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Festuca dertosensis (*Poaceae*), an overlooked fescue from the NE Iberian Peninsula

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Abstract: A new species of *Festuca* L. (*Poaceae*) is described from the southern mountains of Tarragona (Catalonia, Spain). The new taxon belongs to the *F. rubra* aggregate, and superficially resembles plants of the *F. trichophylla* group. Its leaf anatomy, however, suggests a closer relationship with *F. rubra* and, in particular, *F. heterophylla*. Although sharing some features with *F. paucispicula*, a sympatric taxon, there are sufficient differences to warrant its separation from this local endemic. A comparative table and key are provided to assist in the identification of this overlooked fescue, and its relationship to other species present in the area is discussed, with special attention paid to species sharing a similar distribution. Mitosis studies have been carried out to determine the chromosome number, and the results suggest a decaploid, with a chromosome number of $2n$ = c. 70.

Key words: chromosome count, endemism, *Festuca*, flow cytometry, *Gramineae*, Iberian Peninsula, mountain flora, *Poaceae*, Spain, taxonomy

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Introduction

The genus *Festuca* L. (*Poaceae*, *Loliinae*) is one of the most critical groups of the European flora. The high level of morphological plasticity within *Festuca* together with nomenclatural complexity makes its systematic interpretation difficult (Angelov & Ivanova 2012). The number of species fluctuates constantly according to the changing perspectives in the field of systematics. Generally speaking, however, it can be said that *Festuca* comprises 400–450 species with a cosmopolitan distribution across the temperate regions and mountain areas in the tropics (Clayton & Renvoize 1986; Watson & Dallwitz 1992). The primary centre of diversification of the genus is found in the meadows, alpine grasslands and steppes of Eurasia and N Africa. About 100 taxa (more than 80 species) are found in the Iberian Peninsula, 38 of these taxa endemic to this area, and 13 or so constituting Ibero-Maghrebian endemics (Cebolla & Rivas Ponce 2003; Devesa & al. 2013).

During recent field exploration and study of the vascular flora of the S Catalonian coastal mountain chain

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and adjacent areas, some plants belonging to the *Festuca rubra* L. aggregate (*F.* sect. *Aulaxyper* Dumort.) came to our attention. These plants were initially equated with *F. trichophylla* (Ducros ex Gaudin) K. Richt. and presumed to be either that species or the closely related local endemic *F. paucispicula* Fuente & Sánchez Mata (≡ *F. rubra* subsp. *font-queri* Litard.), a seldom-collected plant of disturbed sites in these coastal mountains. However, on closer examination it was discovered that, though superficially similar, these plants possessed sufficient distinguishing characteristics to warrant their recognition as a distinct species.

Going back to July, 2002, living material of this fescue was collected during a field trip to the Ports massif. This material was subsequently cultivated first in the nursery area and then planted out in the Botanic Garden of Barcelona, where its growth has been monitored. In 2014, a further trip to this and the Serra de Cardó, both in the province of Tarragona, was made in order to observe the grass in the field and make a more detailed study of the *Festuca* material collected there.

In the present contribution, morphological, cytogenetical and ecological data set out below support the description of plants from the Ports mountain area and from the mountains of Cardó and Montsià as belonging to a new species, *Festuca dertosensis*.

Material and methods

Morphological and anatomical observations were undertaken on herbarium specimens from BC and BCN (herbarium codes according to Thiers [continuously updated]). Representative herbarium material examined is listed in the Appendix. In addition, field observations were made on individuals from several populations of the Ports mountain area and Cardó (including the type locality of *Festuca paucispicula*).

For the study of leaf anatomy, fully-developed basal (innovation) leaves were rehydrated, sectioned and mounted in water, to be observed under a Nikon stereoscopic zoom microscope.

For the chromosome counts, root tips from plants growing in pots were pretreated in distilled water for 24 h at 4 °C. This material was fixed in a solution of absolute ethanol and glacial acetic acid (3 : 1) for 30 min in the dark. Subsequently, the material was transferred to a new solution of absolute ethanol and glacial acetic acid (3 : 1) for 4 h in the dark. After this step, the material was conserved at −20 °C in the same solution. For chromosome counts, root-tip meristems were excised, hydrolysed for 10–12 min on 1NHCl at 60 °C, washed with distilled water, stained with 1% aceto-orcein and squashed on a drop of 9 : 1 45% acetic acid : glycerol. Slides were observed with a Zeiss Axioplan microscope and the best metaphase plates were photographed with an AcioCam-HRm camera.

The DNA 2C-value of three individuals of *Festuca dertosensis* was estimated using flow cytometry. One plant is from the Creu de Santos population, and the other two from Mont Caro. *Pisum sativum* 'Express Long' (2C = 8.37; Marie & Brown 1993) was used as internal standard. The total nuclear DNA content was calculated by multiplying the known DNA content in *Pisum* by the quotient between the 2C peak positions of the target species and the internal standard in the histogram of fluorescence intensities. The half peak coefficient of variation (HPCV hereinafter) was calculated for plants and standards in order to test the quality of assessments (see Garnatje & al. 2007 for more details).

Results

Our findings resulting from these morphological and cytological studies lead us to the conclusion that we are faced with a fescue sufficiently distinct to merit its recognition as a new taxon, for which we believe the rank of species to be the most appropriate, and which we describe as follows.

Festuca dertosensis Pyke & L. Sáez, **sp. nov.** – Fig. 1, 2, 3A–C.
Festuca subg. *Festuca* sect. *Aulaxyper* Dumort.
Holotype: Spain, Catalonia, Tarragona province, Roquetes municipality, Portell de Caro, 31TBF7722, 1000 m, fissures in calcareous cliffs, 16 Jun 2014, *L. Sáez & S. Pyke SBP6977* (BC 879690 [Fig. 1]; isotype: JACA R299666).

Diagnosis — *Festuca dertosensis* differs from *F. paucispicula* and *F. trichophylla* subsp. *meridionalis* Pyke & Molero in its basal leaf morphology and in the smooth abaxial leaf surface, a feature shared with *F. rubra* subsp. *rubra*. The epidermis of these plants lacks the small protuberances characteristic of the *F. trichophylla* group of species. The internal leaf anatomy, very close to that of *F. heterophylla*, distinguishes it from the previously-mentioned taxa. In addition, it can be distinguished from *F. paucispicula* by its glabrous ovaries and from *F. heterophylla* by its narrow, tightly-infolded cauline leaves, creeping habit and much smaller size.

Description — Chasmophytic *grass*, perennial, laxly caespitose, spreading, with extravaginal vegetative shoots and thin, diffuse underground stolons or rhizomes that exploit crevices between rocks. *Culms* (12–)15–25(–30) cm, ascending, smooth, glabrous, weakly striate below panicle. *Innovation leaf sheaths* at first closed almost to mouth, soon splitting, glabrous or weakly scabrid distally, reddish purple basally, becoming brown when dry and eventually decaying into fibres. *Ligules* very reduced, without auricles. *Cauline leaves* like basal ones, but with 5 veins and 3 ridges. *Innovation leaf blades* 3–15 cm, green

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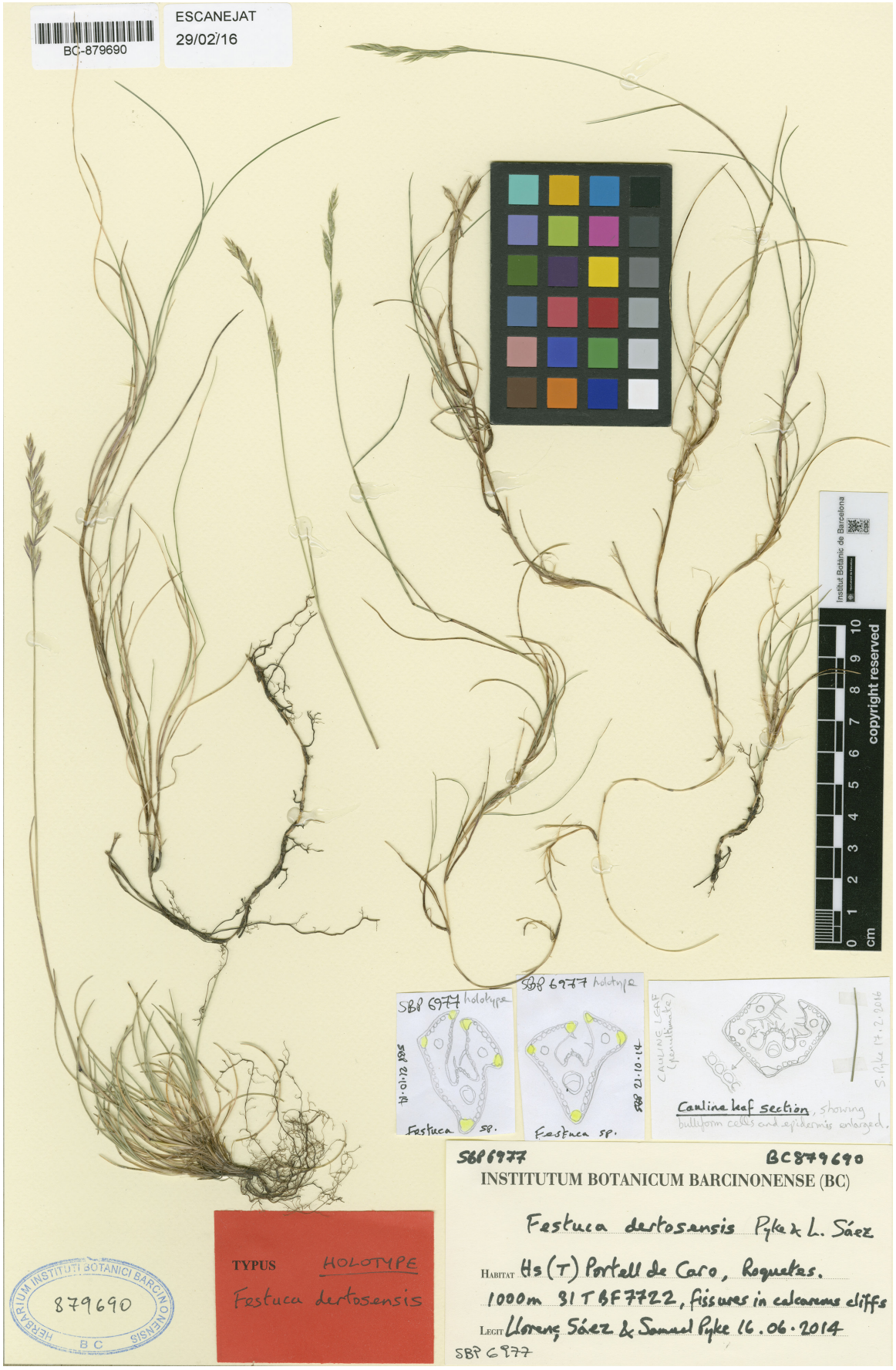


Fig. 1. *Festuca dertosensis* – holotype specimen (BC 879690).

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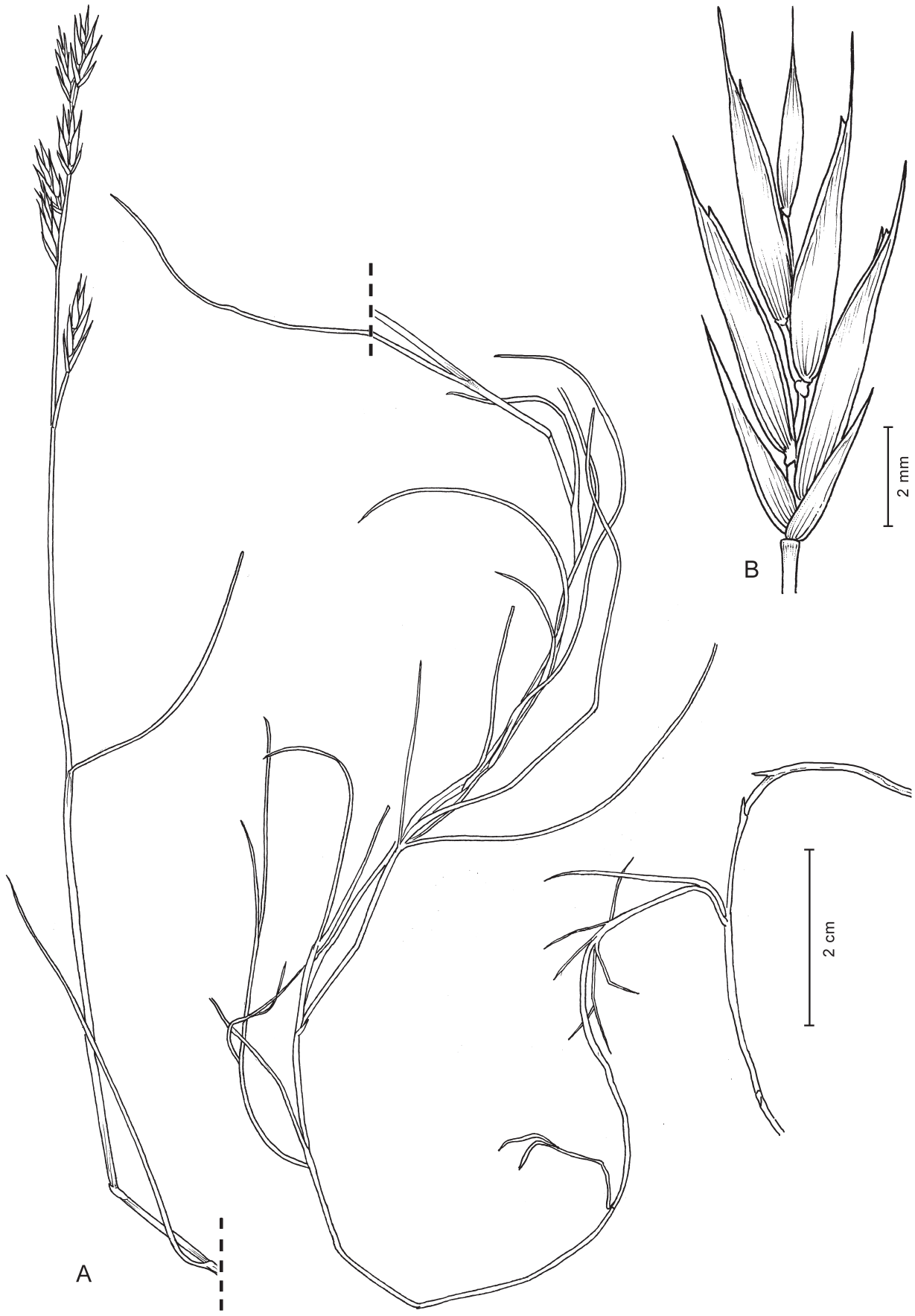


Fig. 2. *Festuca dertosensis* – A: habit; B: details of spikelet. – All drawn from the holotype by L. Sáez.

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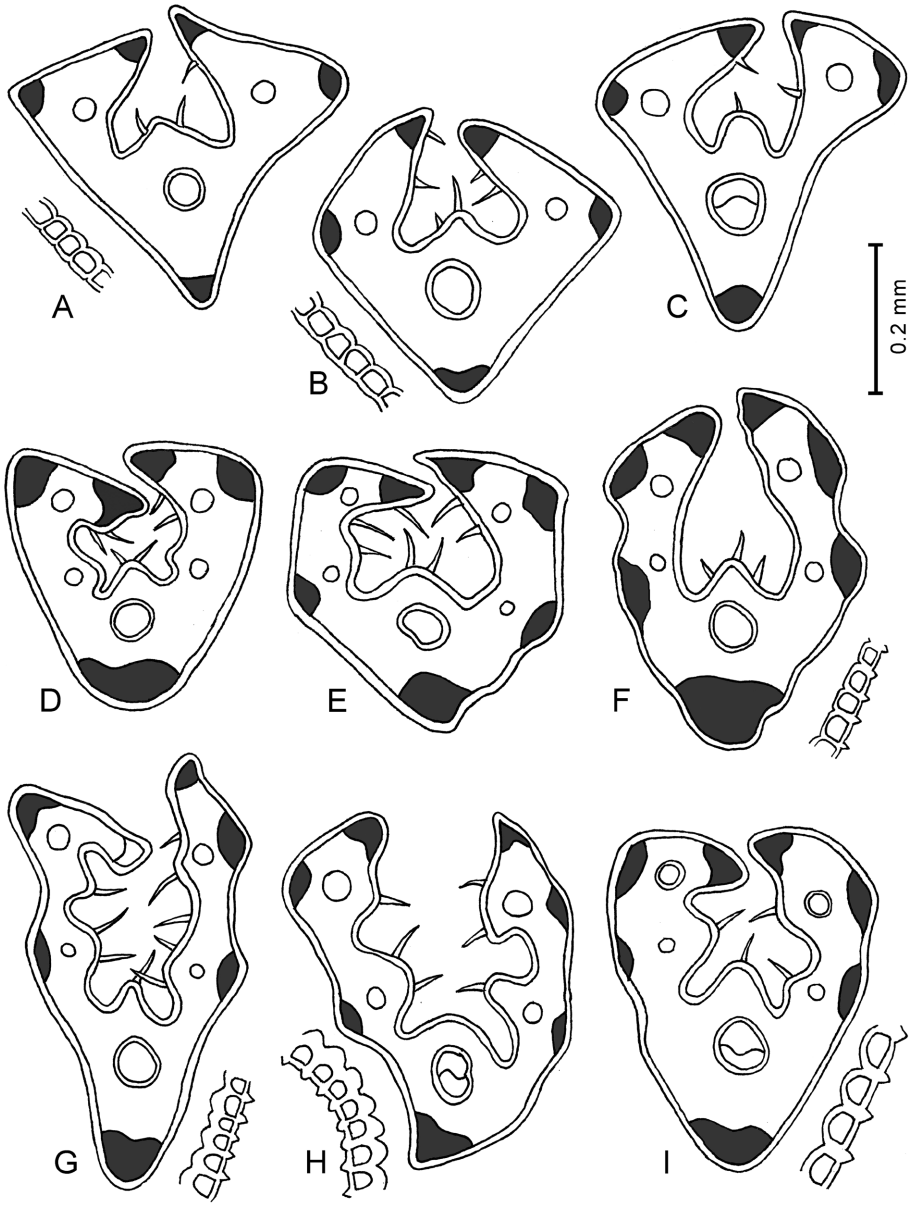


Fig. 3. Cross-sections of basal leaves with some portions of abaxial epidermis amplified – A–C: *Festuca dertosensis*; D–F: *F. paucispicula*; G–I: *F. trichophylla* subsp. *meridionalis*. – All drawn by L. Sáez.

or slightly glaucous, flexible, abaxially glabrous, with a ± acute, non-pungent apex; cross-section triangular, square or rhombic, 0.2–0.4(–0.6) mm wide (maximum folded width, sometimes wider in fresh state), with 3(–5) veins; sclerenchyma in 5(–7) strands of approximately equal size; adaxial grooves 2, ridge 1, with long, scattered hairs on adaxial surface; abaxial epidermis smooth, lacking protuberances. *Panicles* 3–7(–8) cm, with (4 or)5–13(–19) spikelets and 0–2 short branches scabrid on veins. *Spikelets* 8–10 mm (to apex of 4th lemma, excluding awns), with 3–5(or 6) florets. *Glumes* unequal, margin broadly scarious, lower glume 3–4 mm, 1-nerved; upper glume 4–5.5 mm, 3-nerved, lanceolate, acuminate. *Lemmas* 4.8–6 mm with a thin, scarious margin, 5-nerved, glabrous except at apex, shortly ciliate on margin, with an awn of 1–3 mm. *Paleas* 5–6 mm, glabrous, with ciliate margin and apex, keels rough. *Lodicules* 0.9–1.1 mm, deeply indented. *Ovary* glabrous. *Anthers* 3.2–3.5 mm.

Distribution and ecology — *Festuca dertosensis* is, as far as is known, restricted to the Ports massif and the Cardó and Montsià summit areas (all within the provinces of Tarragona and Castellón) (Fig. 4). The new species is clearly sciophilous and grows in ledges and fissures in limestone cliffs and among rocks (mainly N-facing aspects) between c. 600 m and 1400 m. It is also found on the ground at the foot of cliffs and descends exceptionally via screes to c. 500 m, as testified by the Bolòs sheet from Castellón province (see Appendix). Companion species include *Agrostis schleicheri* Jord. & Verlot, *Chaenorhinum crassifolium* subsp. *cadevallii* (O. Bolòs & Vigo) Güemes, *Festuca gautieri* (Hack.) K. Richt. and the three locally endemic species *Aquilegia paui* Font Quer, *Salix tarraconensis* Pau and *Thymus willkommii* Ronniger.

Etymology — The specific epithet *dertosensis* derives from Tortosa, in Latin *Dertosa*, the Roman colony that became an important centre for the Ebro delta and surrounding area.

Leaf anatomy — The epidermal cell structure of *Festuca dertosensis* conforms to the pattern of *F. rubra* subsp. *rubra*, differing from *F. trichophylla* and its subspecies (Molero & al. 2015) in the absence of minute protuberances, which Al-Bermani & al. (1992) considered a significant unifying feature of their *F. trichophylla* group. This group is made up of *F. nevadensis* (Hack.) K. Richt., *F. paucispicula*, *F. rothmaleri* (Litard.) Markgr.-Dann. and *F. trichophylla* with its subspecies, including the plant now referred to as *F. iberica* (Hack.) K. Richt.

The leaf cross-section (Fig. 3), however, bears a strong resemblance to that of *Festuca heterophylla* Lam.,

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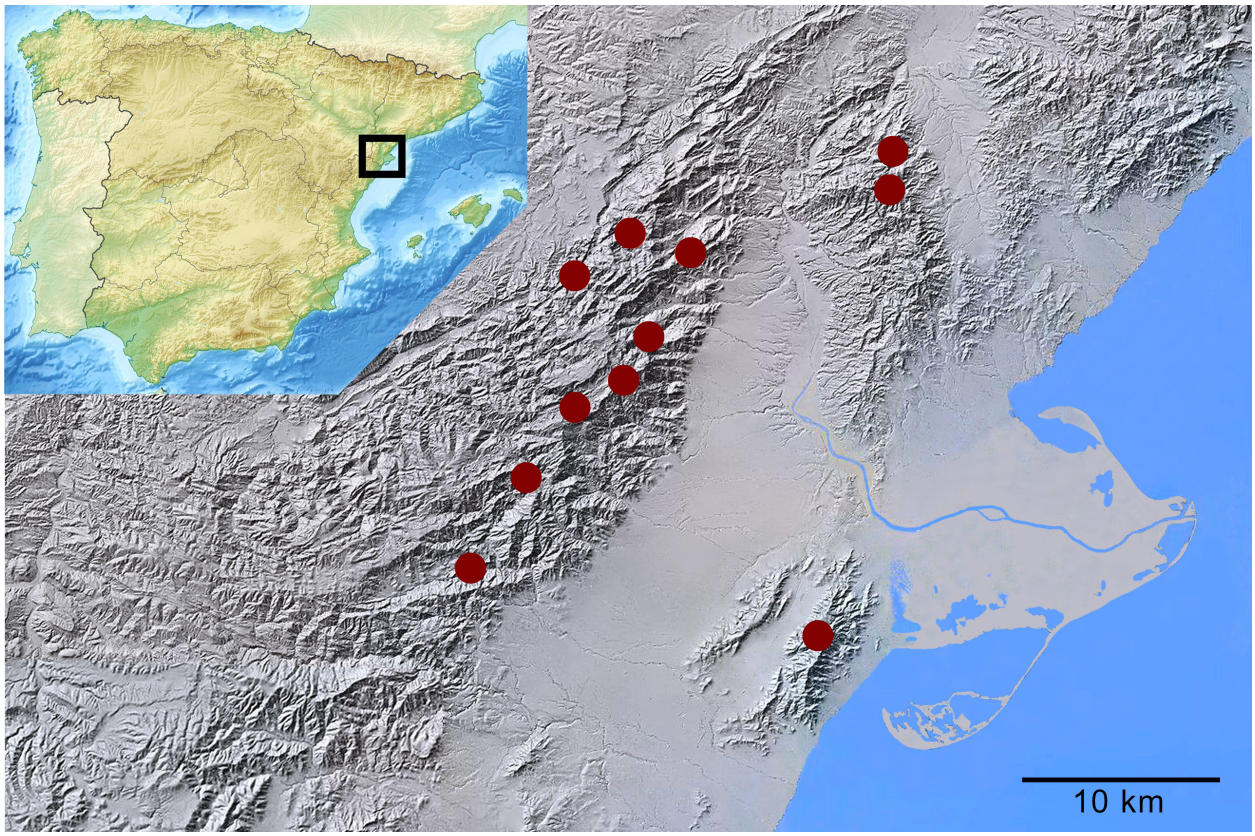


Fig. 4. Distribution of *Festuca dertosensis*. The dots show the known populations

a plant present in the region, where it grows in the mountains of the Prades area about 50 km from the Cardó site. This differs in being a more robust plant with dimorphic leaves, the basal ones capillary with a very similar cross-section, and the cauline leaves wider and flat in the fresh state. The leaf anatomy of *F. dertosensis* is also very close to that of *F. plicata* Hack. (*F.* sect. *Festuca*), which, however, is a densely caespitose, intravaginal, saxicolous species, with corrugated basal leaf sheaths, shorter and denser panicles, and awns often as long as the lemmas. This fescue does not seem to have been found further north than the Gúdar massif in the province of Teruel, some 90 km south of the Ports massif.

Comparative morphology — Although related species of the *Festuca rubra* and *F. trichophylla* groups can sometimes be found growing on inland cliffs, *F. dertosensis* is of clear preference a saxicolous species, its roots and slender hypogeal stolons (rhizomes, generally speaking) exploiting the cracks and ledges in the often vertical rock surfaces where it is most commonly found growing.

Apart from the method of anchorage and the internal leaf structure, the new taxon can be distinguished from *Festuca trichophylla* subsp. *meridionalis* by its smaller size, more diffuse habit, and shorter panicles with few spikelets. These reduced panicles have a parallel in *F. paucispicula*, which, however, differs in its thicker rhizomes, its shorter, somewhat scabrid leaves with scabrid-pubescent sheaths, and its pubescent ovaries.

A further species from the *Festuca trichophylla* group, *F. iberica*, does not appear to be present in the limestone coastal sierras where *F. dertosensis* is found. Apart from the distinct epidermal protuberances, this Ibero-Maghrebian taxon normally has scabrid leaves and a less spreading, more densely caespitose habit.

Festuca heterophylla and *F. heteromalla* Pourr. are large, normally terrestrial plants. *Festuca dertosensis* shares a similar leaf anatomy with the nemoral *F. heterophylla*, but differs from both species in its much smaller size, its reduced panicles with smaller spikelets, and its narrow, infolded cauline leaves. The pubescent ovary of *F. heterophylla* is an additional distinguishing feature.

Festuca rubra subsp. *rubra* and *F. rubra* subsp. *juncea* (Hack.) K. Richt. both differ from *F. dertosensis* in their leaf cross-section, which is not only larger in most cases but also has a distinct polygonal shape, with more veins, sclerenchyma strands and adaxial grooves. Subsp. *juncea*, probably not present in the mountains of this region, has wider, rush-like leaves (c. 1 mm wide), and subsp. *rubra*, introduced through agricultural, amenity and land-reclamation activities, is variable, but generally a stronger-growing plant with more consistent leaves. Both have longer, more branched panicles with more numerous spikelets. Subsp. *juncea*, here considered in its wider sense, which includes subsp. *pruinosa* (Hack.) Piper, also appears to have been distributed by humans beyond its supposed native range – high European mountains and N coasts of Europe.

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Chromosome number and DNA content — *Festuca dertosensis* shows a chromosome number of $2n$ = c. 70 and a 2C = 20 pg (population of Caro) and 2C = 19.90 pg (Creu de Santos population), which corresponds to a 2C mean value of 19.95 pg. The HPCV were lower than 3% in all cases (for targeted plants and standards). Counts were made from a large number of root tips taken from four plants: one of these from Creu de Santos (Serra de Cardó) and three from the scattered population below the summit of Mont Caro, one of which is a cultivated plant originating from material collected in 2002, while the other two date back to a 2014 collection. Other decaploid fescues in *F.* sect. *Aulaxyper* include *F. nevadensis*, a high-mountain species, and *F. duriotagana* Franco & Rocha Afonso, a lowland species related to *F. rubra* and of a W Iberian Peninsula distribution. These fescues are clearly distinct from our plant.

Key to the Mediterranean taxa of *Festuca* sect. *Aulaxyper* in the NE Iberian Peninsula

This dichotomous key includes taxa of *Festuca* sect. *Aulaxyper* either present in or cited from the geographic area corresponding to the Mediterranean-climate E Iberian region. Of the c. 30 W Mediterranean taxa involved at specific and subspecific levels, the key has been elaborated for those taxa that are relevant to this paper. Twelve Iberian taxa have been excluded for simplicity's sake: these include fescues from the siliceous soils of the C and W Iberian Peninsula as well as high-mountain and coastal or littoral taxa.

Leaf details refer to basal innovations unless otherwise stated (width is maximum folded diameter of involute or plicate leaves; length refers to lamina only). The term "rhizome" includes any hypogeal stolons present. Spikelet length is to the apex of the fourth lemma, awn excluded, conforming to standard procedure with *Festuca*.

Characteristics of the section: Non-flowering shoots extravaginal [partly intravaginal in *Festuca heterophylla* and *F. braun-blanquetii* (Fuente & al.) Rivas Mart. & al.]; sheaths generally closed to mouth, without deeply infolded, thin margins, usually decaying into fibres; ligules without auricles.

Remarks: *Festuca iberica* comprises subsp. *iberica*, subsp. *yvesiana* (Litard. & Maire) Dobignard & Portal and subsp. *atlantigena* (Litard.) Dobignard, the latter two present in N Africa. The form described in this key includes plants (voucher sheets in BC) from around 1500 m present in the S part of the Iberian (Sistema Ibérico) mountains from localities in and around the Gudar, Javalambre and Rayo sierras in the provinces of Teruel and Castellón.

Festuca heteromalla [= *F. megastachys* Hegetschw. & Heer] was described from plants found growing around Narbonne, France. Likely to be present in the study area (voucher sheets from the Montseny, Montnegre and the Montserrat massifs seem to pertain to this probably native species). A close taxon, *F. rubra* var. *multiflora* Asch. & Graebn. [≡ *F. rubra* subsp. *multiflora* Piper; = *F. planifolia* (Hack.) K. Richt.], considered by some to be synonymous, may appear in artificial habitats, although to date this flat-leaved fescue with large, lax panicles has not yet been recorded from the study area.

Festuca trichophylla is represented here by subsp. *meridionalis*. Gaudin's type – now subsp. *trichophylla* – and St.-Yves's subvar. *asperifolia*, combined as a subspecies of *F. trichophylla* in 1992 by Al-Bermani, also occur in the Iberian Peninsula, but in the cooler, wetter mountain areas of the north (from the Pyrenees across to the Galician mountains), for which reason we have omitted them from the key.

1. Plants with normally intravaginal (sometimes extravaginal) shoots, entirely caespitose **2**
– Plants with normally extravaginal shoots, caespitose with poorly developed rhizomes or clearly rhizomatous with diffuse development of shoots **3**
2. Plants tall, to 150 cm; shoots intra- and extravaginal; basal and cauline leaves markedly dimorphic; ovary distally pubescent . . . . . ***F. heterophylla***
– Plants to 90 cm tall, usually much less; shoots mainly intravaginal; basal and cauline leaves not obviously dimorphic; ovary distally glabrous . . ***F. nigrescens***
3. Plants strongly rhizomatous, with smooth, folded basal leaves and wide cauline leaves, flat when fresh . . . . . ***F. heteromalla***
– Plants rhizomatous or not; basal and cauline leaves setaceous, folded even in fresh state **4**
4. Leaves (0.2–)0.3–0.6(–0.7) mm wide, abaxial surface (except in *F. dertosensis*) ± scabrid and with minute protuberances **5**
– Leaves (0.5–)0.6–0.9(–1) mm wide or more, abaxial surface smooth and without minute protuberances **8**
5. Plants forming ± dense tufts, weakly or not rhizomatous; culms 20–90 cm long or more; panicles variable with numerous (generally 11–40) spikelets **6**
– Plants rhizomatous and of diffuse growth; culms to 30 cm long; panicles short, with few (generally 2–13) spikelets **7**
6. Culms generally 30–90 cm long; leaves to 40 cm long, weakly scabrid; panicles well developed, with up to 40 spikelets; lemmas with 1–3 mm-long awns . . . . . ***F. trichophylla*** subsp. ***meridionalis***
– Culms generally 20–30 cm long; leaves 5–15 cm long, moderately to strongly scabrid; panicles short, with 5–15(–18) spikelets; lemmas with short awns to c. 1 mm . . . . . ***F. iberica*** (see remarks above)
7. Plants creeping, terrestrial, strongly rhizomatous; leaves less than 9 cm long, not flaccid; cross-section polygonal with 5 veins; culms and panicles short, with (1 or)2–4(–10) spikelets; ovary distally pubescent . . . . . ***F. paucispicula***

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– Plants ± spreading, saxicolous, with very fine, wiry rhizomes; leaves more than 9 cm long, often flaccid; cross-section triangular to quadrangular, with 3 veins; culms few, with (4 or)5–13(–19) spikelets; ovary glabrous . . . . . ***F. dertosensis***

8. Plants rhizomatous and often quite densely caespitose; leaves smooth, 0.5–0.9 mm wide, sheaths generally scabridulous or pubescent; sclerenchyma strands ± equal (casual; introduced for agricultural and amenity purposes) . . . . . ***F. rubra*** subsp. ***rubra***

– As above, but with wider (0.7–1.3 mm), rush-like leaves, sheaths glabrous or pubescent; sclerenchyma strands unequal, some clearly thicker than others . . . . . ***F. rubra*** subsp. ***juncea***

Discussion

Festuca dertosensis has in the past apparently been taken for two, or probably three, related species. St.-Yves studied plants collected in the area in question between 1917 and 1949, including material collected by Pio Font i Quer (see Appendix), some of which was referred to as "forma inter var. *trichophyllam* Gaud. et var. *genuinam* Hack. medium tenens". He would have included these plants among the "Hispania" references of his "*F. rubra* (*eu-rubra*) var. *yvesiana* R. Lit. et R. Maire" and "var. *trichophylla* Gaud. subvar. *setacea* St.-Y." entries in his *Tentamen* of Old World fescues (St.-Yves 1927). These at present would correspond to *F. iberica* and *F. trichophylla* s.l., respectively. Other material, for example sheet BC 148940, containing material collected by Antoni and Oriol de Bolòs, was interpreted as falling within *F. rubra*, with no infraspecific epithet. Cadevall (1936) also lumped all similar plants together under the name *F. rubra*, although in the footnote of this entry he mentioned the race *F. trichophylla* Ducros, without entering into more details. Font i Quer (1950) evidently equated these plants either with *F. trichophylla* or, more unlikely, with *F. gautieri* subsp. *scoparia*, rather than *F. paucispicula*, since he clearly stated on page 67, entry 58, that he had been unable to find further plants belonging to this species he himself had discovered (to be named later by Litardière as *F. rubra* subsp. *font-queri*), despite revisiting the Font del Oliver area, where he deemed it to have become extinct. He went on to say that "*F. rubra* L. ssp. *eu-rubra* Hack. var. *trichophylla*" grew in the rocky area close to Coll de Cosp, towards the Font del Teix, locality close to that of our recently collected material. He also annotated *F. gautieri* from the same general area, referring to plants growing in the Creu de Santos ("Creu dels Sants") at 940 m, and near to the Font del Teix (sub *F. pumila* Chaix.). Litardière (1945) published the Coll de Cosp ("Cops" in the text) plants under the name "*F. rubra* subsp. *eu-rubra* var. *yvesiana* R. Lit. et Maire". The specimen from this locality with his annotations, sheet BC 93049, "var. *trichophylla* fa. ad var. *yvesiana*" corresponds, in our understanding, to the new species. In the same paper he published *F. rubra* subsp. *font-queri*. Evidently, he considered these plants to be two distinct taxa. Bolòs & Vigo (2001), clearly influenced by Litardière's herbarium notes, equated the populations with *F. rubra* subsp. *yvesiana*, a combination made by these authors to accommodate these and other fescues of the region that could not easily be attributed to other close taxa. Royo & al. (2010) made a general reference to subsp. *yvesiana*, as well as mentioning subsp. *font-queri* in a text accompanied by a photograph of two herbarium specimens determined as such (Mont Caro, near summit, BF7520, 1400 m, 4 Jul 2009, *S. Pyke SBP6247*, Museu d'Amposta, Tarragona, sub *F. paucispicula*) but not subsequently studied. Over the years, several people, including the first of the authors of this paper, have taken the more frequently occurring saxicolous plant for the species at present known as *F. paucispicula*, but when the leaf anatomy and flowering material with sufficiently developed ovaries was studied, it became clear that they could not be attributed to this taxon. The new species is rather a shy flowerer, producing few fertile culms per plant, and it has not been easy to observe these details in some cases. *Festuca paucispicula* can look very similar. However, despite the superficial similarities, the anatomical differences (particularly the minute protuberances and generally dispersed prickle-cells of the epidermis, the 5-veined basal leaves and the pubescent ovary) lead us to consider the two as being distinct though sympatric species. The leaf sheaths are variable on specimens of both taxa, those of *F. dertosensis* being usually glabrous, and those of *F. paucispicula* being somewhat more pubescent, as observed by De la Fuente & Sánchez-Mata (1986). This value, however, appears to be inconsistent, and the limited material available of the latter species (we have consulted three sheets, from two localities) prevents us from getting a better picture.

What remains clear is that the true *Festuca paucispicula* is a rare plant consisting of scattered individuals or small groups, in all probability endangered, whereas *F. dertosensis* is locally abundant close to the summits of both Cardó and Mont Caro, with smaller colonies or isolated individuals in shaded places of the wider area, and does not appear to be endangered. The new taxon grows mainly on cliffs and among rocks, whereas *F. paucispicula*, from what we can deduce at present, is found in disturbed mountain pastures, anchoring itself by means of its thicker rhizomes to clay or stony soil and thereby helping to fix it.

Although we could not determine accurately the number of chromosomes of *Festuca dertosensis*, the amount of nuclear DNA suggests that this species is decaploid. After consultation of several studies related to DNA amount and chromosome numbers (Rice & al. 2015), we can affirm that a 2C value of c. 20 pg corresponds to 70 chromosomes. The diploid species of *Festuca* present 2C values ranging between c. 1.5 and 3.5 pg; this means about 2 pg corresponding to 1C*x* value, so this allows us to infer the ploidy level. Further fieldwork is required before we can provide karyological data for *F. paucispicula.*

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Table 1. Main distinctive morphological characters of *Festuca dertosensis*, *F. heterophylla*, *F. paucispicula*, *F. rubra* subsp. *rubra* and *F. trichophylla* subsp. *meridionalis*. Only basal (innovation) leaves were compared (cauline leaves are excluded from this table). "Leaf width" refers to maximum diameter of dry, infolded leaves. Material studied, including type specimens, is detailed in the Appendix.

	Festuca dertosensis	***Festuca heterophylla***	***Festuca paucispicula***	***Festuca rubra*** subsp. ***rubra***	***Festuca trichophylla*** subsp. ***meridionalis***
Plant dimensions (culm length at anthesis)	(12–)15–25(–30) cm	(55–)70–95(–150) cm	(9.5–)12–20(–28) cm	(22–)35–70(–100) cm	(20–)30–75(–100) cm
Hypogeal stolons / rhizomes	extensive, ≤ 1 mm wide	absent	well-developed, ≥ 1 mm wide	generally well-developed, ≥ 1 mm wide	generally poorly developed
Leaf length (blade only)	to 15 cm	(20–)22–32(–36) cm	to 8 cm	to 46 cm	to 40 cm
Leaf width	0.2–0.4(–0.6) mm	(0.2–)0.3–0.4(–0.45) mm	0.3–0.4(–0.6) mm	(0.3–)0.4–0.7(–1) mm	(0.2–)0.3–0.5(–0.6) mm
Leaf sheath indumentum (distal half)	glabrous or scabrid	usually minutely scabrid	scabrid-pubescent	pubescent	glabrous or scabrid
Leaf indumentum (abaxial surface)	glabrous	glabrous, scabrid on nerves	scabrid	glabrous	glabrous, ribs sometimes weakly scabrid
Leaf epidermis (abaxial surface)	minute protuberances absent	minute protuberances absent or not	minute protuberances present	minute protuberances present	minute protuberances present
Leaf cross-section, veins; sclerenchyma bundles	triangular or quadrangular, 3(–5) veins; 5(–7) bundles	triangular to polygonal, 3(–5) veins; 5(–7) bundles	polygonal (V-shaped, ± hexagonal), (3–)5 veins; (5–)7 bundles	polygonal (V-shaped or otherwise), 5(–7) veins; 7 bundles	polygonal (V-shaped or otherwise), (3–)5 veins; (5–)7 bundles
Leaf adaxial surface: ridges; grooves	1(–3); 2(–4)	1–3; 2–4	1–3; 2–4	3–5; 4–6	1–3; 2–4
Panicle size	3–7(–8) cm	(11–)12.5–16(–21) cm	2–5 cm	(5–)8–10(–13) cm	(4–)6–16 cm
Spikelet number	(4 or)5–13(–19)	(23–)26–40(–52)	(1 or)2–4(–10)	(13–)20–28(–60)	(8–)11–40
Spikelet length (to 4th lemma)	8–9(–10) mm	10–12 mm	7.5–9 mm	(5.5–)7–9(–9.5) mm	7–9(–10) mm
Lemma length (excluding awn)	4.8–6 mm	6–8 mm	4.5–5 mm	(4.5–)5–6(–7) mm	4–6 mm
Ovary	glabrous	pubescent distally	pubescent distally	glabrous	glabrous

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Appendix: Representative specimens included in the morphological study

UTM reference = 31T except where stated.

Festuca dertosensis

Spain: Catalonia, Tarragona: Creu de Santos (Cardó) in umbrosis, 900 m, 27 Jun 1918, *P. Font i Quer* (BC 77694); Creu de Sants, Cardó, s. calc. 900 m, 28 Jun (1920 o 1942), *P. Font i Quer* (BC 111179); Cardó: Coll de Cosp, in saxosis calc., 26 May 1942, *P. Font i Quer* (BC 93049); Serra de Cardó, la Creu de Santos, 25 Jun 1949, *P. Font i Quer* (BC 868907, BC 868909); Benifallet: Creu de Santos, obaga, roques calcàries, BF9635, 900 m, 17 Jun 2014, *L. Sáez & S. Pyke SBP7006* (BC); idem., penya-segats de l'obaga, BF9635, 900 m, 17 Jun 2014, *L. Sáez & S. Pyke SBP7008* (BC); Benifallet: Barranc de Sant Roc, fissures de les roques calcàries, BF9736, 750 m, 15 May 2016, *S. Pyke SBP7288* (BC); Ulldecona, 11 Jun 1916, *P. Font i Quer* (BC 68892); Baix Ebre: Ports de Paüls, Serrra d'Alfara, pujant a la Punta del Mig, repeus de cingle calcari, BF93, 820 m, 4 Jun 1982, *J. Molero & A. Rovira* (BCN 74050); Punta del Mig, BF83, 900 m, 1 Jul 1984, *J. Molero & A. Rovira* (BCN 74048); Terra Alta: Ports d'Horta, barranc del riu Estrets, prop del Mas de Lliberòs, BF73, 10 Aug 1983, *J. Molero & A. Rovira* (BCN 74045); Ports d'Horta: Ombries de la Roca d'en Benet, BF73, approx. 600 m, 11 Jun 1982, *J. Molero & A. Rovira* (BCN 74046); Montsià: barranc de l'Astor, repeus de cingle a l'obaga, BF90, 600 m, 1 Jun 1996, *Anglès*, *Molero & Vallerdú* (BCN 26303); Tortosa: Lo Caragol, claper calcari, BF72, 920 m, 29 Jun 1987, *L. Torres* (BC 905492); Roquetes: rodalies dels bassis del Masturi, BF71, 1140 m, 7 Jul 1987, *L. Torres* (BC 905490); Ports de Tortosa, in rupestribus l. Els Bases, 800 m, 18 Jun 1935, *P. Font i Quer & W. Rothmaler* (BC 636266); Ports de Tortosa: Tossal de la

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Reina, BF7722, 1000 m, 16 Jun 2014, *L. Sáez & S. Pyke SBP6977* (BC 879690 holotype, JACA R299666 isotype); [Ports de Tortosa] Caro, 26 Jun 1917, *P. Font i Quer* (BC 69662); Ports de Tortosa: Mont Caro, cara nord i cim, penya-segats calcaris, BF7520, 1320 m, 11 Jul 2002, *A. Romo*, *N. Membrives & S. Pyke* (BC 905852); Culta HBB procedente de Mont Caro, 14 Nov 2014, *S. Pyke & al. SBP7096* (BC); La Sènia: Barranc de Fou, penya-segats a l'obaga, BF6712, 750 m, 11 Jul 2002, *A. Romo*, *N. Membrives & S. Pyke* (BC 905836). Castelló: Bellestar [Ballestar o El Bellestar] (Ports de Morella) vall del Salt supra Viver de la Tenalla, in glareosis calc., [BF60], 500 m, exp. N, 18 Jun 1956, *A. Bolòs & O. Bolòs* (BC 148940).

Festuca heterophylla
Spain: Catalonia, Lleida: Val d'Aran, Canejàn, CH1445, 600 m, 7 May 2014, *S. Pyke* (BC 940157); Vall de Boí, hacia Caldes de Boí, CH2212, 1300 m, 19 Aug 2011, *S. Pyke* (BC 915227); Girona: Vall de Ribes: Angelats, 1075 m, 18 Aug 1982, *J. Vigo & A. Anglada* (BC 616696); Olot: Fageda d'en Jordà, 550 m, sine datum, *A. Bolòs & O. Bolòs* (BC 109802); Barcelona: Montnegre, La Miranda, 730 m, 23 Jul 1948, *P. Montserrat* (BC 610785); Vallès: Montcau, 1000 m, Jun 1946, *A. Bolòs & O. Bolòs* (BC 688215); Tarragona: Prades, Jun 1931, *P. Font Quer* (BC 111138); Muntanyes de Prades, Vall de Castellfollit, 950 m, 28 Jun 1954, *F. Masclans & E. Batalla* (BC 916012).

Festuca paucispicula
Spain: Catalonia, Tarragona: Serra de Cardó, font d'Oliver, 800 m, 28 Jun 1942, *P. Font i Quer* (BC 93053 lectotype designated by De la Fuente & Sánchez-Mata 1986: 443); Serra de Cardó: Benifallet, hacia Creu de Santos, BF9634, 810 m, 17 Jun 2014, *L. Sáez & S. Pyke SBP7005* (BC); Baix Ebre: Ports de Tortosa, Mont Caro, BF7520, 1420 m, 16 Jun 2014, *L. Sáez & S. Pyke SBP6984* (BC).

Festuca rubra subsp. ***rubra***
Spain: Catalonia, Barcelona: Serra del Cadí, Coll de Pal, DG0982, 1900 m, 5 Jul 2003, *S. Pyke* (BC 863705); Girona: Sant Feliu de Buixalleu, DG6523, 120 m, culta HBB, 20 May 2015, *S. Pyke SBP7109* (BC); Campelles: Prat de Jou, 1700 m, 23 Jul 1971, *J. Vigo* (BC 612897); Vall de Ribes: Pla de Prats, 1600 m, 17 Jul 1971, *J. Vigo* (BC 612895); Lleida: Val d'Aran, Naut Aran, CH2833, 1689 m, 14 Jul 2011, *O. Barceló Barnés & J. Nuet Badia* (BC 877061); Pallars Jussà: Vall Fosca, CH3103, 1900 m, 20 Jul 1984, *A. Romo* (BC 824141). — United Kingdom: Clwyd, Cefn Mawr, 300 m, Jun 1958, *V. H. Heywood* (BC 145214); Devon: Totnes, 23 Jun 2009, *S. Pyke* (BC 871745); Channel Isles, Alderney: Longis Bay, 5 m, 26 May 2008, *S. Pyke* (BC 905841). — Switzerland: Zürich: Schmelzberg à Zürich, Station fédérale du contrôle des semences à Zürich, 6 Jun 1891, sine leg. (BC 69648). — Czech Republic/Austria: Bohemia: Gratzen: ad pagum Sonnberg, 3 May 1884, *A. Topitz* (BC 69667 det. Celakovský).

Festuca trichophylla subsp. ***meridionalis***
Spain: Catalonia, Barcelona: Anoia: la Pobla de Claramunt, vall a l'E de cal Soterons, CG90, 375 m, 11 Jun 1983, *J. Nuet* (BC 687483); El Bruc, Font Poma, CG90, 700 m, 20 May 1987, *J. Nuet & J. M. Panareda* (BC 675547). Bages: Santa Cecília de Montserrat, font de la Teula, DG0017, 765 m, 6 Jul 1983, *J. Nuet Badia & J. M. Panareda* (BC 687516). Tarragona: La Conca de Barberà: L'Espluga de Francolí, CF48, "in graminosis humidis ad margines rivuli, solo calcareo ad 45 m", 17 Jun 1951, *E. Batalla* (BC 124655); vers Vilaverd, CF47, vores del riu Francolí, 260 m, 7 Jun 1954, *F. Masclans & E. Batalla* (BC 916010); entre Vimbodí i Vallclara, CF48?, vores del riu, 525 m, 27 Jun 1954, *F. Masclans* (BC 916008). Alt Camp, Montagut, prope Valls, CF68, 964 m, 18 Jun 1933, *P. Font i Quer* (BC 111168); Baix Camp: muntanyes de Prades, els Motllats, al peu de la Cova de les Gralles, CF37, 892 m, 3 Aug 2014, *J. Felip & J. Molero* (BCN 113975); muntanyes de Prades: Els Motllats, entre La Mussara i Capafonts, CF3770, 990 m, al peu d'un cingle d'obaga, 4 Jul 2014 (BC 879472 holotype; BCN 103186 isotype); castell de l'Albiol, CF46, cingle d'obaga al peu del castell, esquerdes i replanets sobre calcàries, 845 m, 4 Jul 2014, *J. Molero & S. Pyke* (BCN 113974); la Mola de Colldejou, les Obagues, CF25, replà de roca calcària, 850 m, 27 Jul 1972, *R. Folch* (BC 627526); Priorat: cova de l'Ascla, serra de Montsant, Margalef, CF1672, 955 m, 1 Jul 2012, *M. Guardiola* (BCN 118111); Sota la Roca Corbatera, serra de Montsant, la Morera de Montsant, CF2372, 1130 m, 4 Jun 2012, *M. Guardiola* (BCN 118113); Baix Ebre: Ports de Tortosa: Alfara de Carles, vessant NW de la Mola, BF72, 1180 m, 21 Aug 1987, *L. Torres* (BC 905489); Terra Alta: Els Ports de Paüls: Serra del Montnegre, BF83, c. 800 m, 1 Jul 1984, *J. Molero & A. Rovira* (BCN 71116); Terra Alta: Horta de Sant Joan, camps, BF73, 10 Jun 1982, *J. Molero & A. Rovira* (BCN 71115). Castelló: Baix Maestrat, Pobla de Benifassà, BF60, barranc del Salt, 540 m, 16 Jun 2002, *F. Royo* (BCN 12625). Sant Joan de Penyagolosa, serra de la Batalla, 30TYK25, 1500 m, c. Jul 1963, *J. Vigo* (BC 602319); Vistabella del Maestrat, 30TYK25, 1250 m, Jul 1963, *J. Vigo* (BC 602318).

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