

## On the identity of *Festuca jubata* Lowe (Poaceae) and the description of a new *Festuca* species in the Azores Islands

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The majority of authors consider *Festuca jubata* Lowe as an endemic species common to Madeira and the Azores. Saint-Yves proposed that *F. jubata* was an Azorean endemic and described a geovivacious taxon in Madeira: *F. filiformis* C. Sm. ex Link in Buch ssp. *mandonii* St.-Yves. We undertook a complete bibliographical revision of the taxonomy, nomenclature, and chorology of *F. jubata* s.l., and contrasted it with morphological and anatomical studies performed on samples from the Azores and Madeira. Azorean plants usually identified as *F. jubata* had a character combination distinct from that of those with a Madeiran provenance. Saint-Yves' proposal of two independent taxa was correct, but he erroneously considered *F. jubata* as an Azorean endemic because the name *F. jubata* was based on Madeiran plants. Consequently, *F. jubata* auct. pl. from the Azores belongs to a new species. © 2008 The Linnean Society of London, *Botanical Journal of the Linnean Society*, 2008, 157, 493–499.

ADDITIONAL KEYWORDS: Gramineae – Madeira – nomenclature – plant taxonomy.

### INTRODUCTION

According to the literature, all the indigenous *Festuca* L. of the Azores and Madeira archipelagos are endemic species restricted to one island group or, at most, shared by these two Macaronesian archipelagos (Saint-Yves, 1930). Nonendemic species, such as *F. arundinacea* Schreb. and *F. gr. rubra* L., are neophytes voluntarily or involuntarily (for example, transported in cattle rumen) introduced as fodder plants.

The Madeiran and Porto-Santo endemic *F. donax* Lowe (Saint-Yves, 1922: 59; Hansen & Sunding, 1993: 220; Press & Short, 1994: 415; Costa *et al.*, 2004a: 192) is a meso-supratemperate forest species (Costa

*et al.*, 2004b). The orophyte endemic of Madeira, *F. albida* Lowe (Saint-Yves, 1922: 58; Hansen & Sunding, 1993: 224; Press & Short, 1994: 422; Costa *et al.*, 2004a: 195), was transferred to the monospecific genus *Parafestuca* E.B. Alexeev: *Parafestuca albida* (Lowe) E.B. Alexeev (Alexeev, 1985; see also Clayton & Renvoize, 1986). Nowadays, this plant is placed in the genus *Koeleria* Pers.: *Koeleria loweana* Quintanar, Catalán & Castrov. (Quintanar, Catalán & Castroviejo, 2006: 668).

The subgenus *Festuca* (genus *Festuca* L.) is represented in the Azores by two indigenous species: *F. petraea* Guthnick ex Seub. and *F. jubata* Lowe. The first is an Azorean endemic species. It is frequent throughout all the archipelago islands (Schäfer, 2003: 431) on sea cliffs and in littoral lava fields, but rarer on nonlittoral thermotemperate steep cliffs because of

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competitive exclusion by neophytes. The majority of authors consider *F. jubata* Lowe as an endemic species common to Madeira and the Azores (for example, de Menezes, 1894: 41, 1926: 132; Palhinha, 1966: 152; Markgraf-Dannenbergh, 1980: 137; Sjögren, 1984: 68; Hansen & Sunding, 1993: 220; Press & Short, 1994: 415; do Amaral Franco & Rocha Afonso, 1998: 23; Schäfer, 2002: 212; Costa *et al.*, 2004a: 192). In the Azores, the plants identified as *F. jubata* replace altitudinally *F. petraea* in rupicolous habitats, marking the transition between the thermotemperate and meso-temperate vegetation levels (J. A. Fernández Prieto, C. Aguiar, and E. Dias, unpubl. data). On Madeira and Porto-Santo islands, *F. jubata* is a meso-supratemperate chasmo-comophyte (Costa *et al.*, 2004b).

Eighty years ago, Saint-Yves (1922: 52) proposed that *F. jubata* was an Azorean endemic, and described a geovicarious taxon in Madeira: *F. filiformis* C. Sm. ex Link in Buch ssp. *mandonii* St.-Yves (Saint-Yves, 1922: 55). Recently, Schäfer (2002: 212) expressed his doubts about the *F. jubata* chorology: 'Native: Az, Madeira (this species?)'. During our own studies of the vegetation of Madeira and the Azores, we had similar doubts about the chorology of *F. jubata*. In this paper, we clarify the chorology, taxonomy, and nomenclature of the plant taxa usually identified as *F. jubata* in the Azorean and Madeiran archipelagos.

## MATERIAL AND METHODS

The information obtained from a bibliographical revision of the taxonomy, nomenclature, and chorology of *Festuca jubata* s.l. in the Azores and Madeira was contrasted with morphological and anatomical studies performed on 14 samples specifically collected by us in the Azores and Madeira or obtained from Portuguese herbaria (LISI, AZU, and MADJ). The selected samples were submitted to morphological and anatomical studies according to the methods of Hackel (1882: 81) and Saint-Yves (1927: 4). These studies examined leaf, inflorescence, spikelet, and floret morphological characters, and leaf cross-sections to show leaf anatomy (Table 1). In the leaf cross-section preparations, the differential staining techniques described by Tolivia & Tolivia (1987) were used.

## STUDIED SAMPLES

### Azores

CORVO: Caldeirão, 500 m, 8.v.1968, *J. Botelho Gonçalves* [LISI. 2136]. FAIAL: Interior da Caldeira, 700 m, 10.vi.1964, *Botelho Gonçalves* [LISI. 1538]. FLORES: Rocha dos Bordões, 250 m, 6.viii.1963, *J. Botelho Gonçalves* [LISI. 1383]. Alto da Fajãzinha, 500 m, 12.vi.1964, *J. Botelho Gonçalves* [LISI. 1671].

PICO: Mistério da Prainha, Caminho dos Burros, 600 m; 19.vi.1963, *J. Botelho Gonçalves* [LISI. 1152]. Pico do Miradouro, Serra de Água de Pau, banc. de Vila Franca 700 m, Exp. Sul, 26.viii.1958, *Pedro Luis de Q. Cymbron* [LISI. s/n]. Madalena, base de Grotões, 850 m, 18.vii.1968, Leg: *J. Botelho Gonçalves* [LISI. 2303]. SÃO JORGE: Calheta, Ribeira dos Vimes, 660 m 4.ix.1971, Leg: *J. Botelho Gonçalves* [LISI. 3454]. SÃO MIGUEL: Estrada da Lagoa do Fogo, 500 m, talude da estrada; 29.viii.1979 [LISI. 6161]. TERCEIRA: Angra do Heroísmo, caminho florestal de Santa Bárbara, 520 m, 12.vii.1971 [LISI. 3229]. Stª Bárbara, Serra de Santa Bárbara, Portal da Serra (27:19:30796; 38:43:40040), Parede ressumante, 900 m, 10.viii.2005, *E. Dias, J.A. Fernández Prieto & C. Aguiar* [AZU. 12035].

### Madeira

MADEIRA: Pico do Cedro-Santo António, vertente da Ribeira do Cidrão, 16.vi.1993, Nóbrega [MADJ. 07892 & 07892 bi]. Entre Bica da Canal e Lombo do Mouro ao longo da Vereda, 21.vii.1992, Nóbrega [MADJ. 09469]. Pico Ferreiro- lado norte ao longo de um risco a 1300 metros que dá a volta ao Pico, 'Muito poucos pés', 14.vi.1994, Nóbrega [MADJ. 08185].

## RESULTS

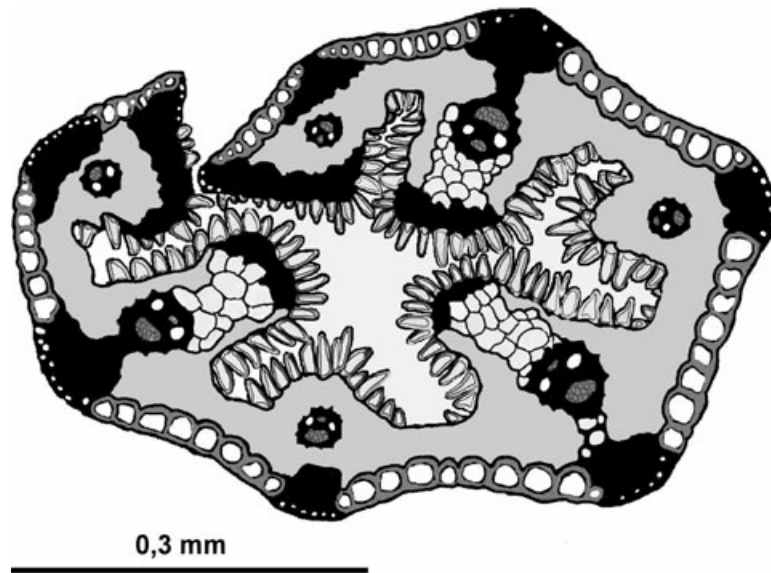
### NOMENCLATURE AND TAXONOMIC HISTORY

*Festuca jubata* was originally described by R.T. Lowe (*Transactions of the Cambridge Philosophical Society* 6: 530. 1838; reprinted in Lowe, 1851: 8) based on Madeiran plants. Incorrectly, Jackson (1893: 954) indicated that *F. jubata* Lowe had been described from 'Ins. Azor.' and, since then, this statement seems to have been a continuous source of error about the identity of *F. jubata* Lowe (see ePIC at <http://www.rbgekew.org.uk/epic/>).

Watson (1844: 612) was the first author to record the presence of *F. jubata* Lowe in the Azores. He included in this species '*F. glauca* var. *longebracteata*', Hochst. in *Flora Azorica*, no. 120', a clear error as he intended to refer to *Festuca glauca* Schrad. var. *longearistata* Hochst. ex Seub., a plant quoted by Seubert & Hochstetter (1843: 10), and which Seubert (1844: 20) described and localized '*in rupibus littoralibus ins. Fayal et Pico*'. Later, Watson (1870: 247) confirmed the identification of *F. jubata* Lowe in his herbarium material, but indicated doubts about the synonymy between *F. glauca* var. *longearistata* and *F. jubata*, arguing that his samples were taken 'inland on the mountains' and not from 'coast-rocks', as was *F. glauca* var. *longearistata*. Trelease (1897: 167) reaffirmed the presence of *F. jubata* in the Azores and the synonymy between '*F. glauca*  $\beta$  *longearistata* Hochst. in Seub.' and *F. jubata*.

**Table 1.** Comparison of morphological and anatomical characteristics of Madeiran and Azores samples (own data) with *Festuca filiformis* ssp. *mandonii* St.-Yves and *Festuca jubata sensu* St.-Yves, non Lowe, according to Saint-Yves' (1922) description

Taxonomic characters	Madeiran samples (own data)	<i>Festuca filiformis</i> ssp. <i>mandonii</i> St.-Yves (Saint-Yves, 1922: 55)	Azores samples (own data)	<i>Festuca jubata sensu</i> St.-Yves, non Lowe (Saint-Yves, 1922: 51)
<b>Leaves</b>				
Shape of foliar section	Suborbicular	Suborbicular	Hexagonal	Subhexagonal
Foliar diameter (mm)	0.75–1.0	0.9–1.0	(0.4–)0.5–0.76	0.6–0.7
No. of foliar veins	(7–)9–11	13	7	7
No. of leaf ridges	(5–)7–9	13	5	5
Abaxial side sclerenchyma	Continuous or (rarely) slight interrupted; only united to the central vascular bundle (not always)	Continuous; directly united to the central vascular bundle	In broad bands against the vascular bundles; united to primary and, frequently, to secondary vascular bundles	In broad bands against the vascular bundles; united to primary and, frequently, to secondary vascular bundles
Adaxial side sclerenchyma	In front of the corresponding vascular bundles in the primary and secondary ridges; missing in tertiary ridges; connected to the central vascular bundle through a parenchyma bundle	In front of the corresponding vascular bundles in the primary and secondary ridges; missing in tertiary ridges; connected to the central vascular bundle through a parenchyma bundle	Present in primary ridges, sometimes in secondary ridges; connected to primary vascular bundles through a parenchyma bundle	Present in leaf ridges; connected to primary vascular bundles through a parenchyma bundle
<b>Foliar trichomes: type and length (µm)</b>				
	Large, stiff and acute; (35–)50–130	Large, stiff and acute	Papilliform, conical, and obtuse; 15–50; a few slightly large, stiff, and acute	Papilliform, conical, and obtuse; 30; a few slightly large, stiff, and acute
<b>Flowers and inflorescences</b>				
Panicle: length (cm)	6.0–10.0	6.0–8.0	(5.0–)7.0–11.0	8.0–10.0
Florets: no. of florets/spikelet	(3–)4–6(–7)	5–6	(3–)4–6	4–5
Spikelets: length (mm)	8.5–14.0	10.0	7.0–10.0	9.0–10.0
Lower glumes: length/width	4.5–6.0/1.0–1.2	5.0/–	(4.0–)5.0–8.5/0.7–1.0	7.0–8.0/–
Upper glumes: length/width	5.7–7.5/1.5–1.75	6.0/1.75	6.0–9.5/1.0–1.5	8.0–9.0/1.0–1.25
Upper glumes awn: length (mm)	0	0	(0.5–)1.0–2.0(–3.5)	Largely awned
Lemmas: length/width	6.0–8.0/1.7–2.3	6.5–7.0/2	6.0–7.0/1.3–2.0	6.0/1.5
Lemma awn: length (mm)	2.5–5.5	2.5	(1.5–)2.3–6.0(–8.0)	Awn length equal to or larger than lemma length
Palea: length (mm)	5.8–7.5	Equal or longer than the lemma	(4.8–)5–6.5	The same size as the lemma
Palea: apices shape	Bidentate	Bidentate	Bifid	Deeply bifid
Anther: length (mm)	3.0–4.5	3.5–4.0	2.5–3.5	2
Ovary: hairs	Glabrous	Glabrous	Glabrous	Glabrous



**Figure 1.** Leaf blade section of *Festuca francoi* Fern.Prieto, C.Aguiar, E.Dias & M.I.Gut., **sp. nov.** [AZU. 12035].

Saint-Yves (1922: 51) identified as *F. jubata* the *Festuca* samples collected in the Azores by Hochstetter [*Ile de Fayal* (*leg. Hochst. 1838, herb. Deless.*)] and Lameiro [*sine loc., Mus. Mun. Ponte Delgada* (*leg. Lameiro n. 878 c., herb. Deless.*)]. Based on this material, Saint-Yves made a detailed description of the plant from the Azores that he identified as *F. jubata*, to which he also synonymized *F. glauca* Schrad. var. *longearistata* Hochst. ex Seub. In the same work, Saint-Yves (1922: 55) described *F. filiformis* C. Sm. ex Link in Buch ssp. *mandonii* St.-Yves from Madeira Island [*Hab.- Madère: Currel et Picos de Arrieros, Melhada velha (Mandon Pl. Mad. 1865–66. n. 279, sub F. jubata Lowe? nova, herb. St.-Y.)*], and erroneously concluded, probably influenced by Jackson's (1893: 954) statements, that *F. jubata* was an Azores endemic (Saint-Yves, 1922: 49, 52) and *F. filiformis* ssp. *mandonii* its Madeiran vicariant (Saint-Yves, 1922: 49, 57).

#### MORPHOLOGY AND ANATOMY

The results of our morpho-anatomical studies with Madeiran and Azores samples are shown in Table 1. Leaf blade sections of plants from the Azores and Madeira are shown in Figures 1 and 2, respectively.

#### DISCUSSION AND CONCLUSIONS

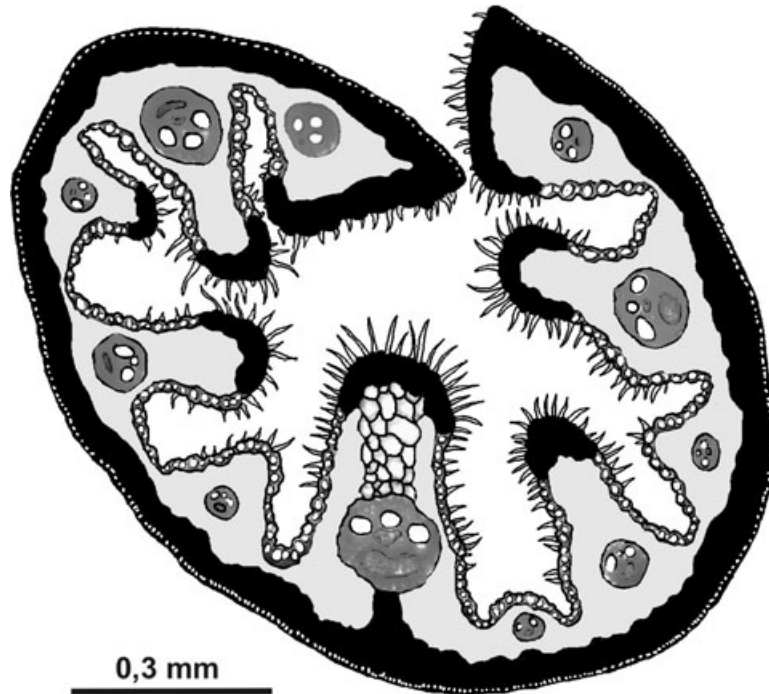
Our morpho-anatomical observations of Madeiran samples are in line with the diagnosis of *F. jubata* published by Lowe (1851: 8). These observations are also in line with the description made by Saint-Yves of *F. filiformis* C. Sm. ex Link in Buch ssp. *mandonii*

St.-Yves (Saint-Yves, 1922: 55), although the majority of our samples from Madeira have a wider character variation than the original description of *F. filiformis* ssp. *mandonii* (Table 1), and there are evident discrepancies in the numbers of foliar veins and leaf ridges. The numbers of foliar veins and leaf ridges in our samples [(7–)9–11 and (5–)7–9, respectively] are lower than those (13) of Saint-Yves' descriptions. However, in Saint-Yves' leaf cross-section drawing of *F. filiformis* ssp. *mandonii* (Saint-Yves, 1922: 56), the numbers of foliar veins (11) and leaf ridges (9, if marginal leaf ridges are excluded, as in Table 1) are consistent with our observations (Fig. 2).

The characters of the Azorean samples studied broadly agree with the description of *F. jubata sensu* St.-Yves (Saint-Yves, 1922: 51), but, again, our Azorean samples, probably because of their wider geographical origins, have a larger variation (Table 1).

From the morpho-anatomical data of Table 1, it is clear that Azorean plants usually identified as *F. jubata* (Watson, 1844, 1870; Trelease, 1897; Saint-Yves, 1922; Palhinha, 1966; Markgraf-Dannenberg, 1980; Sjögren, 1984; Hansen & Sunding, 1993; do Amaral Franco & Rocha Afonso, 1998; Schäfer, 2002, 2003) have a character combination distinct from that of those of Madeiran provenance. The leaf anatomy is particularly useful to discriminate between these two taxonomic entities (Figs 1, 2).

According to the current use of leaf anatomical characters in *Festuca* taxonomy (for example, Kerguelen & Plonka, 1989; Stace, Al-Bermani & Wilkinson, 1992; de la Fuente, Ortúñez & Ferrero, 1997; *Festuca* leaf anatomical characters use the history



**Figure 2.** Leaf blade section of *Festuca jubata* Lowe [MADJ. 07892bis].

summary in Aiken, Darbyshire & Lefkovitch, 1985), both entities should be interpreted as autonomous species. Saint-Yves (1922) was the first author to objectively stress the differences between Madeiran and Azorean *F. jubata* auct. plants, but was less certain when he considered *F. jubata* as an Azorean endemic. Consequently, *F. jubata* auct. non Lowe from the Azores belongs to an undescribed taxon.

**FESTUCA FRANCOI** FERN.PRIETO, C.AGUIAR, E.DIAS & M.I.GUT., **SP. NOV.**

*Festuca jubata* sensu St.-Yves, *Candollea* 1: 51 (1922), et auct. azoriensis pl., non Lowe, *Transactions of the Cambridge Philosophical Society* 6: 8 (1838).

**Holotype:** Azores: Terceira: St<sup>a</sup> Bárbara, Serra de Santa Bárbara, Portal da Serra (27:19:30 796; 38:43:40 040), Parede ressumante, 900 m 10.viii.2005. Leg. E. Dias, J.A. Fernández Prieto & C. Aguiar [AZU. 12035].

**Iconography:** Trelease (1897: plate 60) as '*Festuca jubata*'; leaf blade section (Fig. 1); and Saint-Yves (1922: 51, fig. 20; 1927: 51, fig. 51) sub '*Festuca jubata*'.

**Diagnosis:** Innovationes extravaginales. Vaginae tantum basi iunctae. Innovationum laminae (0.4–)0.5–0.76 mm diametro, tam longa quam panicula vel

amplius; transversa sectio hexagonalis aut subhexagonalis (Fig. 1), 5 cum costis interioribus 7que nervis; abaxialis faciei sclerenchyma modo paratus fascium versus nervos positorum iunctorumque semper primariis nervis saepeque secundariis; adaxialis faciei sclerenchyma in primariis costis aliquandoque in secundariis paratus atque primariis nervis per incolores parenchymalis pontes iunctus; adaxialis facies tricomatibus papilliformibus densissimis, brevissimis, 15–50 µm, conicis, apice late obtuso; sunt etiam nonnulli pili perpaulum longiores, rigidi, acuti, valde rari. Panicula (5.0–)7.0–11.0 cm longa. Spiculae anthesi subcuneiformes, apice late aperto, 7.0–10.0 mm longo. Glumae inaequales; gluma I (4.0–)5.0–8.5 × 0.7–1.0 mm, subulata; gluma II 6.0–9.5 × 1.0–1.5 mm, in aristam (0.5–)1.0–2.0 mm sensim attenuata. Lemmae 6.0–7.0 × 1.3–2.0 mm, aristis (1.5–)2.3–5.5(–8) mm longis. Paleae (4.8–)5–6.5 mm longae, apice bifido vel profunde bifido. Antherae 2–3.5 mm longae, dimidia palea breviores. Ovarium oblongum, glabrum.

Hoc specie cl. Prof. Doct. João Manuel António (Paes) do Amaral Franco, florum lusitanicae insigne cultore, grato animo dicamus.

**Description:** Extravaginal vegetative shoots. Leaf sheaths only closed at base. Leaves (0.4–)0.5–0.76 mm wide, as long as the panicle or more; hexagonal to subhexagonal in cross-section (Fig. 1), ribs 5, veins 7; abaxial side sclerenchyma in broad bands against the vascular bundles united to primary and

frequently to secondary vascular bundles; adaxial side sclerenchyma present in primary ridges, sometimes in secondary ridges, connected to primary vascular bundles through parenchyma bundles; papilliform adaxial side trichomes, very dense, very short, 15–50 µm, conical, obtuse broad apex; a few slightly large, stiff and acute adaxial side trichomes. Panicle (5.0–)7.0–11.0 cm. Subcuneate spikelets in the anthesis, with broadly uncovered apex, 7.0–10.0 mm. Glumes unequal; lower glume (4.0–)5.0–8.5 × 0.7–1.0 mm, subulate; upper glume 6.0–9.5 × 1.0–1.5 mm, with awn (0.5–)1.0–2.0 mm. Lemmas 6.0–7.0 × 1.3–2.0 mm, awn (1.5–)2.3–5.5(–8.0) mm. Paleas (4.8–)5.0–6.5 mm, with bifid apex or deeply bifid apex. Anthers 2.0–3.5 mm, less than one-half as long as palea. Ovary oblong, glabrous.

*Distribution:* Azorean endemics known from all the Azores Islands, except Graciosa (Schäfer, 2003: 430).

*FESTUCA JUBATA* LOWE, TRANSACTIONS OF THE CAMBRIDGE PHILOSOPHICAL SOCIETY 6: 8 (1838)

= *Festuca filiformis* C. Sm. ex Link in Buch ssp. *mandonii* St.-Yves, *Candollea* 1: 55 (1922).

= *F. agustinii* Linding. ssp. *mandonii* (St.-Yves) A.Hansen, *Bocagiana* 25: 5 (1970).

*Locotypic indication:* 'Hab. rariss. in rupibus convallium Maderæ, cum Deschampsia argentea nob., cui

*habitu simillis, nascens. Primus invenit Car. Lemann M.D.*'

*Type:* Not yet designated. In Kew Herbarium (see ePIC at <http://www.rbgb.org.uk/epic/>), there are two sheets collected in Madeira by C. Lehmann, s.n., where the type of the plant could be fixed: K000345306 and K000345303.

*Iconography:* Press & Short (1994: table 53, fig. 2); leaf blade section (Fig. 2); and Saint-Yves (1922: 56, fig. 23; 1927: 108, fig. 155) sub *Festuca filiformis* ssp. *mandoni*.

*Description:* Lowe (1851: 8); Saint-Yves (1922: 55) sub *Festuca filiformis* C. Sm. ex Link in Buch ssp. *mandonii* St.-Yves.

*Distribution:* Madeiran and Porto Santo endemics (Hansen & Sunding, 1993: 220).

#### KEY TO PLANTS OF THE *FESTUCA* GENUS STUDIED IN THIS WORK

For the identification of the plants of the *Festuca* genus studied in this work, we propose the following key.

1. Plants from Madeira with suborbicular shape of foliar section and diameter at least 0.75 mm wide, usually with 9–11 foliar veins and seven to nine leaf ridges (marginal leaf ridges excluded) covered with stiff and acute trichomes longer than 50 µm; abaxial side sclerenchyma continuous or slightly interrupted; upper glumes without awn..... *Festuca jubata*
2. Plants from Azores with hexagonal or subhexagonal shape of foliar section and diameter shorter than 0.75 mm, with seven foliar veins and five leaf ridges (marginal leaf ridges excluded) covered with papilliform, conical and obtuse trichomes, at most 50 µm long; abaxial side sclerenchyma in broad bands against the vascular bundles; upper glumes with awn..... *Festuca francoi*

As previously stressed, *F. glauca* var. *longearistata* was described from littoral plants of the islands of Pico and Fayal (Seubert, 1844: 20). Seubert (1844: 20) described *F. petraea* from the same locality 'A precedente, quae iisdem locis crescit, ... Coll. nr. 131', based on a description made by Guthnick ('Guthnick in litt. ad Hochst.'). The taxonomic treatment of *F. glauca* var. *longearistata* by Saint-Yves results in confusion, because he did not understand the anti-thetic ecology of *F. petraea* Guthnick ex Seub. and *F. jubata sensu* auct. non Lowe and their differential characters. In our opinion, the available information is sufficient to consider *F. glauca* var. *longearistata* a synonym of *F. petraea*.

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