Alchemilla cadinensis (Rosaceae), a new species from the Pyrenees (SW Europe)

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Abstract

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Alchemilla cadinensis Aymerich & L. Sáez, sp. nov. (*Rosaceae*) is described, illustrated and compared to morphologically close species. The new species morphologically resembles *A. demissa* Buser, but it is easily distinguished by several qualitative and quantitative characters in leaf shape, indumentum and fruit. The conservation status of *A. cadinensis* is assessed as Endangered (EN) according to IUCN Red List categories and criteria

Additional key words: taxonomy, *Alchemilla*, alpine flora, conservation, endemism

Introduction

Alchemilla L. is one of the most diverse genera in the *Rosaceae*, being highly diverse in W Eurasia (Fröhner 1990). The taxonomy of *Alchemilla* is complex and poorly understood, most likely due to confusion resulting from apomixis, polyploidization and hybridization (Gehrke & al. 2008). *Alchemilla* is currently accepted to be represented by 541 species in Europe and the Mediterranean region (Kurtto 2009). Among them, only few species grow in areas with late-lying snow (snowbeds) in high mountain areas (Bolòs & Vigo 1984; Fröhner 1998; Festi 2000). Some of these species that grow in areas with late-lying snow in the Pyrenees are a conservation priority (Sáez & al. 2010). They are specialized to the kind of conditions found in these mountain areas and, in some cases, are found at the edge of their natural area of occurrence.

In the course of botanical inventory work conducted on the Cadí range and neighbouring mountains (E Pyrenees, Catalonia, Spain), three populations of an unknown species of *Alchemilla* were found in snowbed habitats and rocky places on the N side of this mountain. The plants drew our attention because they do not match any other species described in recent floras and revisions (Bolòs & Vigo 1984; Fröhner 1998; Festi 2000; Ferrez & Tison 2010; Tison & al. 2014). However, the samples from the Cadí range seemed to be related to the *A. demissa* Buser aggregate. A detailed comparison of the Cadí populations with European taxa of *Alchemilla* revealed constant and conspicuous morphological differences in floral and vegetative features. The combination of ecological data of the population and morphological characters that have diagnostic value suggests that the plants belong to an undescribed species. They are described here as *A. cadinensis*, and the supporting reasons are given.

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Material and methods

Detailed observations and morphological measurements of vegetative and reproductive parameters were undertaken on herbarium materials from BC, BCN, G, W and ZT (acronyms according to Thiers 2015+), as provided in the Appendix. Morphological observations of materials were carried out under a Zeiss Stemi DV4 stereomicroscope. For taxonomic identification, revisionary work on scientific papers and floras of European territories (Bolòs & Vigo 1984; Fröhner 1998; Festi 2000; Ferrez & Tison 2010; Tison & al. 2014) was made. A detailed comparison between the new species and other morphologically related species is shown in Table 1. The descriptive terminology follows Fröhner (1998). The extent of occurrence and area of occupancy were calculated using the GeoCAT tool (Bachman & al. 2011).

Results and Discussion

Alchemilla cadinensis Aymerich & L. Sáez, **sp. nov.** – Fig. 1, 2 & 3.
Holotype: Spain, Catalonia, S Pre-Pyrenees, Serra de Cadí, Cava, between Canal Baridana and la Roca de la Balma, 42°17'19"N, 01°37'48"E, 2250 m, calcareous rock crevices and snowbeds, 9 Aug 2013, *P. Aymerich s.n.* (BCN 122700; isotype: BC).

Description — *Herbs* with woody rhizome; *stems* 1–5, procumbent, slender, 7–25 cm × 0.7–1.2 mm, with adpressed (0–15°) hairs (0.5–1.7 mm long), usually confined to 1 or 2 lowest internodes. *Basal leaves*: *stipules* yellowish becoming cream, brown when dry, 9–17.5 mm long, membranous, abaxially glabrous to sparsely hairy; *auricles* 2–4 mm wide (length/width ratio = 1.4–2), both with 1–3 teeth 0.1–0.3 mm long; *ocrea incision* 3–6.5 mm long; *petiole* 3–10.5 × 0.5–0.8 cm, covered by adpressed (0–15°) hairs 0.5–1.5 mm long; *leaf blade* adaxially dark green, abaxially paler, suborbicular, divided to 32–61 % of nerve length, flat or slightly undulate, 1.5–3.1 × 2–5.5 cm, adaxially glabrous, with adpressed (0–20°) hairs (0.5–1.5 mm long) on margin and main nerves abaxially (main nerves densely covered by hairs throughout their length); *leaf lobes* 7–9, ± cuneiform to hyperbolic, with straight sides and rounded apex, 1.5–2 × longer than wide; *teeth* subequal, obliquely triangular, acute, 0.7–1.7 × 0.5–1 mm (3–4.5 % of nerve length, length/width ratio = 1.4–2.5), ± connivent, apical tooth narrower and shorter than adjacent laterals. *Cauline leaves* 1 or 2(or3), shortly petiolate (petiole to 1 cm long), sometimes subsessile; *stipules* 4.5–7 × 5–8.3 mm, usually wider than long, margin serrate; *leaf blade* usually 5-lobed, to 11 × 17 mm, gradually smaller higher up stem. *Bracts* divided in 20–65 % of their length, 5–12 × 7–12.5 mm. *Inflorescences* 2–7.5 cm long, with 25–87 flowers. *Flowers* yellow-green, 3–4 mm in diam.; *pedicels* 1.5–3.5 mm long, glabrous (sometimes slightly hairy at proximal part). *Receptacle* oblong-cylindric, 1–1.6 × 0.8–1.5 mm, glabrous, base slightly decurrent. *Sepals* triangular-ovate, 1–1.5 × 0.7–1.2 mm (length/receptacle length ratio = 65–100(–120)), glabrous; *epicalyx segments* ovate-lanceolate, 0.7–1.3 × 0.4–0.7 mm, nearly ¾ as long as sepals, glabrous. *Staminodes* 0.4–0.6 mm long. *Style* filiform, 1–1.5 mm long. *Achene* 1.2–1.45 mm long, exceeding receptacle by 15–30 % of its length.

Phenology — Flowering from June to August; fruiting from August to September.

Distribution and ecology — *Alchemilla cadinensis* is currently known only from three populations in the Cadí range and Tosa d'Alp massif, E Pyrenees (Catalonia, Spain) (Fig. 4). The new species grows in rocky calcareous places on N-facing slopes, where snowbeds persist until June and exceptionally until midsummer. Its populations are placed in a narrow altitudinal zone between 2200 and 2250 m. *Alchemilla fissa* Günther & Schummel, a species morphologically close to *A. cadinensis*, was reported from the nearby Pedraforca massif (Fig. 4) by Vigo & al. (2003). This record is not supported by herbarium specimens and it is probably referable to *A. cadinensis*, but the presence of this species in the Pedraforca massif requires verification.

Conservation status — Among alpine plant communities, snowbeds are regarded as particularly sensitive indicators of climate change (Björk & Molau 2007). Therefore, changes in species composition in snowbeds can be expected. In this context, it is likely that *Alchemilla cadinensis* may suffer a loss of its habitat and increased plant competition. Our data so far indicate that *A. cadinensis* should be listed as Endangered EN D, following the categories and criteria of IUCN (2012), in view of its low population size (c. 150 individuals). In addition, this species has an extent of occurrence of 3.15 km² and the area of occupancy calculated on a 0.5 × 0.5 km grid is 0.75 km². The subpopulations from the E Cadi range (Tosa d'Alp) are found close to a ski resort, so it is likely that disturbances caused by heavy machinery and new ski pistes can cause impact on the natural populations of *A. cadinensis*.

Etymology — The specific epithet *cadinensis* is derived from "Cadino", the ancient form of the name for the type locality, the Cadí range, E Pyrenees, Catalonia, Spain.

Remarks — On morphological grounds, the new species is related to *Alchemilla demissa* (endemic to mountains of C and W Europe), with which it shares most of the vegetative characters and some flower features (sepals longer than or exceptionally subequalling epicalyx segments, receptacle glabrous, or sometimes slightly hairy in proximal part). However, a careful comparison of their

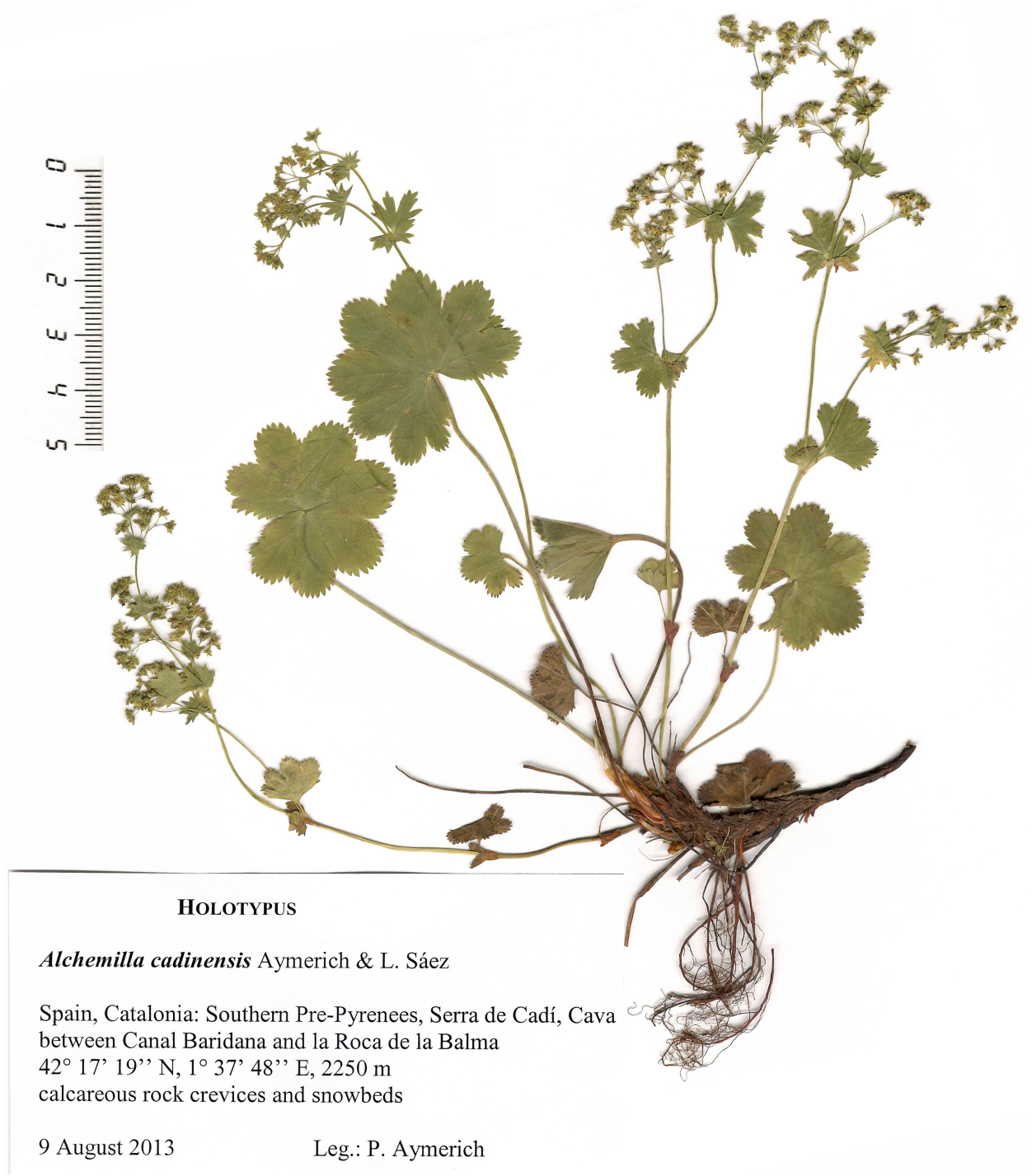

Fig. 1. *Alchemilla cadinensis* – holotype specimen (BCN 122700).

morphological features (Table 1) shows relevant differences: *A. cadinensis* is easily distinguished from *A. demissa* by its hairy petioles, shorter teeth of distal lobes and smaller achenes exceeding receptacle in 15–30 % of their length.

Alchemilla borderei S. E. Fröhner, a species endemic to the C Pyrenees and Cantabrian Mountains (Fröhner, 1998), is somewhat similar to *A. cadinensis*, but can be easily separated by several characters (Table 1): erect to ascending stems, wider petioles (which are sometimes glabrous), basal leaves abaxially hairy only on distal part of nerves, larger distal teeth, larger flowers, achenes exceeding receptacle in 33–40 % of their length and especially by almost always having sepals shorter than epicalyx segments (Fröhner, 1998). We have never observed epicalyx segments longer than sepals in *A. cadinensis*.

Alchemilla cadinensis also resembles *A. frigens* Buser, a species included within the *A. demissa* aggregate (Fröhner 2004) endemic to the Alps and Jura. *Alchemilla*

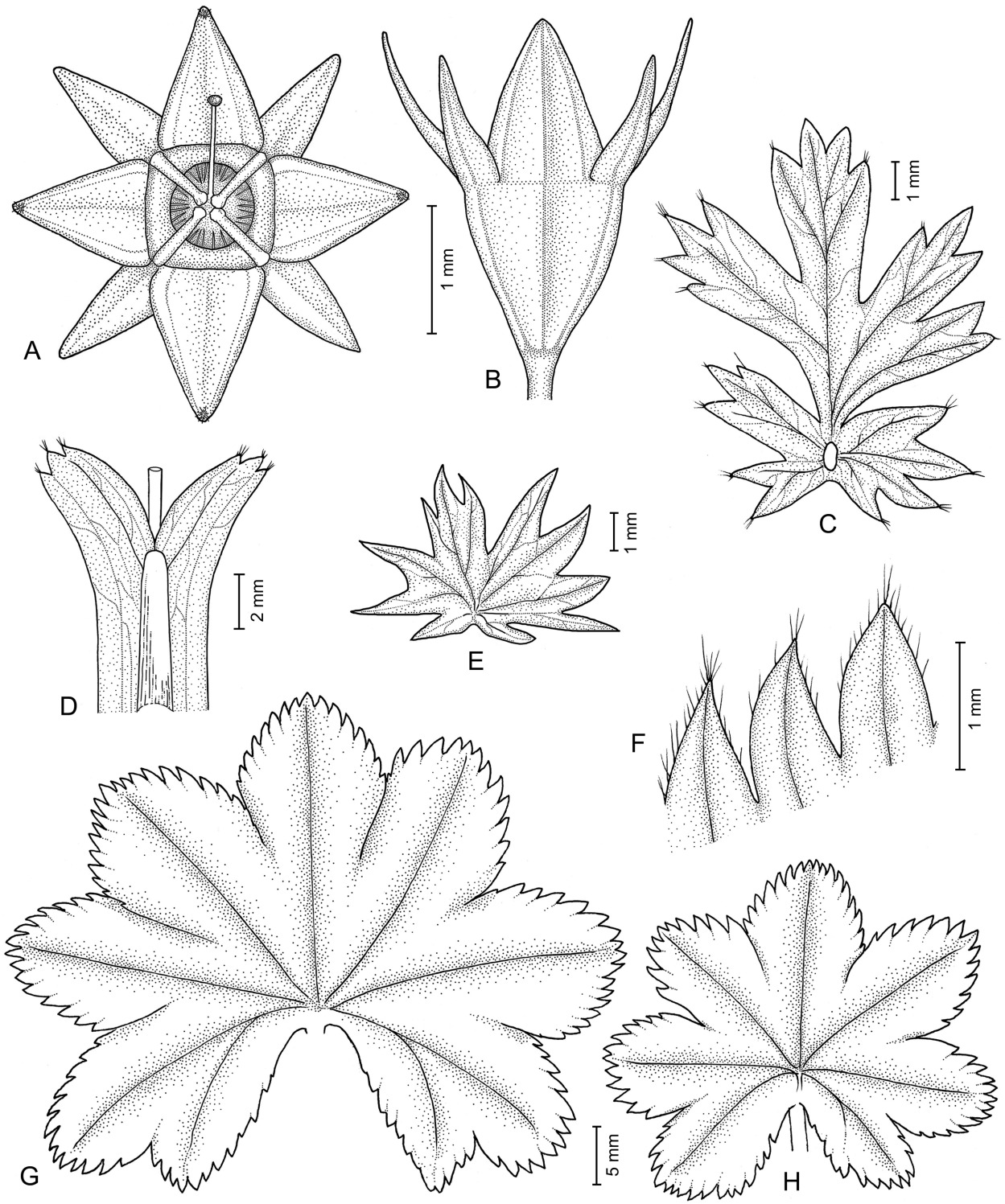

Fig. 2. A–H: *Alchemilla cadinensis* – A: flower, apical view; B: flower, lateral view; C: cauline leaf; D: bract; E: portion of stipule, adaxial view; F: portion of leaf margin, adaxial surface; G, H: basal leaves. – All drawn from the holotype by L. Sáez.

frigens differs from *A. cadinensis* in shorter pedicels, usually 0.4–1 mm long, longer achenes and less deeply lobed leaves (Table 1). In addition, the stems of *A. frigens* are usually glabrous.

The new species is somewhat close to *Alchemilla fallax* Buser (endemic to mountains of S Europe), but differs in the following features: epicalyx segments shorter than or exceptionally subequalling sepals (vs longer than sepals) and length/width ratio 1.6–2.2 (vs 2.5–4), leaves more deeply lobed, 32–61 % of nerve length (vs 8–30(–40) % of nerve length), stems distinctly narrower, 0.7–1.2 mm wide (vs 7–30 mm wide), hairy in 15–25 % of their length (vs 30–80 % of their length), and achenes smaller, 1.2–1.45 mm long (vs 1.5–1.8 mm long).

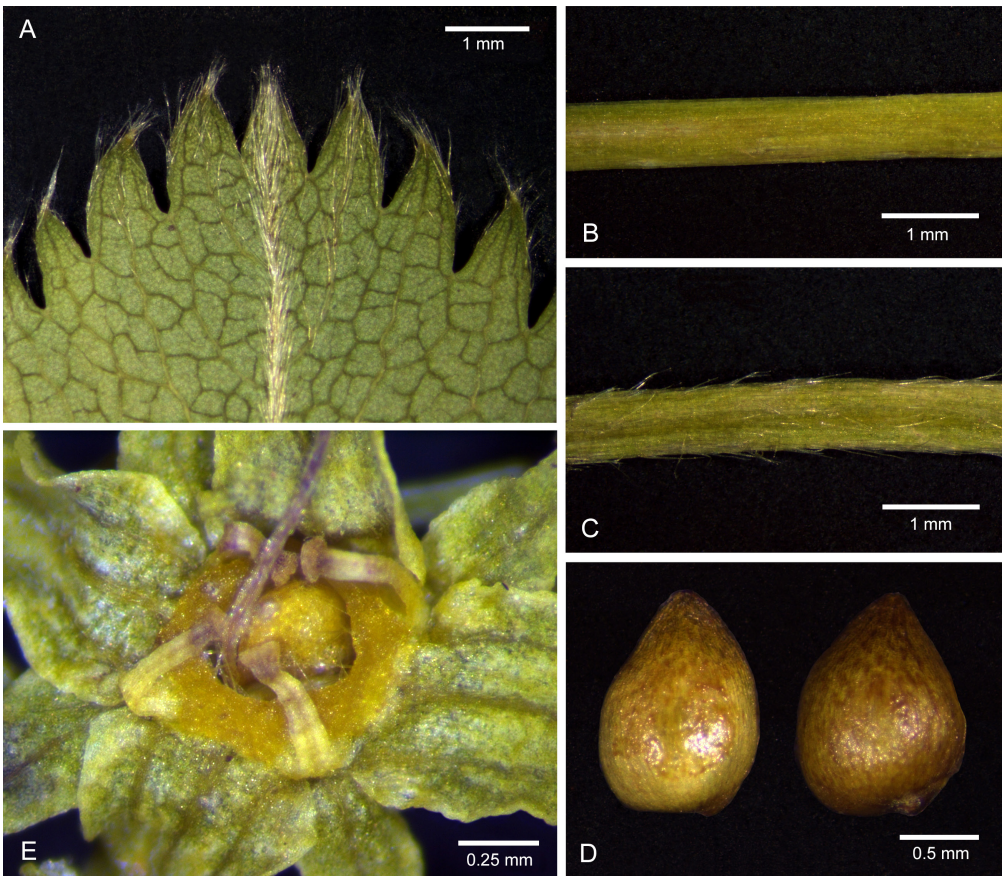

Fig. 3. A–E: *Alchemilla cadinensis* – A: apical portion of basal leaf, abaxial surface; B: portion of upper stem; C: portion of basal stem; D: fruits; E: portion of a flower. – All from the holotype.

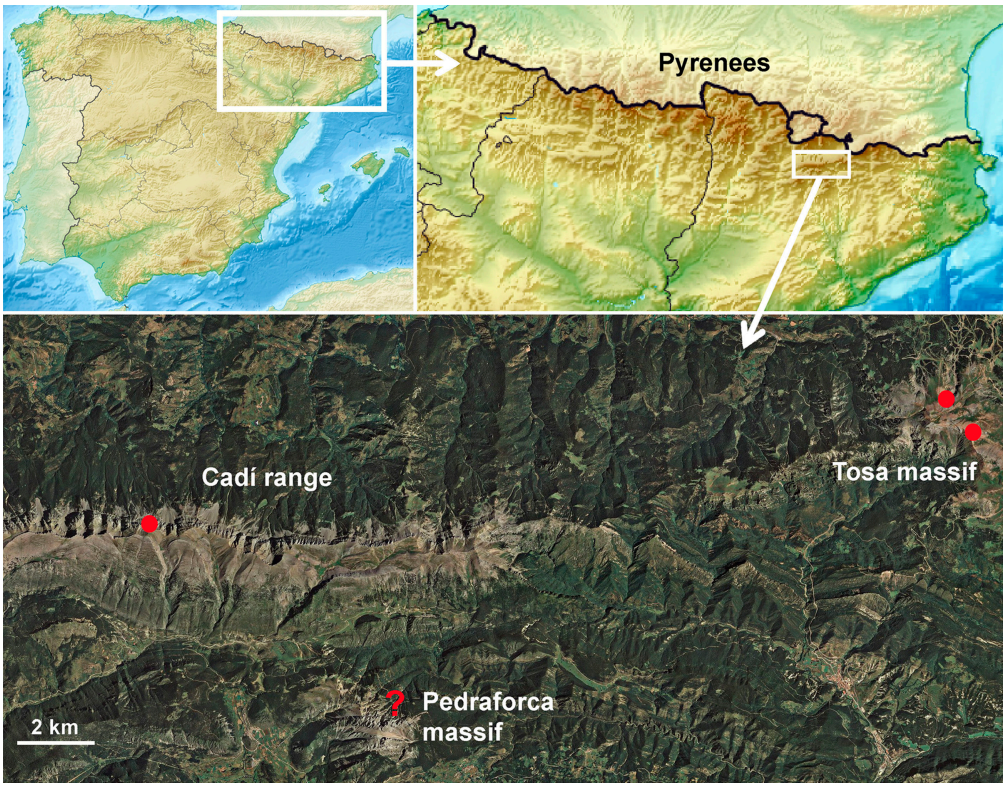

Fig. 4. Distribution of *Alchemilla cadinensis*. The red spots show the known populations. The question mark represents the unconfirmed record of *A. fissa* from the Pedraforca massif.

Table 1. Comparative table with discriminant characters between *Alchemilla cadinensis* and the most similar species. All measurements are in mm.

	A. borderei	***A. cadinensis***	***A. demissa***	***A. fallax***	***A. fissa***	***A. frigens***	***A. incisa***
Stem							
size	100–400 × 1–2	70–250 × 0.7–1.2	50–200 × 1–4	150–700 × 7–30	50–400 × 0.5–2	70–350 × 0.7–2	50–300 × 1–2
hairiness	glabrous or hairy in 10–40% of its length	hairy in 15–25% of its length	glabrous or hairy in c. 40% of its length	hairy in 30–80 % of its length	glabrous (rarely hairy in 10–30 % of its length)	glabrous or hairy in 30–75 % of its length	glabrous or hairy in 10–40% of its length
Petiole of basal leaves							
width	1–1.5	0.5–0.8	1–2.5	0.5–2	0.6–1	0.5–1.5	1–1.5
hairiness	glabrous to sparsely hairy	sparsely hairy	glabrous (rarely hairy)	densely hairy	glabrous to sparsely hairy	glabrous to sparsely hairy	glabrous to sparsely hairy
Blade of basal leaves							
width	20–100	20–55	20–70	30–120	10–100	25–75	20–100
blade division as % of nerve length	33–50	32–61	20–50	8–30(–40)	33–80	25–50	40–67
translucence	not translucent	not translucent	not translucent	not translucent	translucent	not translucent	not translucent
hairiness	adaxially glabrous, abaxially hairy on distal part of nerves	adaxially glabrous, abaxially sparsely hairy on nerves and teeth	adaxially glabrous, abaxially glabrescent or sparsely hairy on nerves and teeth	adaxially glabrous, abaxially hairy on nerves and teeth	adaxially glabrous, abaxially glabrescent or sparsely hairy on nerves and teeth	adaxially glabrous, abaxially glabrous to sparsely hairy on nerves and teeth	adaxially glabrous, abaxially hairy on distal part of nerves
teeth of distal lobe divergence	not divergent	not divergent	not divergent	not divergent	strongly divergent	not divergent	not divergent
teeth of distal lobe size	1–3.5 × 1–3	0.7–1.7 × 0.5–1	1.5–5 × 1–3.5	1–3.5 × 1–3	1–5 × 0.5–4.5	1–2.5 × 0.7–2	1–2.5 × 1–2.2
Pedicel							
length	2–5	1–3.5	0.5–3(–5)	1–3(–7)	1–4(–7)	0.4–1(–2)	2–5(–7)
Flower							
size	2–4 × 2.5–5	2–3 × 3–4	2.5–5 × 3–5	2.5–3.5 × 3–5	2–4.5 × 2–6.5	1.7–3.5 × 2.5–4.5	2.5–4 × 2.8–5
Sepals							
length/width ratio	1–2	1.2–1.5	0.9–2	1.3–2	1.2–2	1.1–1.3	1.2–2
% of receptacle length	80–120	65–100(–120)	67–100	(70–)100–130	90–140	60–75	75–115
Epicalyx segments							
length/width ratio	1–2	1.6–2.2	1.2–2	2.5–4	1.5–4	1.7–3.2	1.5–3
% of receptacle length	67–100	57–80	50–90	40–100	30–120	50–67	62–95
% of sepals length	75–120	65–80	60–90	(50–)90–110	50–120	60–80	85–100
nervature	1–3-nerved	1-nerved	1–3-nerved	1–3-nerved	(1–)3-nerved	1–3-nerved	(1–)3-nerved
Stamen filament							
length	0.4–0.7	0.35–0.5	0.5–0.7	0.5–0.8	0.4–0.7	0.4–0.7	0.4–0.7
Achene							
length	1.2–1.7	1.2–1.45	1.5–1.7	1.5–1.8	1.2–1.5	1.5–1.8	1.3–1.5
length/width ratio	1.3–1.5	1.3–1.5	1.3–1.5	1.5–2	1.3–1.5	1.3–1.45	1.2–1.5

Morphological relationships with *Alchemilla fissa* (endemic to mountains of C and S Europe) appear to be more remote. This species can be easily separated by several characters: glabrous (rarely hairy) stems and leaves, translucent and deeply divided basal leaves with strongly divergent teeth, and longer epicalyx segments (Table 1).

Moreover, there are significant morphological differences between *Alchemilla cadinensis* and other species that are not strictly associated with alpine snowbeds, such as *A. incisa* Buser, endemic to the Alps, Jura, N Apennines and Tatra. *Alchemilla incisa* differs distinctively from *A. cadinensis* in its deeply divided basal leaves (40–67 % of nerve length) with well-separated lobes (with almost U-shaped incisions) and longer teeth (up to 4 mm long), and by its epicalyx segments being usually as long as the sepals.

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Appendix

Representative specimens included in the morphological study

Alchemilla borderei S. E. Fröhner

Spain: Catalonia, Lleida province, Portarró d'Espot, 2400 m, 20 Jul 1944, *P. Font Quer s.n.* (BC 95632, det. S. Fröhner); sobre Estany d'Amitges, 2430 m, 9 Aug 1981, *A. Carrillo & J. M. Ninot s.n.* (BCN 93512, det. S. Fröhner); Estany de Besiberri (Vall de Barravés), 1980 m, 14 Jul 1985, *R. Massalles & J. M. Ninot s.n.* (BCN 93513, det. S. Fröhner); Pirineus, s.d., *A. C. Costa s.n.* (BCN 614000, det. S. Fröhner).

Alchemilla cadinensis Aymerich & L. Sáez

Spain: Catalonia, Girona Province, Alp-Urús, La Masella, Coma Oriola, 31TDG084870, 2237 m, rock crevices, 29 Jun 2006, *A. Romo, N. Nualart & I. Soriano s.n.* (BC 864184, sub *A. fissa*); Catalonia, Barcelona Province: E Pyrenees, Tosa d'Alp, Bagà, Comabella, 42°18'58"N, 01°54'33"E, 2200–2210 m, snowbeds and rock-crevices, 20 Aug 2014, *P. Aymerich s.n.* (BCB); also the holotype and isotype (see above).

Alchemilla demissa Buser

Andorra: Canillo, sota la Portella de Joan Antoni, 2550 m, snowbed, 14 Aug 1986, *J. Nuet s.n.* (BC 672893).

— Spain: Catalonia, Lleida Province, C Pyrenees, sota el Portarró d'Espot, 2320 m, snowbed, 24 Aug 1981, *A. Carrillo & J. M. Ninot s.n.* (BCN 52812). — Switzerland: Vallesia inferior, Monts Gran Sant Bernard, Col de fenetre de Ferret, 2500–2800 m, Jul 1894, *F. O. Wolf 3623* (W); Montsalvens, 1400 m, Jul 1905, *Jaquet s.n.* (W); Wallis, Berner Alpen, Leukerbad: zwischen Rinderhütte (Bergstation) und Wolfstritt, 1900–2300 m, 17–25 Jul 1982, *A. Polatschek s.n.* (W).

Alchemilla fallax Buser
Austria: Steirische Kalkalpen, Grüner See NW Tragöss Oberort, 780 m, 19 Jun 1983, *A. Polatschek s.n.* (W). — France: Pyrenäen Oirent., Vallée d'Err, 1350–1550 m, 4–17 Aug 1974, *A. Polatschek s.n.* (W); Pyrenäen Oirent., Vallée d'Eyn, 1650–1800 m, 4–17 Aug 1974, *A. Polatschek s.n.* (W); Pyrenäen Oirent., Saillagouse, 1400–1650 m, 4–17 Aug 1974, *A. Polatschek s.n.* (W). — Spain: Catalonia, Girona Province Vall de Ribes, vora Toses, 1450 m, 2 Jul 1978, *J. Vigo & M. Anglada s.n.* (BC 605296); Huesca Province, Vall de Ribes, vora Toses, 1450 m, 2 Jul 1978, *J. Vigo & M. Anglada s.n.* (BC 605296); Benasque, westlich la Renclusa, 2100 m, 27 Jul 1993, *M. Nydegger 32664* (BC 837634); Lleida Province, C Pyrenees, Espot, meadows, 4 Jul 1934, *P. Font Quer s.n.* (BC 79393); Boi, Estany Llebreta, 1700 m, 15 Jul 1944, *P. Font Quer s.n.* (BC 95631); Estany Llong, 2000 m, 21 Jul 1944, *P. Font Quer s.n.* (BC 95635); Catalonia, Montis de Llacs, 2100 m, alpine meadows, 26 Jul 1944, *O. Bolòs & P. Font Quer s.n.* (BC 95634); Areo, in Monte Monteixo, inter Pla de la Selva et Escala Mala, 1600–1800 m, 4 Aug 1949, *P. Font Quer s.n.* (BC 110538); Obaga de Montanui, Vall de Llauset, 1980 m, 27 Jul 1987, *A. Carrillo & J. M. Ninot s.n.* (BCN 52814).

Alchemilla fissa Günther & Schummel
Spain: Catalonia, Girona Province Nuria, 5 Jul 1919, *M. Garriga de Gallardo s.n.* (BC 877325); Catalonia, Lleida Province, C Pyrenees, Coll Alfred, 7 Aug 1924, *J. Cuatrecasas s.n.* (BC 79389); Catalonia, Espot, La Mosquera, 2000 m, wet places, 14 Jul 1934, *P. Font Quer s.n.* (BC 79334); Catalonia, Montis de Llacs, 2100 m, alpine meadows, 26 Jul 1944, *P. Font Quer & O. Bolòs s.n.* (BC 95443); Catalonia, Aigues Tortes, 2200 m, meadows, 25 Jul 1979, *P. Litzler 79477* (BC 802216); Vall d'Aneu, Qüenca, 2350 m, 26 Jul 1985, *A. Carrillo & R. M. Masalles s.n.* (BCN 60376).

Alchemilla frigens Buser
France: Jura, Crêt de la Neige, Jura Français, 1700 m, 9 Aug 1891, *A. Schmidely s.n.* (ZT 88830, ZT 88832); Haute Savoie, Mont Méry, 24 Jul 1893, *R. Buser s.n.* (ZT 88817). — Switzerland: Alpes Valaisannes, plateau de la gemmi, près du Daubuensee, 2050–2400 m, 12 Aug 1891, *O. Buser 3772* (G 408045); Alpes Valaisannes, massif du Grand Saint-Bernard, 2100–2500 m, 23–29 Aug 1893, *W. Barbey s.n.* (W); Wallis, Berner Alpen, Leukerbad, zwischen Rinderhütte (Bergstation) und Wolfstritt, 1900–2300 m, 17–25 Jul 1982, *A. Polatschek s.n.* (W).

Alchemilla incisa Buser
France: Jura, chemin de la Feucille, au mont Colombier, en travers les bois dans de petites éclaircies, 1500 m, 30 Jul 1890, *R. Buser & A. Schmidely 2730* (G 386946, 386948, 386949-holotype). — Italy: Vallombrosa, Toscana, Jul 1855, *E. Caruel s.n.* (G 408056). — Poland: Tatry Wysokie, m. Zoltas Turnia, 2000 m, 4 Aug 1929, *B. Pawlowski & K. Wallisch 35* (G 408054). — Switzerland: Alpes Lemaniennes (Valais), versant N Pas de la Boste, 4 Aug 1899, *J. Briquet s.n.* (G 408063).