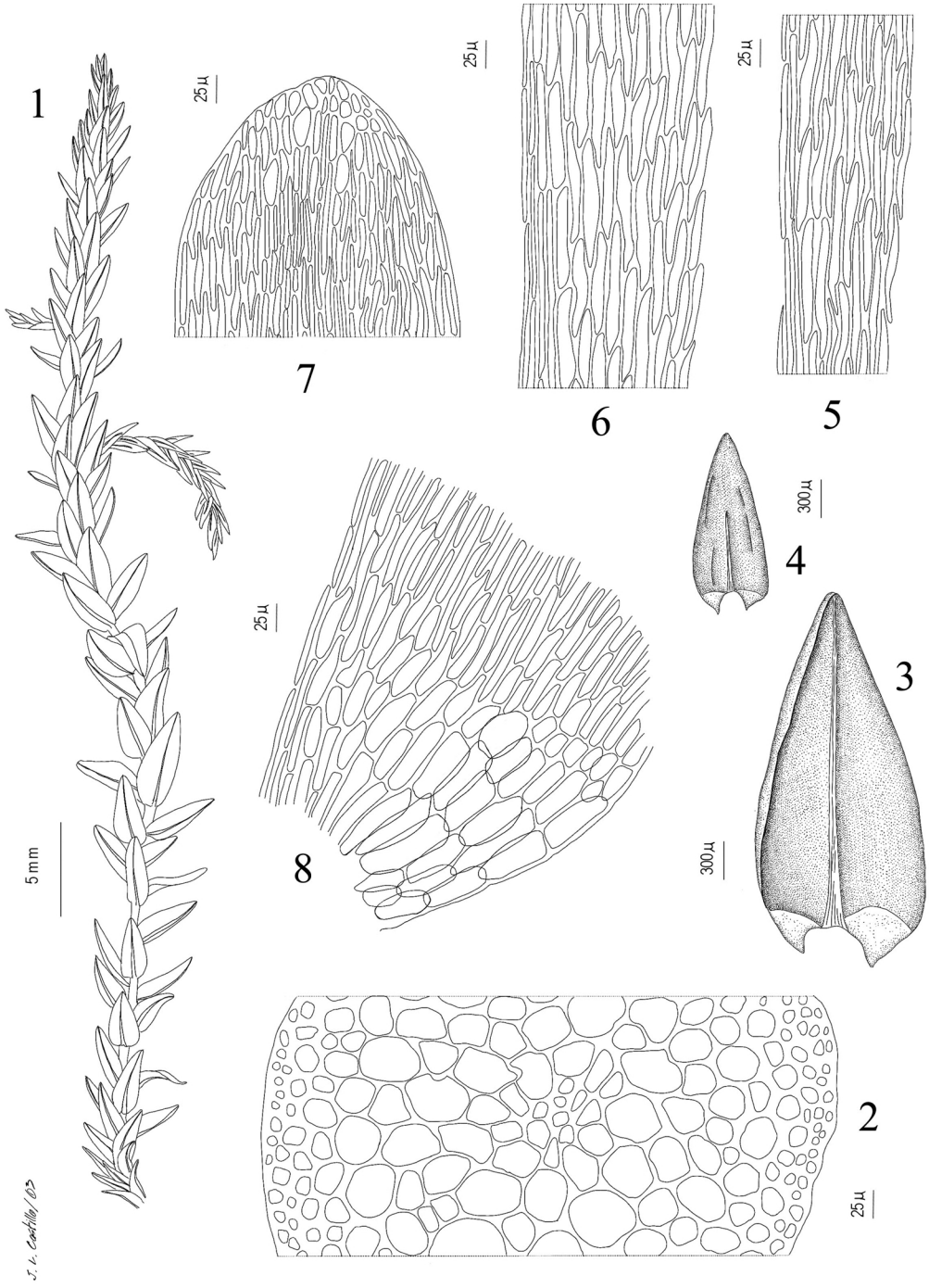

Figure 3.— *Calliergon cordifolium*. 1, shoot; 2, stem transverse section; 4 stem leaf; 5, branch leaf; 5, median lamina cells; 6, median lamina cells beside costa; 7, apical cells; 8, alar cells.

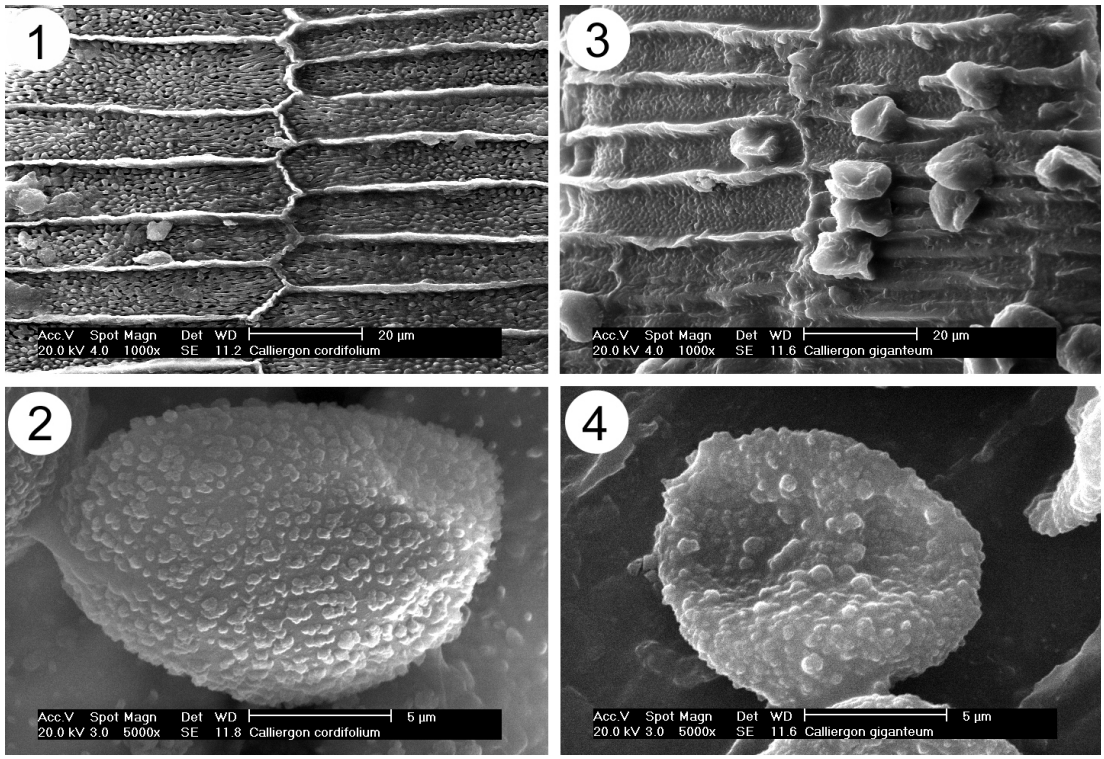

Figure 4.— SEM photographs. 1-2, *Calliergon cordifolium*: 1, lower outside ornamentation of exostome; 2, spore. 3-4, *Calliergon giganteum*: 3, lower outside ornamentation of exostome; 4, spore.

finely papillose, cilia 2-4, long, nodose. Lid conical. Calyptra cucullate, naked. Spores 12.5-23 µm, finely papillose.

Calliergon includes four species, from which two occur in the Iberian Peninsula, *C. cordifolium* and *C. giganteum*.

Key to the species of *Calliergon* in the Iberian Peninsula

Stems slightly and irregularly branched or unbranched. Alar groups (diffusely to well defined, usually reaching the costa or almost so; transition from alar cells to adjacent basal cells gradual. Autoicous .....*C. cordifolium*
Stems densely and pinnately branched. Alar groups very well defined, usually not reaching the costa (75-90% of distance from leaf margin to costa); transition from alar cells to adjacent basal cells abrupt. Dioicous .....*C. giganteum*

Calliergon cordifolium (Hedw.) Kindb., *Canadian Record of Science* 6(2): 72. 1894.
Hypnum cordifolium Hedw., Sp. Musc. Frond. 254. 1801 (basionym) (*Stereodon cordifolius* (Hedw.) Brid., Bryol. Univ. 2: 824. 1827 (*Amblystegium cordifolium* (Hedw.) De Not., Cronac. Briol. Ital. 2: 23. 1867 (*Acrocladium cordifolium* (Hedw.) P.W. Richards & E.C. Wallace, Transac. Brit. Bryo. Soc. 1(4): xxv. 1950. *Lectotype*: "In Svecia lectam acceptiunque a D. O. Swartz" (plant no. 3 from the left of the sheet), G, selected by HEDENÄS (1993), amending previous selection by KARCZMARZ (1971).
Full synonymy in HEDENÄS (1993).

Plants in loose tufts (Figure 3, 4(1-2)), green or pale green, medium-sized to large (7-12(15) cm). Stem erect, slightly and irregularly branched or unbranched, branches 2-3 cm; stem cross section round, with central strand, large and thin-walled medullar cells and 2-3 rows of yellowish thick-walled cells, without hyalodermis; axillary hairs abundant (3-5 per leaf axil), with 2-5 hyaline apical cells; pseudoparaphyllia foliose, semi-orbicular or broadly triangular, margin irregular. Rhizoids forming tufts on back of leaves or scattered on stem, brown-reddish, scarcely branched, smooth, quite abundant. Stem leaves straight, concave, broadly ovate or ovate-cordate,

1.5-2.0 mm wide (3.0-4.0 mm long; attitude upon the stem erect-spreading to spreading; margin plane, convolute when dry, entire or slightly sinuate; apex rounded or obtuse; costa long and single, almost reaching the apex, (60)80-100(120) µm wide at base and gradually narrowed along leaf; median lamina cells linear, straight or slightly flexuose, 5.0-8.75 µm wide (75.0-112.5 µm long, thin-walled, smooth, becoming shorter, wider and flexuose towards apex, shorter and wider, longly rhomboidal to rectangular and porose towards base; marginal cells narrower than adjacent median lamina cells; alar cells rectangular, hyaline, inflated, thin-walled, forming a (diffuse to well defined group, triangular, usually reaching the costa, sometimes excavate and broadly decurrent, transition from alar cells to adjacent basal cells gradual; initial cells of rhizoids very common in apex and beside nerve, specially in the upper fifth of leaf. Branch leaves ovate, smaller and narrower than stem leaves, 1.0-1.6 mm wide (2.4-2.7 mm long. Autoicous. Perichaetia lateral on stem above usually numerous perigonia; inner perichaetial leaves straight, not plicate, ovate-lanceolate, erect, margin entire or slightly sinuate, apex abruptly and shortly to longly acuminate, costa long and single, almost reaching the apex, cells linear, thin-walled, smooth, sometimes initial cells of rhizoids present in upper part of perichaetial leaves; vaginula naked. Sporophyte typical for the genus. Spores 12.5-20 µm, finely papillose. Sporophytes very rare in Iberian specimens.

Habitat: Rich fens, wet high-mountain meadows, beside mountain pools and streams and on soil in wet forests. Rarely submerged.

General distribution: Temperate areas in the Northern Hemisphere (HEDENÄS, 2003a).

Distribution in the Iberian Peninsula (Figure 5): *Calliergon cordifolium* grows in the montane to alpine belts (1200-2000 m a.s.l.) in the Pyrenees (Huesca),

Figure 5.— Distribution map of *Calliergon cordifolium* in the Iberian Peninsula. ● confirmed occurrence (10 x 10 Km square).

Cantabrian Range (Asturias and León) and northwestern part of the Iberian Range (La Rioja and Soria).

Specimens examined: Appendix 1.

Specimens erroneously identified as Calliergon cordifolium: Appendix 3.

Calliergon giganteum (Schimp.) Kindb., *Canadian Record of Science* 6(2): 72. 1894.
Hypnum giganteum Schimp., Syn. Musc. Eur. 642. 1860 (basionym) (*Stereodon giganteus* (Schimp.) Mitt., J. Proc. Linn. Soc. 8: 43. 1864 (*Amblystegium giganteum* (Schimp.) De Not., Cronac. Briol. Ital. 2: 23. 1867 (*Amblystegium aduncum* var. *giganteum* (Schimp.) De Not., Cronac. Briol. Ital. 2: 24. 1867 (*Hypnum cordifolium* var. *giganteum* (Schimp.) Sanio, Verh. Bot. Prov. Brandenburg 24: 84. 1882 (*Acrocladium giganteum* (Schimp.) P.W. Richards & E.C. Wallace, Trans. Brit. Bryol. Soc. 1(4): xxv. 1950. Syntypes: "Suecia", "pedale et altius Wiszniewo Borussiae occid. a cl. Dr Klinggräff lectum", "Vogeso", "Helvetia" and "Salisburgia amic. Sauter misit" (not seen).
Calliergon subsarmentosum Kindb., Rev. Bryo. 36: 42. 1909. *Holotype*: "Noth America, Canada, Vancouver Island, Shawnigan Lake, wet earth, 18 june 1908 J. Macoun", S!: B8239.
Full synonymy in HEDENÄS (1993).

Plants forming loose tufts (Figure 6, 4(3-4)), shiny yellowish-green or brownish, large and robust (10-20 cm). Stem erect, pinnately and radially branched, branches 0.5-1.0 cm; stem cross section round-oval, with central strand, large and thin-walled medullar cells and 2-3 rows of yellowish thick-walled cells, without hyalodermis; axillary hairs abundant (3-5 per leaf axil), with 2-5 hyaline apical cells; pseudoparaphyllia foliose, broad, margin irregular. Rhizoids on back of leaves or scattered on stem, red-brown, scarcely branched, smooth, infrequent. Stem leaves straight, plane, broadly ovate-cordate, 1.7-3.0 mm wide x 2.25-4.0 mm long; attitude upon the stem erect-spreading to spreading; margin plane, entire or slightly sinuate or finely denticulate at apex; apex rounded or obtuse; costa long and single, almost reaching the apex, 90-190 µm wide at base and narrowing very little, keeping a stout appearance throughout its length; median lamina cells linear, 3.7-4.5 µm wide x 50.0-70.0 µm long, thin-walled, becoming wider beside costa, shorter, wider and more flexuose towards apex, shorter, wider, thick-walled and porose towards base; marginal cells narrower than adjacent median lamina cells; alar cells rectangular, hyaline, inflated, thin-walled, forming a very well defined group, triangular, usually not reaching the costa (up to 70-90% of distance from leaf margin to costa), strongly excavate and broadly decurrent, transition from alar cells to surrounding cells abrupt; initial cells of rhizoids very common in the upper third of leaves and beside costa, rhomboidal and hyaline. Branch leaves ovate-lanceolate, 0.5-1.0 mm wide (1.5-2.0(3.0) mm long; apex acute and blunt, usually incurved, giving a tubular appearance. Dioicous. Perichaetia lateral on stem; inner perichaetial leaves straight, not plicate, ovate-lanceolate, erect, margin entire or slightly sinuate, apex abruptly and shortly to longly acuminate, costa long and single, almost reaching the apex, cells linear, thin-walled, smooth; vaginula naked. Sporophyte typical of the genus. Spores 20-23 µm, finelly papillose. Sporophytes very rare in Iberian specimens.

Habitat: Rich fens and wet meadows beside mountain pools and streams. Sometimes submerged.

General distribution: Temperate areas in the Northern Hemisphere, southernmost South America and New Zealand (HEDENÄS, 2003a).

Distribution in the Iberian Peninsula (Figure 7): *Calliergon giganteum* is restricted to the Eurosiberian Region, in the Pyrenees (Lérida) and Cantabrian Range (Asturias). In the Pyrenees it grows only in the alpine region (1800 m a.s.l.), while in the Cantabrian Range it has been collected at lower altitudes, from 90 to 1870 m a.s.l.

Specimens examined: Appendix 1.

Specimens erroneously identified as Calliergon giganteum: Appendix 3.

DISCUSSION

TAXONOMIC REMARKS

Straminergon stramineum is a very distinct species, usually easily recognized, since it is not very variable. However, in the Iberian Peninsula it has occasionally been confused with *Calliergon cordifolium*, which can be more variable, especially in branching pattern and leaf shape. Therefore, *C. cordifolium* forms with unbranched stems and narrow leaves were confused with *S. stramineum*, while forms with branched stems and very broad leaves were sometimes identified as *C. giganteum* and more rarely as *Brachythecium rivulare* (see Appendix 3). From the latter species *C. cordifolium* can be differentiated by the apex acute and apiculate or shortly acuminate, and leaf margin dentate that *B. rivulare* usually

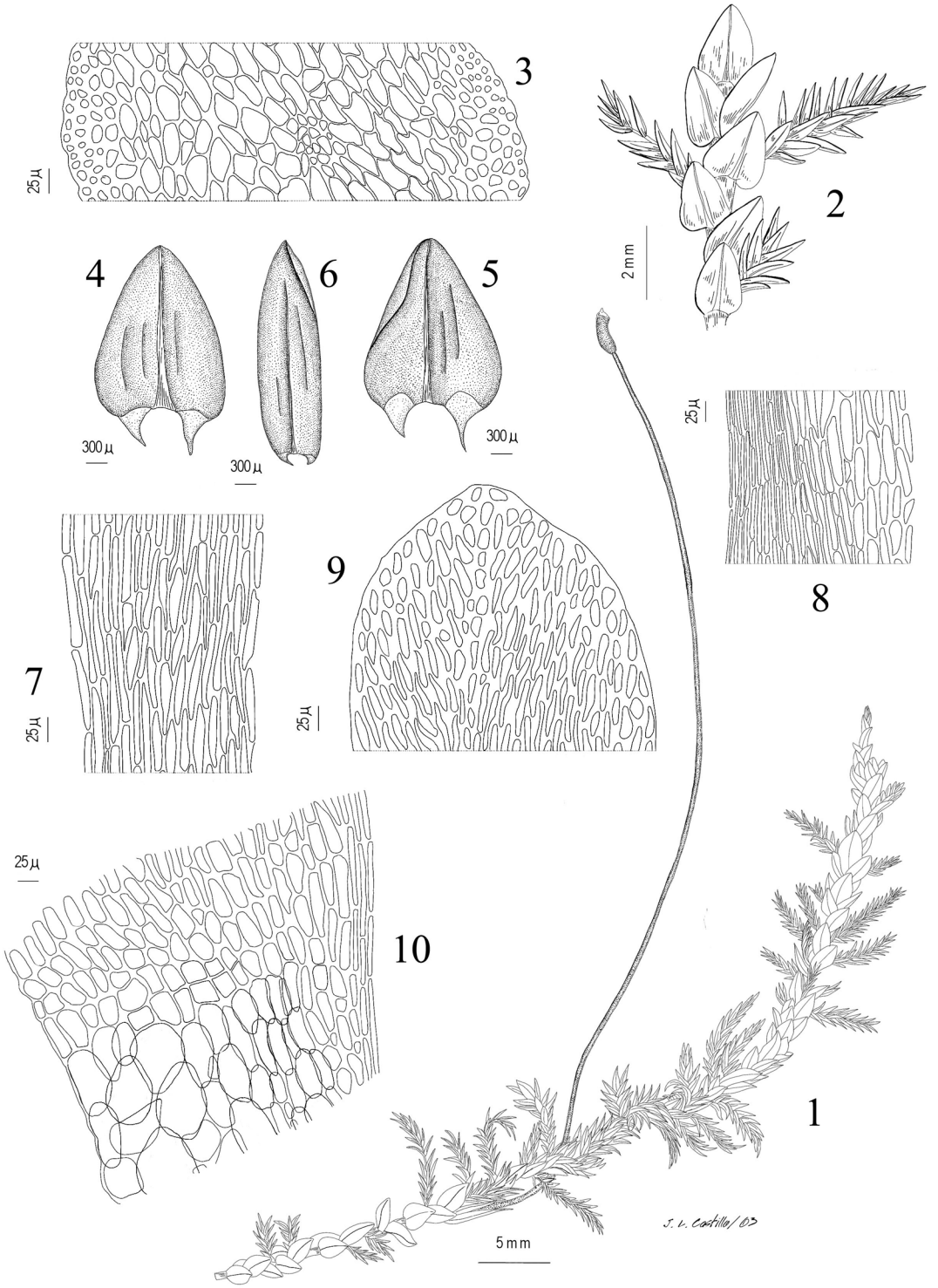

Figure 6.— *Calliergon giganteum*. 1, shoot with sporophyte; 2, shoot apex; 3, stem transverse section; 4-5 stem leaves; 6, branch leaf; 7, median lamina cells; 8, median lamina cells beside costa; 9, apical cells; 10, alar cells.

Figure 7.— Distribution map of *Calliergon giganteum* in the Iberian Peninsula. ● confirmed occurrence (10 x 10 Km square).

shows. Table 1 summarize the differences among *S. stramineum*, *C. cordifolium* and *C. giganteum* for Iberian specimens.

Habitat and distribution in the Iberian Peninsula

Straminergon stramineum grows usually in fens in the mountainous areas of the northern half of the Iberian Peninsula and in Sierra Nevada, mainly from 1200 to 2200 m.a.s.l., except in the Cantabrian Range, where it can be found at lower altitudes, in fens close to the sea, about 100 m.a.s.l.

This distribution pattern is very common in many bryophyte species in the Iberian Peninsula. These occur in the alpine regions, above 1200 m.a.s.l., in the interior mountainous areas of the Peninsula, while grow under 100 m.a.s.l. in the Cantabrian Range thanks to the Atlantic influence, which provides higher humidity conditions, allowing many plants with high humidity requirements to grow at lower altitude than they do in the interior mountain ranges, which have more continental conditions.

Calliergon cordifolium was recorded in two localities in the Central Range (Elías-Rivas, 1988), but the specimens from these localities were erroneously identified (see Appendix 3). Thus, the distribution of this species in the Iberian Peninsula is restricted to the northern third of the peninsula, occurring in rich fens or wet meadows in the alpine regions (1200-2000 m.a.s.l.) in the Pyrenees, Cantabrian Range and north-western part of the Iberian Range.

Even rarer than *Calliergon cordifolium* is *C. giganteum,* which despite having very similar habitat preferences, is only present in one locality in the Catalonian Pyrenees and in other four in the Cantabrian Range. Just like *Straminergon stramineum*, *Calliergon giganteum* grows at lower altitudes in the Cantabrian Range than in the Pyrenees.

Tabla 1
Differential characters among *Straminergon* and *Calliergon* species in the Iberian Peninsula

	Straminergon stramineum	*Calliergon cordifolium*	*Calliergon giganteum*
Branching pattern	Unbranched or sparsely branched	Sparsely branched to irregularly branched	Densely and pinnately branched
Axilary hairs	Scarce and small	Abundant and large	Abundant and large
Leaf shape	Ovate, elongate-ovate or lingulate	Broadly ovate or ovate-cordate	Broadly ovate-cordate
Costa	Single, up to 80% of length leaf	Single, almost reaching the apex, (60)80-100(120) µm wide at base	Single, almost reaching the apex, 90-190 µm wide at base
Alar groups	Longitudinally ovate or rectangular along margin (up to 50% of distance from leaf margin to costa)	Triangular, usually reaching the costa	Triangular usually not reaching the costa (75-90% of distance from leaf margin to costa)
Sexuality	Dioicous	Autoicous	Dioicous

The three species studied in the present paper grow in similar habitats, mainly fens in communities of the class *Scheuchzerio palustris-Caricetea nigrae* Tüxen (cf. RIVAS-MARTÍNEZ & *al*., 2002). However, *Straminergon stramineum* occurs in poor to rich fens, while *Calliergon cordifolium* and *C. giganteum* seem to prefer rich fens, with more vascular plants. According to HEDENÄS & KOOIJMAN (1996), who studied the habitat adaptations within the *Calliergonaceae*, based on morphological and habitat data measured in Sweden, *Straminergon* is adapted to less mineral-rich habitats and drier conditions than *Calliergon* species. This could explain why *Straminergon* has a larger distribution area in the Iberian Peninsula, since it grows in a wider range of pH and nutrient contents and can better bear dry periods. On the other hand the fact that *Calliergon* species need high contents of minerals and constant wet conditions restrict their growth to a few localities in the northern part of the Iberian Peninsula, where they can find such environmental conditions. There are some works about bryophyte vegetation in fens in the Eurosiberian Region of Spain (e.g. BALLESTEROS & *al*., 1983; FERNÁNDEZ-PRIETO & *al*., 1987). However, more habitat data, specifically collected in the sites where the *Calliergon* species grow, are needed to clarify the reasons of their distribution.

CONSERVATION

Calliergon cordifolium and *C. giganteum* are considered as vulnerable species in the Iberian Peninsula and Spain (SÉRGIO & *al*., 1994), but not throughout Europe (SCHUMACKER & MARTINY, 1995).

Applying the criteria to evaluate the threat category of mosses by HÄLLINGBACK & *al*. (1998), *C. cordifolium* is a Vulnerable (VU) species in the Iberian Peninsula, as defined by criterion B (species recently recorded in twenty or fewer 10 km x 10 km squares and found in ten or fewer localities/severely fragmented and in decline). The occurrence of *C. cordifolium* has been confirmed in the present work for seven 10 km x 10 km squares and seven localities in three different areas (Figure 5).

Even more critical is the situation of *C. giganteum* in the Iberian Peninsula, since it has been reported from five 10 km x 10 km and five localities, one of them isolated in the southern slope of the Pyrenees. According to HÄLLINGBACK & *al*. (1998) *C. giganteum* could be considered as an endangered (EN) species in the Iberian Peninsula, as defined by criterion B (species recently recorded in five or fewer 10 km x 10 km squares and found in two to five localities/severely fragmented and in decline).

ACKNOWLEDGEMENTS

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APPENDIX 1. Specimens examined.

Straminergon stramineum

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PORTUGAL. **Beira Alta**: 29TPE16, Serra da Estrela, Fonte da Canoriza, pr. Lagoa Redonda, LISU 176125, C. Sérgio, A. Seneca & J. Jansen, 1992; Serra da Estrella, Lagunillas de la Torre, MACB, E. Fuertes, M. Acón & G. Oliván, 2000.

Calliergon cordifolium

SPAIN. **Asturias**: 29TQH16, Puerto de Leitariegos, lagunas turbosas sobre la laguna de Arbás, PC, P. Allorge, 1927; 29TQH39, Grao, Cuellagar, MA-Musci 15981, J. Muñoz, 1990; 29TQH16, Puerto de Leitariegos, MA-Musci 9712, P. Allorge, 1911; *Ibidem*, MA-Musci 3041, P. Allorge, 1927. **Huesca**: 31TCH02, Benasque, Plan d'Estan, VIT 29310, M. Infante & P. Heras, 2002; 30TXN94, Arangües del Preesto. Paul de Bernera, BCB 22980, P. Monserrat & D. Gómez, 1985. **La Rioja**: 30TWM05, Laguna de Urbión, Herbario de Martínez-Abaigar, García Álvaro, 1995. **León**: 30TUN35, Riaño, orillas del Esla, BCB 15115, 15108, M. Losa & P. Monserrat, 1952. **Soria**: 30TWM39, Sierra del Moncayo, vertiente norte, MACB 62129, E. Fuertes, 1982.

Calliergon giganteum

SPAIN. **Asturias**: 29TQH26, Puerto de Somiedo, VIT 24519, P. Heras & M. Infante, 1999; 29TQH27, Puerto de Somiedo, vega Penonta, FCO-briof 355, J. L Fernández-Prieto, 1978; Puerto de la Cubilla, FCO-briof 354, C. Fernández-Ordóñez & Vigón, 1978; 29TQJ12, Cadavedo, PC, V. Allorge, 1956; 30TTN66, Lena, Puertos de la Cubilla, MA-Musci 15980, C. Fernández-Ordóñez, 1978. **Lérida**: 31TCH23, Pla de Beret, Vall d'Arán, BCB 31840, C. Casas, 1975.

APPENDIX 2. Morphological and anatomical characters studied.

GAMETOPHYTE

Plant

1. Habit
2. Colour
3. Size

Stem

4. Orientation to the substrate
5. Branching pattern
6. Size of branches

Anatomy

7. Shape of the transversal section
8. Central strand
9. Basic tissue
10. Cortex
11. Hyalodermis

Axillary hairs

12. Number hairs/leaf axil
13. Number of apical cells
14. Colour of apical cells
15. Description of basal cells

Pseudoparaphyllia

16. Present/absent. Shape

Paraphyllia

17. Present/absent. Shape

Rhizoids

18. Position
19. Colour
20. Branching
21. Ornamentation
22. Abundance

Stem leaves

23. Symmetry
24. Rugosity/ undulosity/ concavity
25. Shape
26. Size

Attitude upon the stem

27. Wet condition
28. Dry condition (if different)

Margin

29. Curvature
30. Denticulation

Apex

31. Description

Costa

32. Length, double, single, etc
33. Surface cells
34. Proration/papilosity?

Areolation

Mid-leaf cells

35. Shape
36. Size
37. Cell walls
38. Papillosity

Apical cells

39. Shape
40. Size
41. Cell walls

Basal cells

42. Shape
43. Cell walls

Marginal cells

44. Shape
45. Size

Alar cells

46. Appearance
47. Cell walls
48. Alar group appearance
49. Alar group decurrency

Initial cells of rhizoids

50. Position
51. Appearance

Branch leaves (if different)

52. Symmetry
53. Shape
54. Size

Sexuality

55. Sexual condition

Perigonia

56. Position
57. Leaf shape
58. Leaf margin
59. Leaf costa

Perichaetia

60. Insertion
61. Paraphyses

Inner perichaetial leaves

62. Simmetry
63. Plication
64. Shape
65. Attitude
66. Margin
67. Apex
68. Costa

Areolation

Upper cells

69. Shape
70. Cells walls
71. Papilosity/proration

Lower cells

72. Shape
73. Cell walls
74. Papilosity/proration

Vaginula

75. Description

SPOROPHYTE

Seta

76. Length
77. Colour
78. Twisting
79. Ornamentation

Capsule

80. Orientation
81. Shape
82. Size
83. Colour
84. Ornamentation (wet/dry)

Exothecial cells

85. Shape
86. Size
87. Papillosity/ mamillosity
88. Differentiation (apophysis to mouth)

Stomata

89. Number
90. Position
91. Structure

Separating annulus

92. Absent/present. Description

Peristome

Exostome

93. Colour
94. Orientation (wet/dry)
95. Lower outside ornamentation
96. Upper outside ornamentation
97. Margin
98. Border

Endostome

99. Colour
100. Basal membrane height (%)

Segments

101. Perforation
102. Ornamentation

Cilia

103. Number
104. Development
105. Appendiculate/nodose

Lid

106. Description

Calyptra

107. Shape
108. Ornamentation

Spores

109. Size
110. Ornamentation

APPENDIX 3: Specimens erroneously identified.

Specimens erroneously identified as *Calliergon cordifolium*.
SPAIN. Cáceres: 30TTK56, Castañar de Hervás, SALA-Bryo 248 is *Brachythecium rivulare* (Elías Rivas, 1988). **Guipúzcoa**: 30TWN45, Monte Garagarza (Monte Gartzaga), PAMP 3267 is *Straminergon stramineum*. **Navarra**: 30TXN68, Zurian, PAMP 3268 is *Straminergon stramineum*. **Salamanca**: **3OTTK67**, Sierra de Béjar, Circo de la Peña Negra, SALA-Bryo 241 is *Brachythecium rivulare* (Elías Rivas, 1988).
Specimens erroneously identified as *Calliergon giganteum.*
SPAIN. **ASTURIAS**: 30TQH39, Grao, Cuellagar, MA-Musci 15981 is *Calliergon cordifolium*.

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