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Androsace halleri subsp. *nuria* Schönsw. & Schneew. (Primulaceae), a new taxon from the eastern Pyrenees (Spain, France)

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Abstract

In the course of molecular phylogeographical investigations in the *Aretia* group of *Androsace* (Primulaceae), a previously unrecognised entity from the eastern Pyrenees (Spain/France) was identified as genetically distinct lineage. The entity is here morphologically characterised and described as new subspecies, *Androsace halleri* subsp. *nuria* Schönsw. & Schneew.

Key words: *Androsace*, France, Pyrenees, Spain, subspecies nova

Introduction

The genus *Androsace* Linnaeus (1753a: 141) comprises 155 species (Mabberley, 2008) mainly distributed in extra-tropical mountain ranges of the northern hemisphere. A phylogeny based on nuclear ribosomal ITS and chloroplast *trn*LF data (Schneeweiss & al. 2004) strongly suggested the monophyly of the *Aretia* group, comprising *A.* sect. *Aretia* (Linnaeus) W.D.J. Koch (1837: 583) (endemic to Europe), a single species of *A.* sect. *Chamaejasme* (Linnaeus) W.D.J. Koch (1837: 584) from northern Siberia and the often segregated genera *Vitaliana* Sesler in Donati (1758: 69) (southern European mountains) and *Douglasia* Lindley (1827: 385) (northeastern Siberia, Beringia, North American Cordilleras). In Europe, the *Aretia* group is most diverse in the Alps (13–15 species) and the northern Iberian mountain ranges including the Pyrenees (nine species); considerably fewer species are found in the Balkan Peninsula (three species), the Carpathians, the Apennines and the central and southern Spanish mountains (two species each) and the French Massif Central (one species). As European members of the *Aretia* group show a number of different distribution patterns in the central and southern European mountain ranges (narrow or wide distribution areas without or with disjunctions within or among major mountain ranges), they have become subject of several molecular phylogeographic studies (Schönswetter & al. 2003ab; Dixon & al. 2007, 2008, 2009ab; Schönswetter & Schneeweiss 2010).

Although the taxonomy of the European members of the *Aretia* group is well established (Lüdi 1927; Ferguson 1972; Kress, 1991, 1997), the broad sampling in the course of these phylogeographical investigations allowed previously unrecognised genetically differentiated entities to be discovered. For instance, a population from the Dinaric Mountains was found to be phylogenetically and morphologically distinct and was consequently described as *A. komovensis* Schönswetter & Schneeweiss (2009: 547). Strong intraspecific divergence was also encountered in the highly disjunctly distributed *A. halleri* Linnaeus (1753a: 142). Based on Amplified Fragment Length Polymorphism (AFLP) data, populations of *A. halleri* from the eastern Pyrenees (France, Spain) were clearly distinct from accessions from the rest of the distribution area, i.e. Sierra Cantabrica (Spain), Massif Central and Vosges (France; Dixon & al. 2007, 2008; Fig. 1). The populations of *A. halleri* in the eastern Pyrenees have previously been recognised as morphologically different from *A. halleri* found elsewhere in having shorter (but relatively broader) leaves with no or only weakly developed hooks at their tips (Kress, 1991, 1997). Most of the eastern Pyrenean populations of *A. halleri* are growing in snow-bed communities in the upper alpine or subnival vegetation belt, suggesting ecological divergence from the populations elsewhere that dwell in subalpine and lower alpine dwarf shrub communities dominated by *Juniperus communis* Linnaeus (1753b: 1040) and *Vaccinium* Linnaeus (1753a: 349) species. Since ecology and morphology of

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Pyrenean *A. halleri* approach those of *A. laggeri* A. Huet (1853: 254), it has been hypothesised that Pyrenean *A. halleri* has experienced introgression from *A. laggeri* (Kress, 1991). This is supported by phylogenetic analysis of DNA sequence data, where eastern Pyrenean accessions of *A. halleri* are more closely related to *A. laggeri* than to accessions of *A. halleri* from elsewhere (Schönswetter & Schneeweiss 2009). This relationship was, however, not confirmed by AFLP data, where Pyrenean *A. halleri* either grouped with *A. rioxana* A. Segura (1973: 47; Dixon & al. 2007), a local endemic of the Sierra de la Demanda in northern Spain, or with the other accessions of *A. halleri* (Dixon & al. 2008). Irrespective of these incongruences, genetic differentiation of Pyrenean populations of *A. halleri* from other populations of *A. halleri* is of similar extent as between *A. halleri* and the morphologically divergent *A. rioxana*.

Here, we test whether the genetic divergence of eastern Pyrenean populations of *A. halleri* is also reflected in morphological divergence, as suggested by Kress (1991). As this is the case, we describe a new subspecies of *A. halleri* to encompass the Pyrenean populations and provide a morphological characterisation as well as a taxonomic treatment.

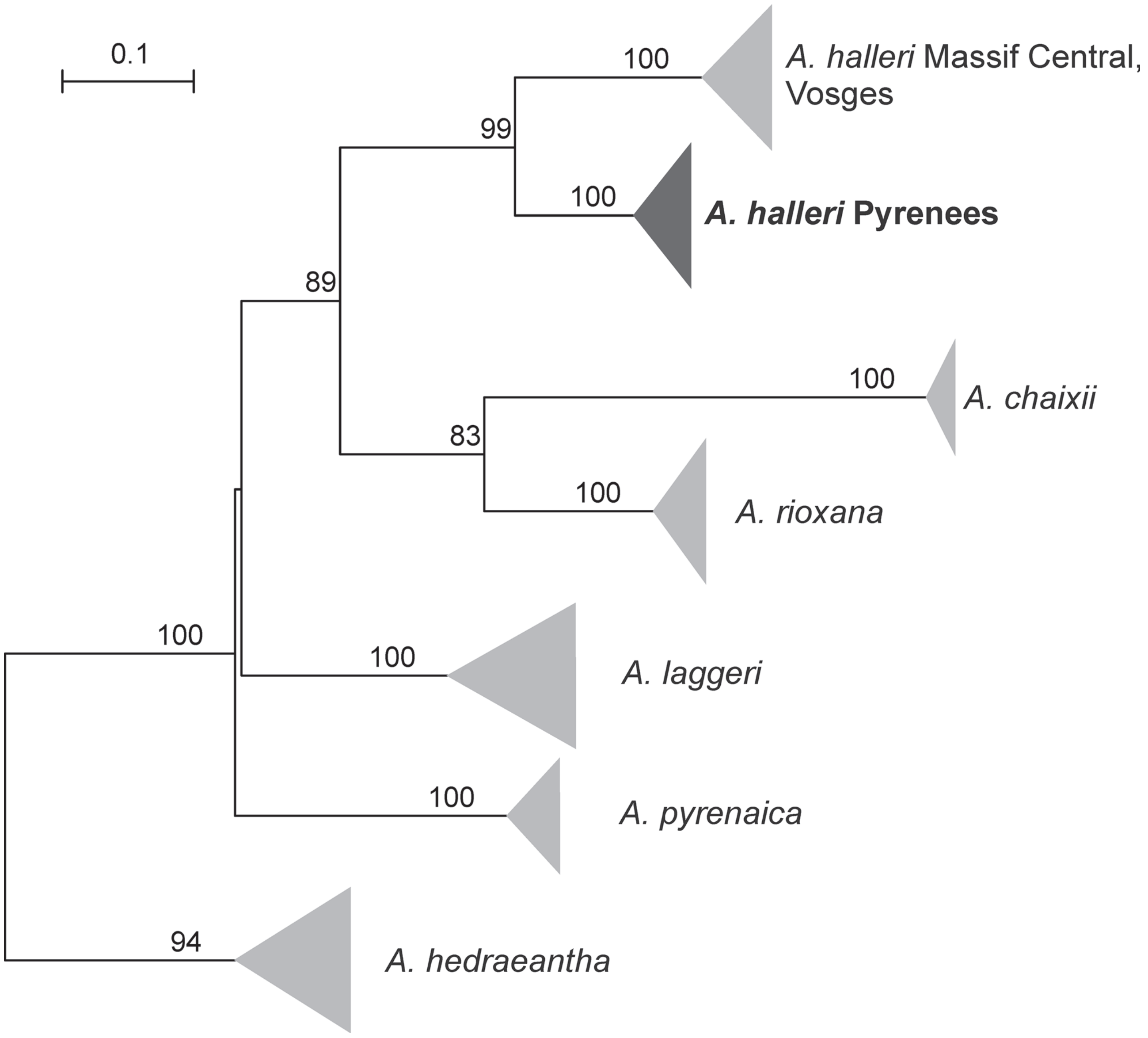

FIGURE 1. Phylogenetic relationships of *A. halleri* and its closest relatives. Shown is a neighbour joining analysis based on Nei-Li distances of the dataset presented in Dixon & al. (2008; the distantly related *A. adfinis* s. l. and *A. cantabrica* (Losa & P.Monts.) Kress (1981: 2) were excluded). The tree was rooted with *A. hedraeantha* Grisebach (1844: 3). A triangle's height reflects the intra-taxon genetic differentiation, a triangle's width is proportional to the number of individuals analysed.

Material and Methods

We checked the herbaria BCN, JACA, M, MSB and WU for specimens of *A. halleri* from the Pyrenees. Stimulated by an initial inspection, leaf length, leaf width and length of the scapes during anthesis were measured on 23 individuals of Pyrenean *A. halleri* and on 26 individuals of *A. halleri* from Massif Central and Vosges (France). Additional characters listed in the description below were measured on a subset of Pyrenean individuals. Measurements of leaves, rosettes, scapes, bracts and calyces were performed with ImageJ (Abràmoff & al. 2004) on scans of herbarium specimens. T-tests were performed with SPSS 18.0.2 to compare the ratio of leaf length and width as well as the length of the scapes between Pyrenean and extra-Pyrenean specimens. Pyrenean specimens used for the morphometric analyses are marked with an asterisk in the section "Additional specimens examined". Investigated specimens of *A. halleri* outside the Pyrenees were: FRANCE. Cantal: steep slope above Pont-Allagnon, 19 June 1903, *J.B. Charbamel* (M-0223627! & M-0127567!); FRANCE. Puy-de-Dôme: Monts-Dores, cliffs of Roc de Cuzeau, 1700 m, July 1935, *Ch. D'Alleizette* (M-0223633!); FRANCE. Puy-de-Dôme: northern slope of Puy de Sancy, 1700–1800 m, 29 June and 1 July 1971, *V. Rastetter* (M-0223637!); FRANCE. Haut-Rhin: rocky summit of Mt. Großer Belchen [Grand Ballon] close Gebweiler [Guebwiller], 6 June 1897, *Th. Linder* (M-0223635!). Finally, the conservation state of the Pyrenean populations of *A. halleri* was assessed following the IUCN categories (IUCN 2012).

Results and Discussion

Both the ratio of leaf length and width and the length of the scapes differed significantly between Pyrenean and extra-Pyrenean populations of *A. halleri* ($p < 0.001$; Fig. 2). Plants from the Pyrenees are generally smaller than those from the Massif Central and the Vosges, with shorter scapes and broader, shorter leaves. The morphological differentiation is paralleled by ecological divergence—preference for upper alpine habitats in the Pyrenees versus restriction to subalpine and lower alpine habitats elsewhere—and the reciprocal monophyly of Pyrenean and extra-Pyrenean accessions (Fig. 1; Dixon & al. 2007, 2008), altogether forming a solid basis for recognizing the Pyrenean populations of *A. halleri* as a distinct taxon (Fig. 3). Such a taxonomic recognition has already been anticipated by Dixon & Schneeweiss (2007; their *A.* spec. nov.).

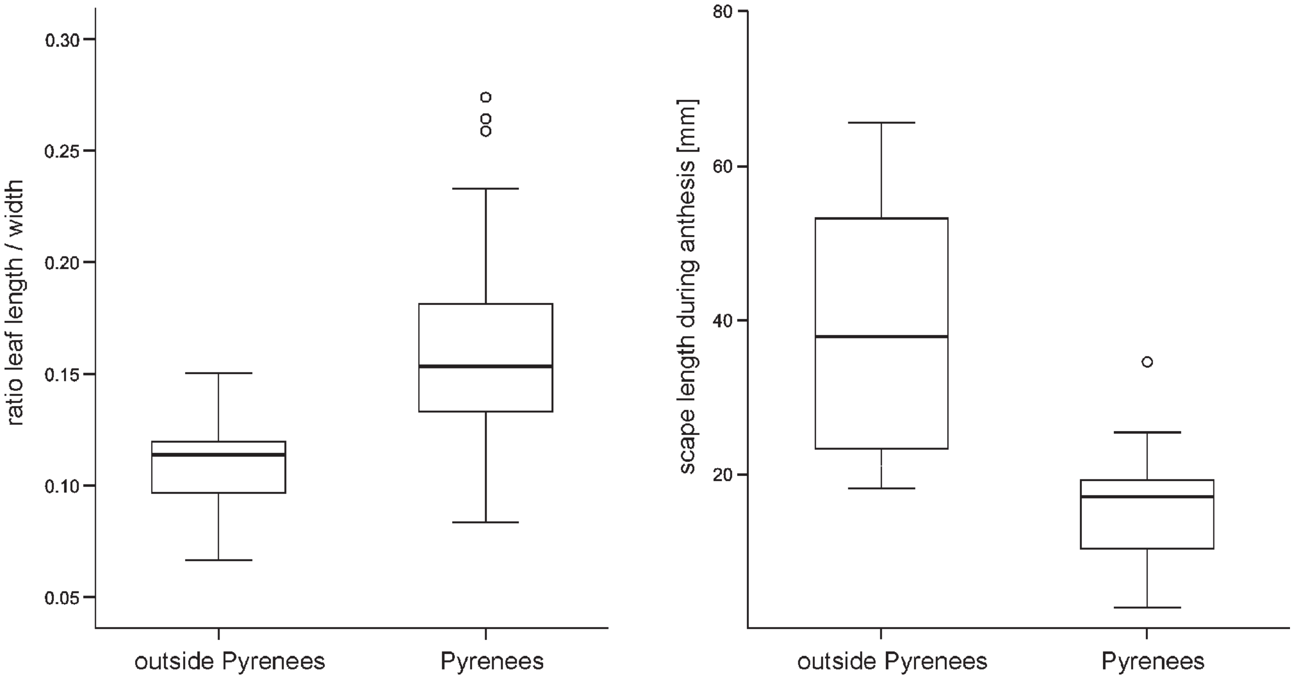

FIGURE 2. Comparison of morphological variation between populations of *Androsace halleri* from Massif Central and Vosges (France) and populations from the Pyrenees. Boxes define 25 and 75 percentiles; horizontal lines indicate medians, whiskers are from 5 to 95 percentiles, and circles indicate extreme values. The groups are different at $p < 0.001$ (T-test) for both characters. Left, ratio between leaf length and leaf width. Right, length of scapes during anthesis in mm.

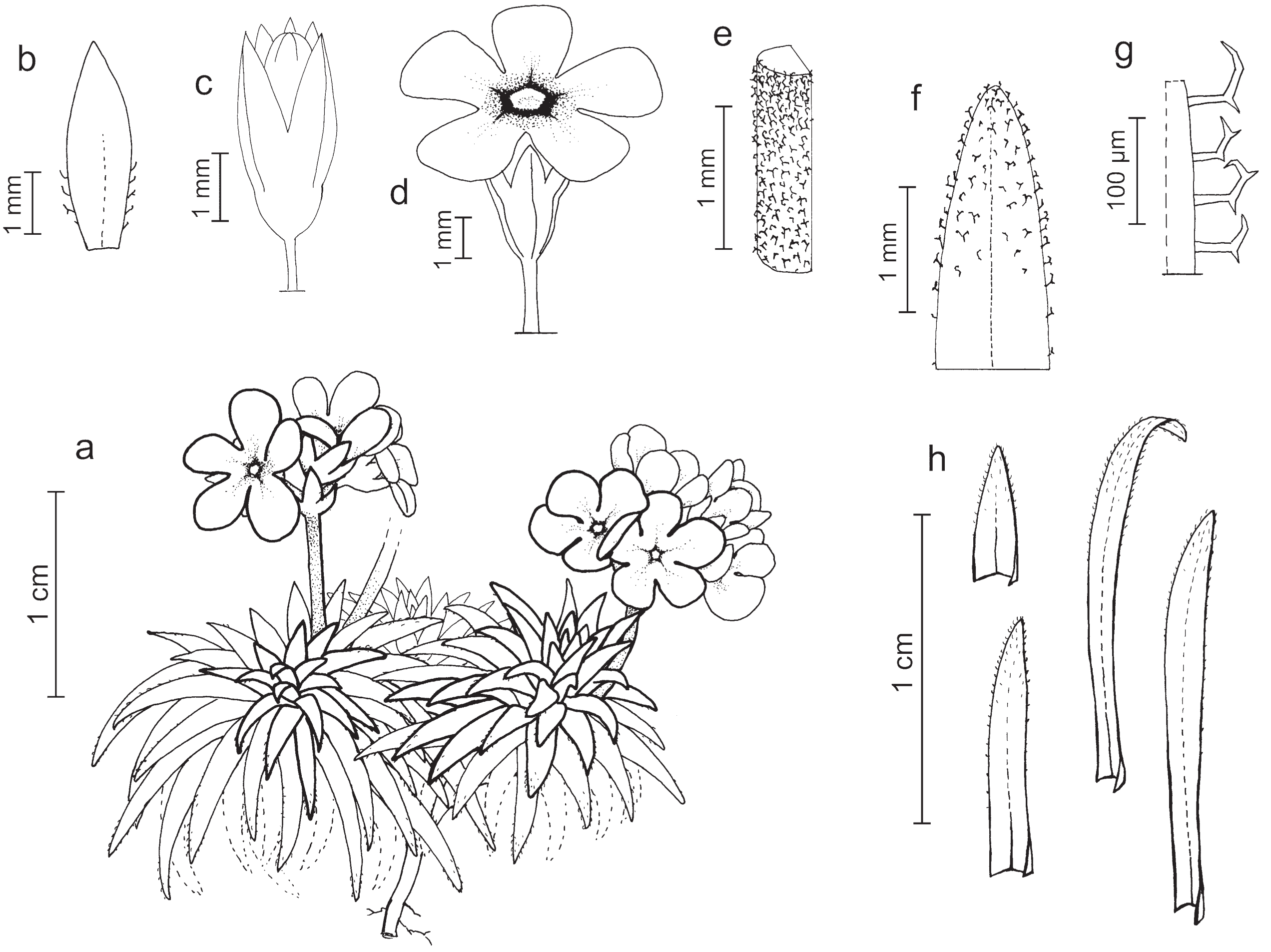

FIGURE 3. *Androsace halleri* subsp. *nuria*. **a,** habit; **b,** bract; **c,** young capsule; **d,** flower; **e,** scape; **f,** leaf apex (upper side); **g,** hooked hairs on leaf margin; **h,** rosette leaves. Drawing by M. Magauer.

Taxonomic Treatment

Androsace halleri* L. subsp. *nuria Schönsw. & Schneew. *subsp. nov.*

Diagnosis:—*Androsace halleri* L. subsp. *nuria* Schönsw. & Schneew. differs from *A. halleri* L. subsp. *halleri* in its shorter scapes and shorter, relatively broader leaves—*A. halleri* subsp. *nuria*: scapes (6)7–29(37) mm, leaves (3)5–12(15) mm × (0.8)1–1.7(1.8) mm; *A. halleri* subsp. *halleri*: scapes (21)22–62(67) mm, leaves 11–18(22) mm × 1.3–1.8(2) mm.

Type:—FRANCE. Dép. Pyrénées Orientales; Grenzkamm zwischen Frankreich und Spanien, westlich des Puigmale, Kalk, Kalkschiefer und kalkfreies Silikat, Fels und Schutt [Pyrénées Orientales: border crest between France and Spain, west of Mt. Puigmal, limestone, calciferous schist and carbonate-free silicate, rocks and scree], 2450–2600 m. 25 Juli 1971, *H. Merxmüller & B. Zollitsch* 26932, (holotypus M! [M-0127564]).

Description:—Perennial rosette plant, 1.5–8.3 cm high, rosettes 1.1–3.8 cm diameter, singly or forming loose cushions. Leaves basal, narrow triangular, linear-lanceolate or linear, sometimes with hooked tip, (3)5–12(15) × (0.8)1–1.7(1.8) mm. Leaf margin entire, often ciliate. Upper surface sometimes hairy, especially towards the tip; towards the margin densely and regularly hairy. Hairs mostly hooked, often with subordinate branches, up to 100 µm long. Scapes (0.6)0.7–2.9(3.7) cm during anthesis, elongated to 1.8–7.5 cm when fruiting, densely stellate hairy. Bracts obovate, 2.5–4.8 × 1.2–1.8 mm. Inflorescence with (1)2–5(6) flowers. Flowers with pedicel 0.9–3 mm at anthesis, elongated to 4 mm when fruiting. Calyx 3.1–5.6 mm, divided to 40–60% of its length. Corolla diameter 6–7 mm, petals pink. Capsule ovoid, 4.0–5.0 × 1.8–2.2 mm.

Etymology:—Named after the Valle de Nuria in the Spanish province of Girona/Gerona.

Distribution, ecology and conservation:—*Androsace halleri* subsp. *nuria* is distributed in the eastern Pyrenees, in the Spanish province of Girona/Gerona (for a comprehensive list of localities see Benito Garzón & al. 2001) and the French department Pyrénées-Orientales. The altitudinal distribution ranges from (1900) 2200 to 2850 m on Mt. Puigmal. Preferred habitats are open alpine meadows, more rarely dwarf shrub communities with relatively long snow cover or subnival scree communities. *Androsace halleri* subsp. *nuria* is restricted to a relatively small area with 40 km southwest-northeast extension, where it is growing up to the highest summits (e.g., Mt. Puigmal). It adds to the list of (sub)endemics of the eastern Pyrenees, which includes *Delphinium montanum* De Candolle ex De Candolle & Lamarck (1805: 641), *Salix ceretana* (P. Montserrat) J. Chmelař (1982: 111), *Senecio leucophyllus* De Candolle (1813: 144) and *Xatardia scabra* Meisner (1838: 145; Gómez & al. 2003). We suggest classifying the taxon as Near Threatened because of its small distribution area (extent of occurrence c. 500 km^2) and the anticipated range loss triggered by global warming (IUCN, 2012).

Additional specimens examined:—FRANCE. Pyrénées Orientales: basis of a rock face facing towards Porteille d'Orlu, 1900–2000 m, 9 June 1983, *P. Montserrat & L. Villar F-66* (JACA-138283!); ibid., massif of Puigmale d'Err (above the skiing resort Las Planes, close to the Spanish border), 2400 m, 10 July 1991, *J. Lambinon 91/F/200* (MSB-002534!)*; ibid., crest on the border between France and Spain, west of Mt. Puigmale, 2450–2600 m, 25 July 1971, *H. Merxmüller & B. Zollitsch 26932* (M-0127564!)*; ibid., crest on the border between France and Spain, Pla de Salinas south of Osseja, 2200–2300 m, 23 July 1971, *H. Merxmüller & B. Zollitsch 26817* (M-0127568!)*; ibid., crest on the border between France and Spain, between Pla de Salinas and Col de Caralps, southwest of Mt. Puigmale, 2400–2560 m, 23 July 1971, *H. Merxmüller & B. Zollitsch 26852* (M-0127569!)*; ibid., Puigmal, 2200–2350 m, 5 July 1986, *P. Montserrat, L. Villar, G. Montserrat* (JACA-443386!); ibid., Puigmal, 2400–2500 m, 5 July 1986, *P. Montserrat, L. Villar, G. Montserrat* (JACA-446086!); ibid., Canigou massif, Plas de Cady—Pic du Canigou, 2300–2784 m, 2°26‘E, 42°30‘30“N, 14 July 2001, *G. Schneeweiss, P. Schönswetter & A. Tribsch 6416* (WU!)*.

SPAIN. Girona: Queralps, close to the tunnel of the cog railway, in a valley below the Santuario de Nuria, 10 June 1955, *P. Montserrat, O. de Bolos & J. Braun-Blanquet* (JACA-13055!); ibid., Ribas de Ferrer [Ribes del Freser?], above the treeline in the Valle de Nuria, 2200–2800 m, 3 August 1974, *L. Villar* (JACA-5324!); ibid., Nuria, Collet Verd, 2100 m, *L. Vigo*, 2 July 1977 (BCN-46700!); ibid., Nuria, Cossa de l'Embut, 2250 m, *A. Farràs*, 2 July 1977 (BCN-46702!); ibid., La Molina, *M.T. Losa* (BCN-16973!); ibid., Nuria, in the alpine zone, 2000–3000 m, July 1879. Herbarium Dris Frio Tremols (WU!)*; ibid., eastern Pyrenees, southern ridge of Puigmal d'Err, from the Baga de les Clotes to the summit, 2500–2910 m, 2°7‘35“E, 42°22‘30“N, 22 July 2003, *G. M. Schneeweiss & P. Schönswetter 8836* (WU!).

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