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A NEW TAXONOMIC SURVEY OF THE FESTUCA RUBRA COMPLEX
IN NORTHWESTERN NORTH AMERICA, WITH EMPHASIS ON BRITISH COLUMBIA

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A new look at the taxonomy of the Festuca rubra complex in northwestern North America is presented. One new variety (F. rubra subsp. secunda var. mediana) and two new formae (subsp. aucta f. pseudovivipara and subsp. secunda f. psilolemma) are described. Two neglected taxa, F. rubra subsp. secunda and F. rubra subsp. vallicola (both new combinations) are recognized for northwestern North America. Festuca rubra subsp. aucta is documented from coastal British Columbia. Introduced taxa are discussed. A key to taxa and descriptions are provided.

INTRODUCTION

Festuca rubra L. sensu lato (Festuca, section Festuca) is a morphologically diverse, polyploid complex (see Bowden, 1960; Calder and Taylor, 1968; Löve and Löve, 1961, 1975; Markgraf-Dannenberg, 1980; Taylor and Mulligan, 1968; Welsh, 1974). It is of widespread occurrence in Europe (Auquier, 1971b; Markgraf-Dannenberg, 1980), Asia (Kreczetovich and Bobrov, 1934; Tzvelev, 1972) and North America (Piper, 1906; Saint-Yves, 1925; Hultén, 1942, 1968). It is a complex that consists of both morphologically distinctive taxa (see e.g. Hackel, 1882; Beal, 1896; Auquier, 1968, 1971a, 1971b; Alexeev, 1982a), and plants morphologically intermediate to the recognized taxa (see e.g. Piper, 1906; Saint-Yves, 1925; Hultén, 1942).

The F. rubra complex in North America, as in Eurasia, occurs in diverse habitats e.g. beaches, sand dunes, coastal rocks and cliffs, saltmarshes, riverine gravel bars, moist meadows, boreal grasslands and highway verges (as a planting). Festuca rubra sensu lato is so variable that a list of distinguishing characters held in common by all its subtaxa, would be short. It usually, but not always, has pronouncedly shredding red-brown basal leaf sheath bases. It is usually, but not always, rhizomatous. It usually has extravaginal innovations, and intravaginal ones as well (see Hubbard, 1968). It may be loosely caespitose, densely caespitose, or not caespitose at all. It has a more or less recognizable constellation of spikelet characteristics (e.g. in regard to lemma length, awn length,

anther length, lack of vestiture on the ovary and coloration), but most of these too can vary greatly in some subtaxa.

In view of the morphological gradation between F. rubra's recognizable subtaxa, some of which probably involves hybridization (and polyploidy) following evolutionary divergence, the question arises as to whether they should be recognized at all. Piper (1906) recognized several subspecies of F. rubra but noted that these are for the most part but ill defined and wondered whether "a more philosophical treatment [would be] to reduce most of the subspecies to the species....". Kjellqvist (1961) referred to F. rubra in Scandinavia as "somewhat of a crux botanicorum to taxonomists". Welsh (1974), working on Alaskan material, recognized that F. rubra "is a variable, complex entity with a series of polyploid levels, some of which are probably worthy of taxonomic recognition....". Despite the problems, most recent workers (e.g. Piper, 1906; Saint-Yves, 1925; Auquier, 1968, 1971a, 1971b; Taylor and MacBryde, 1977; Alexeev, 1982a) have taken the view that subtaxa of F. rubra should be recognized; this view is accepted here.

Based on (apparently) only a few similar morphological characters, some workers (e.g. Piper, 1906) have applied the names of earlier described European F. rubra subtaxa, to subtaxa native to North America. Others (e.g. Alexeev, 1982a) have recognized distinctly North American taxa of this complex. Based on my comparison of a large number of northwestern North American specimens to a more limited number of European F. rubra specimens, I have concluded the following : Native North American F. rubra subtaxa from the Pacific northwest, for the most part, are morphologically separable from those of Europe ; subspecies pruinosa appears to be the exception.

A complicating factor in the taxonomy of the F. rubra complex, is the widespread introduction into North America of European F. rubra varieties. These have been used as lawn grasses, agricultural grasses, and as soil binders on highway verges and sand dunes. Thus the European ecological counterparts of some North American F. rubra subtaxa have become part of the North American flora e.g. subsp. rubra and subsp. arenaria.

As part of a wider study of Festuca in western North America (e.g. see Pavlick, 1983a, 1983b, 1983c, 1984; Pavlick and Looman, 1984), I have recently made a study of the F. rubra complex, with emphasis on British Columbia. The study was primarily morphological. While recognizing the problems (outlined above) in imposing taxonomic and nomenclatural circumscriptions within this group, a new taxonomic perspective is presented.

METHODS

As part of my study of the genus *Festuca* in western North America (emphasis on British Columbia), I have collected extensively, specimens of the *F. rubra* complex. Some areas of collection in British Columbia are: Kootenay River Valley; Rocky Mountains; Cariboo and Peace River Districts; and Vancouver Island. I have examined these specimens and herbarium specimens from the following herbaria ; ALA, CAN, DAO, MA, P, PE, PR, UBC, and V. Type specimens examined are noted below under individual taxa. From these I have formulated the conclusions presented below, and have prepared a key to taxa and descriptions for the *F. rubra* complex in the study area.

RESULTS AND CONCLUSIONS

The taxonomy of the *F. rubra* complex along the Pacific coast of northwestern North America is very complex, and the component taxa intergrade morphologically.

Key to the *Festuca rubra* complex in British Columbia :

1. Spikelets pseudoviviparous.....subsp. aucta f. pseudovivipara
1. Spikelets mostly not pseudoviviparous :
2. Coastal plants, mostly close to the littoral zone :
3. Leaf sheaths on culm wide and loose; uppermost leaf sheath often approaching or enclosing base of panicle; panicles tending to be secund and nodding :
4. Lowermost lemmas long (5.8-9.0 mm); attenuate in side view :
5. Panicles large (10-25 cm long); culm leaves usually explanate, wide (2-4 mm wide); lowermost lemmas 6-9 mm long.....subsp. aucta
5. Panicles shorter (7.5-12 cm long); culm leaves mostly conduplicate (sometimes explanate), narrow; lowermost lemmas 5.8-6.6 mm long.....subsp. secunda
4. Lowermost lemmas shorter (4.5-6.0 mm long), acuminate (less attenuate)var. mediana
3. Leaf sheaths on culm narrow, close-fitting; uppermost leaf sheath usually not enclosing base of panicle; panicles mostly erect, mostly not secund :
6. Mostly short (20-40 cm tall) plants of coastal rocks and cliffs.....subsp. pruinosa
6. Tall (40-70 cm) plants of maritime sands and gravels

7. Leaves carinate; leaf sclerenchyma wide, thick, with 5-7 costae; lowermost lemmas 6.0-6.5 mm long.....subsp. arenicola
7. Leaves roundish, little carinate; leaves with (7-) 9 costae and with unequal sclerenchyma strands; lowermost lemmas 6.5-9.5 mm long.....subsp. arenaria
2. Interior plants, mostly not near littoral zone :
8. Lemmas moderately to densely covered with long, whitish hairs; lemma awn short, 0.5-1.6 (-2.5) mm long; arctic, alpine, subalpine, boreal.....Festuca richardsonii
8. Lemmas mostly + glabrous (sometimes with some soft hairs); lemma awns to 3.2 mm long; plants of mountain valleys, or introduced lawn, pasture or highway verge plants :
9. Basal and culm leaves mostly explanate.....var. planifolia
9. Basal leaves conduplicate :
10. Usually not caespitose; culm very narrow, about 1.0 mm wide; plants of moist habitats in mountain valleys...subsp. vallicola
10. Usually caespitose; culms wider than above; introduced lawn, pasture and highway verge plants :
11. Densely tufted, non-rhizomatous plants; basal leaf sheaths sparingly shredding into fibres.....subsp. commutata
11. Loosely tufted, rhizomatous plants; basal leaf sheaths well shredding into fibres.....subsp. rubra

1. Festuca rubra subsp. aucta (Krecz. & Bobr.) Hult., Fl. Aleut. Isl. : 97. 1937. F. aucta Krecz. & Bobr., Fl. U.S.S.R. : 518, 767. 1934. HOLOTYPE : Grebnitzky s. n., 25 Aug., 1894, Ins. Bering (LE). To date I have not been able to examine the type. However, the Alaskan and Canadian specimens I have studied well fit the protologue of Kreczetovich and Bobrov (1934) which was based on Asian material, and the descriptions of Hultén (1937, 1942) for material from the Aleutian Islands and Alaska.
F. rubra var. paludicola Kom., Fl. Penin. Kamtsch. 1 : 188. 1927.

Loosely tufted, rhizomatous grasses, with culms 30-120 cm tall; basal leaf sheaths very shredding into fibres, pubescent above; leaves deep green, loosely conduplicate or explanate, weakly sclerenchymatous, (abaxially) more or less uniformly scabridulous or roughened, and with hispid or pilose costae; culm leaves usually explanate, 2-4 mm wide; culm leaf sheaths wide, loose, the uppermost one often approaching or enclosing the base of the

panicle; panicle large, 10-25 cm long, often open, nodding, secund or partially secund, with scabrous rachises and branches; spikelets mostly deep green or glaucous, oblong; lower glume 3.5-6.0 mm long; upper glume 5.5-8.5 mm long; lemmas deep green or glaucous with violet borders, scabrous (trichomes 0.1-0.2 mm long) usually at apex and along sides, but ranging to scabrous over most of the back (occasionally hairy), 6-9 mm long, attenuate, with awns 2.5-4.5 mm long; anthers 2.5-3.5 mm long.

Chromosome number : Unknown.

Subspecies aucta occurs along the Pacific coast from the Kamtschatka Peninsula (Kreczetovich and Bobrov, 1934) through the Aleutian Islands (Hultén, 1937, 1942), Queen Charlotte Islands, and southward to southern British Columbia (Vancouver Island). It occurs in moist areas, often areas of high annual rainfall, on sand (stabilized sand dunes, beaches, etc.) or silt deposits, from just above high tide line upward.

Material from southern Alaska and southward tends to be taller and to have somewhat narrower culm leaves than that of Kamtschatka and the Aleutian Islands, but otherwise they do not differ significantly. Subsp. aucta has not been nearly so well collected along the North American coast as were other F. rubra subspecies; this may reflect the poor accessibility of sites along the northwestern coast. Along much of the British Columbia coast the range of subsp. aucta overlaps that of subsp. secunda. A pseudoviviparous form, described below, occurs in the Queen Charlotte Islands.

1a. Forma pseudovivipara Pavlick, forma nova

Ut subsp. aucta f. aucta, sed spiculae pseudoviviparae.

HOLOTYPE : Roemer 80266, scree meadow on limestone, north of Van Inlet, Queen Charlotte Islands (V!).

Like subsp. aucta f. aucta, but spikelets pseudoviviparous.

SYNONYMS : Festuca prolifera sensu Calder & Taylor, Fl. Queen Charl. Isl. 1 : 204. 1968, non Fernald.

F. rubra L. var. prolifera sensu Krajina, Biota N. Amer. 2 : 342. 1980, non Piper, pro parte.

Other specimens examined : Calder & Taylor 23581, Mt. de la Touche, Tasu Sound, Moresby Island (DAO, UBC); Calder & Taylor 36418, Mt. Moresby, Moresby Island (DAO, UBC).

Chromosome number : $2n = \text{ca. } 70$ (Taylor and Mulligan, 1968).

Forma pseudovivipara is known only from the Queen Charlotte

Islands. There it grows on mountainsides at elevations of about 300-800 m, on scree slopes and other rocky areas.

Forma pseudovivipara is similar to f. aucta in having deep green, weakly sclerenchymatous, more or less uniformly scabridulous leaves that tend to be explanate, and with hispid or pilose costae, long, deep green glumes, and more or less nodding, secund panicles. As with the more southern specimens of f. aucta, its culm leaves are narrower than those of subsp. aucta from the Aleutian Islands. Its culms and leaf sheaths are narrower than that of subsp. aucta generally. As with f. aucta, its lemmas (bracts) may be glabrous or partially pubescent.

In some respects f. pseudovivipara resembles F. prolifera Fern., a species which Fernald (1933) claimed to be endemic to cold or alpine habitats in eastern North America. For instance, both have awnless, membranous lemmas. They differ in that f. pseudovivipara has regular panicles with 4-5 spikelets on the lower one or two branches (rather than simple, flexuous racemes described by Fernald (1933) for F. prolifera); it may have pubescent as well as glabrous lemmas and bracts on the same plant; it has a chromosome count of $2n = ca. 70$ (Taylor and Mulligan, 1968). For F. prolifera (Piper) Fern., Bowden (1960) reported a chromosome count of $2n = 50$ for specimens from Quebec (Ft. Chimo area), and Löve and Löve (1975) cited eight references giving counts of $2n = 49$ and 63 . Because of its similarities to F. aucta f. aucta which occurs in the same region, the above noted differences from F. prolifera, and its geographical isolation from eastern North America, f. pseudovivipara appears to be a separately evolved taxon.

2. Festuca rubra L. subsp. secunda (J. S. Presl in C. B. Presl) Pavlick, stat. nov. Basionym : Bromus secundus J. S. Presl in C. B. Presl, Reliq. Haenk. 1 : 263. 1830. F. rubra var. secunda (Presl) Scribner, Rep. Mo. Bot. Gard. 10 : 36, 39. 1899. LECTOTYPE : Haenke s. n., "Hab. in sinu Nootka" (Nootka Sound) (MO!).

F. rubra L. subsp. kitaibeliana sensu Piper, Contrib. U. S. Natl. Herb. 10 : 23. 1906, pro parte, non Schult.

? F. rubra L. var. pubescens Vasey ex Beal, Grasses N. Amer. 2 : 607. 1896. TYPE : Howell s. n., Oregon.

Mostly loosely tufted, rhizomatous grasses, with culms (20-) 30-70 (-80) cm tall; basal leaf sheaths shredding into fibres, glabrous or pubescent above; basal leaves green or glaucous, conduplicate, ± weakly sclerenchymatous, (abaxially) more or less uniformly scabridulous or roughened, with pilose costae; culm leaves mostly conduplicate, sometimes explanate and to 2.5 mm wide; culm leaf sheaths mostly wide, loose, the uppermost one often approaching or enclosing the base of the panicle; panicles

7.5-12.0 cm long, \pm open, flexuous, mostly secund, nodding, with scabrous branches; spikelets green and violet, sometimes glaucous, 9.5-13 mm long, with 4-7 florets; lower glume 3.1-4.5 mm long; upper glume 5.0-5.6 mm long; lemmas green or with violet borders, scabrous at apices and along the sides, or \pm uniformly pilose, with relatively long trichomes (to 0.45 mm long), attenuate, (lowermost lemmas) 5.8-6.6 mm long, with long awns (1.0-5.0 mm); anthers 2.8-3.9 mm long.

Chromosome number : Unknown

Subspecies secunda occurs along the Pacific coast of North America from Alaska southward to Oregon. It is a seashore grass, growing on exposed coasts having high annual rainfall, from the upper part of the intertidal zone (pebble beaches) and above (in soil pockets on rocks, in meadows, and on cliffs, banks and stabilized sand dunes).

Subspecies secunda appears to be morphologically intermediate to both subsp. aucta and F. richardsonii, although the genes of other infraspecific F. rubra taxa may well be involved. Subspecies secunda and subsp. aucta are morphologically very close, differing primarily in size (morphometric characters). With subsp. aucta, subsp. secunda shares the characters of wide, loose, culm leaf sheaths, the uppermost of which often approaches or encloses the base of the panicle, flexuous panicles which tend to be secund, at least distally, relatively long, attenuate lemmas, and long awns. In some characters, however, subsp. aucta appears to be gigas; subsp. secunda usually has narrower (conduplicate or explanate) leaves, narrower culms and leaf sheaths, shorter panicles, shorter glumes and shorter lemmas. Subsp. secunda also differs from subsp. aucta in being more caespitose and in f. secunda having longer lemma pubescence.

The type of subsp. secunda has densely pilose lemmas. Most specimens of this subspecies have more or less glabrous lemmas and belong to :

2a. Forma psilolemma Pavlick, forma nova.

Ut subsp. secunda f. secunda, sed lemmata glabra. HOLOTYPE : J. R. Anderson 549, 29 June, 1896, open land, Nootka (V!).

Like subsp. secunda f. secunda, but lemmas glabrous.

The concept of subsp. secunda used here is much broader than that given by Presl (1830) in the protologue for its basionym. Subspecies secunda sensu stricto is morphologically distinct and readily separable from other members of the F. rubra complex; but within this taxon I also include plants which are morphologically transitional to subsp. aucta, F. richardsonii and subsp. pruinosa.

One such form, transitional to subsp. pruinosa is described below as var. mediana.

2b. Variety mediana Pavlick, var. nov.

A Festuca rubra L. subsp. pruinosa Hack. ex Piper foliorum culmorum vaginis laxioribus et latioribus, et fundis panicularum frequenter insertis intra vaginas culmorum supremas, a var. secunda (J. S. Presl in C.B. Presl) Scribn. lemmatibus brevioribus minus attenuatis et aristis brevioribus. HOLOTYPE : Pavlick 82-53, 5 July, 1982, Long Beach, Vancouver Island (V!).

It separates from F. rubra subsp. pruinosa by its looser, wider culm leaf sheaths and bases of panicles often inserted into the uppermost sheaths of the culm; from var. secunda by the shorter, less attenuate lemmas and shorter awns.

SYNONYM : F. rubra var. littoralis Vasey ex Beal, Grasses N. Amer. 2 : 607. 1896, nom. illeg., pro parte. TYPE : Howell s. n., July, 1882, "On sand dunes by the sea", Tillamook Bay, Oregon; Lectotype (MSC!); Isotype (US!).

Variety mediana has lower glumes 2.5-3.2 mm long; upper glumes 3.5-4.6 mm long, lowermost lemmas 4.5-6.0 mm long, and awns 0.5-2.0 mm long.

Other transitional forms : In specimens having pubescent lemmas, the lemmas, in side view, may be long and attenuate as in subsp. secunda sensu stricto, or short and acute (less attenuate) as in F. richardsonii. On the basis of lemma morphology (size, shape and vestiture), some coastal specimens are not readily distinguishable from F. richardsonii (e.g. Pavlick 84-129, Donegal Head, Malcolm Island (V), and Carl & Hardy s. n., Sept. 16, 1941, Muir Creek, Vancouver Island (V)). However, most coastal specimens of this complex are quite unlike F. richardsonii in having longer basal tufts, longer culms, and longer panicles. Both f. secunda and f. psilolemma occur together on coastal till banks of Malcolm Island (near latitude 51° N, longitude 127° W, north of Vancouver Island) where f. secunda has lemmas almost indistinguishable from that of F. richardsonii.

3. Festuca rubra L. subsp. pruinosa (Hack.) Piper, Contrib. U. S. Natl. Herb. 10 : 22. 1906. F. rubra L. [subsp. eu-rubra Hack. var. genuina Hack.] subvar. pruinosa Hack. in Bennett, Bot. Exch. Cl. Brit. Isles, Report for 1884 : 119. 1885. TYPE : E. F. Linton s. n., 6 Aug., 1884, Uig, [Isle of] Skye. According to Auquier (1971a), the type material cannot be found in the herbarium of Hackel (W), nor in K, and therefore no lectotype could be chosen; despite the lack of a type specimen,

Auquier's intensive studies provided a detailed description of subsp. pruinosa in Europe which leaves little doubt as to the identity of this taxon.

F. rubra L. subsp. densiuscula Hack. ex Piper, Contrib. U. S. Natl. Herb. 10 : 22. 1906. F. rubra subsp. eu-rubra var genuina subvar. densiuscula (Hack. ex Piper) St.-Yves, Candollea 2 : 240. 1925. F. densiuscula (Hack. ex Piper) Alexeev, Byull. Mosk. Obva. Ispyt. Prir. Otd. Biol. 87 : 113. 1982. HOLOTYPE : Davy & Blasdale 5931, Crescent City, California (US!).

F. rubra L. var. littoralis Vasey ex Beal, Grasses N. Amer. 2 : 607. 1896, nom. illeg., sensu auct., pro parte.

F. rubra L. subsp. rubra sensu auct., non L., pro parte.

Loosely to densely caespitose, usually with numerous basal shoots, short rhizomatous, with culms 20-40 cm tall; basal tuft (8-) 10-20 cm tall, with leaf sheaths shredding at the base and glabrous to pubescent above; leaves conduplicate, with 5-7 mostly narrow sclerenchyma strands, abaxially smooth or minutely roughened, green to pruinose, and with scabrous costae; culm sheaths closely hugging the culms; panicles (3-) 4-9 cm long, linear to lanceolate, congested to more or less open; spikelets with 4-7 florets, 7.5-14 mm long; lower glume 2.2-3.2 mm long; upper glume 3.5-4.5 mm long, acute or mucronate, scabrous on margins at apices; lowermost lemmas 4.6-6.0 mm long, lanceolate, acuminate, green with purple borders, pruinose or without surface bloom, scabrid near apices, and with awns 0.4-3.0 mm long; anthers 2.5-3.2 mm long.

Chromosome number : For European specimens, $2n = 42$ (Auquier, 1971a; Markgraf-Dannenberg, 1980). For North American specimens, unknown; Taylor and Mulligan (1968) reported $2n = 42$ for some F. rubra specimens from the Queen Charlotte Islands, but it is unclear whether they belong to this subspecies.

Subspecies pruinosa is a seashore taxon which occurs along the Atlantic coast of Europe from Iceland through the British Isles to Portugal (Auquier, 1971a; Markgraf-Dannenberg, 1980), and along the Pacific coast of North America from Alaska to California. In Pacific coastal North America it grows mainly in soil pockets and crevices of rocks and rock cliffs, from the upper littoral zone and above; occasionally it is found on pebble or sand beaches. In Europe its habitat is similar (Auquier, 1971a).

I have examined many North merican specimens of subsp. pruinosa but only about 6 from Europe. The European specimens and Auquier's descriptions of the morphology and ecology of subsp. pruinosa match North American specimens well, so that those of both regions are included in the same subspecies.

The type of F. rubra subsp. densiuscula (see synonymy) is here

included in subsp. pruinosa but it is atypical; it lacks surface bloom on the leaves and has several morphometric characters which are at the lower end of the range for subsp. pruinosa. For example, it has relatively short culms, basal tufts, spikelets, lower glumes, upper glumes, lemmas and awns (awns go to only about 0.4 mm long); but its spikelets are pruinose as found in other subsp. pruinosa specimens.

If the North American material here included in subsp. pruinosa is regarded as taxonomically separate from that of Europe, the name subsp. densiuscula would be appropriate at this rank. Alexeev (1982a) presented arguments for species status for subsp. densiuscula sensu stricto i.e. F. densiuscula.

4. Festuca rubra L. subsp. arenicola Alexeev, Byull. Mosk.

Obva. Ispyt. Prir. Otd. Biol. 87 : 115. 1982. HOLOTYPE : Tracy 894, 4 Aug., 1900, northern coast region of California, sand dunes of ocean at Humboldt Bay (LE).

F. rubra L. subsp. megastachys sensu Piper, Contrib. U.S. Natl. Herb. 10 : 21. 1906, non Caud., pro parte.

F. rubra L. subsp. pruinosa sensu Piper, pro parte.

Loosely to closely caespitose, rhizomatous plants; culms 40-70 cm tall; basal tufts 10-30 cm tall, with sheaths shredding at base, pubescent above; basal leaves conduplicate, green or glaucous-pruinose, more or less smooth abaxially, usually with wide, thick sclerenchyma strands; leaf sheaths close on culm; panicle usually narrow, sometimes open and lanceolate, 10-20 cm long; spikelets with 5-9 florets, (8-) 10-14 mm long; lower glume 2.5-4.5 mm long; upper glume 4.5-6.5 mm long, acuminate, often mucronate; lowermost lemmas 6.0-6.5 mm long, green to violet, pruinose or without a surface bloom, lanceolate, scabrous near apices, and with awns (0.2-) 0.5-2.5 (-3.0) mm long; anthers 2.3-3.2 mm long.

Chromosome number : Unknown.

Subspecies arenicola occurs along the Pacific coast from eastern Vancouver Island (north to about the Campbell River area) to California. It grows above high tide line on sandy beaches and spits. In British Columbia it appears to be restricted to the summer-dry Coastal Douglas-fir Zone.

To date I have not been able to view the type specimen, but I have examined one paratype : M. E. Jones 3251, May 12, 1882, San Francisco, California (BR); differing from the protologue, this specimen has some scabrous panicle branches and lemma awns (0.5-1.2 mm long). Specimens from British Columbia have scabrous panicle branches and lemma awns (0.2-) 0.5-2.5 (-3.0) mm long; also they share with the type material more or less narrow

panicles and wide, thick sclerenchyma strands (a character state unusual in North American *F. rubra*). Specimens from British Columbia are also usually more caespitose (having more culms and more basal shoots) and are less rhizomatous than the M. E. Jones 3251 paratype, but are otherwise morphologically and ecologically similar.

5. *Festuca richardsonii* Hook., Fl. Bor. Amer. 2 : 250. 1840.

Festuca rubra L. subsp. *richardsonii* (Hook.) Hultén, Lunds Univ. Arsskr. Avd. 2, 38 : 246. 1942, nom. illeg. LECTOTYPE : Richardson s. n., Arctic coast (region near Mackenzie River) (K); Syntypes : (NY!, G!).

F. rubra L. var. *mutica* Hartm., Handb. Scand. Fl. ed. 3 : 27. 1938.

F. kirelowii Steud., Syn. Pl. Glum. 1 : 306. 1855. *F. rubra* subsp. *kirelowii* (Steud.) Tzvel.

F. rubra L. subsp. *arctica* (Hack.) Govor., Fl. Urala : 127.

1937, non *F. arctica* Schur. Govorukhin (1937) published this name in the form of *F. rubra* L. subsp. *F. arctica*, which, under Art. 24.4 of the International Code of Botanical Nomenclature, is to be altered to the proper form without change of author's name. *F. rubra* L. subsp. *eu-rubra* var. *genuina* subv. *arenaria* f. *arctica* Hack., Monogr. Fest. Eur. : 140. 1882. "In insulis arcticus, Scandinavia boreali".

F. rubra L. var. *alaica* Drob., Trudy Bot. Muz. Imp. Akad. Nauk. 16 : 135. 1916, non *F. alaica* Drob.

F. rubra L. var. *alpina* Kom., Fl. Penin. Kamtsch. 1 : 188. 1927, non *F. alpina* Suter.

F. eriantha Honda, Tokyo Bot. Mag. 42 : 185. 1928.

F. cryophila Krecz. & Bobr., Fl. U.S.S.R. 2 : 769. 1934. *F. rubra* L. subsp. *cryophila* (Krecz. & Bobr.) Hult., Kungl. Sv. Vetenskapsakad. Handl. 8, 5 : 64. 1964. *F. rubra* L. var. *cryophila* Reverd.

Loosely tufted, rhizomatous grasses with culms 20-40 cm tall (up to 60 cm tall in one variant); basal leaf sheaths sparingly shredding into fibres, pubescent above; basal leaves conduplicate (sometimes + explanate), with 5-7 small sclerenchyma strands plus usually sclerenchyma on some costae, abaxially mostly green, smooth, with pilose costae; culm leaves conduplicate or explanate; uppermost culm leaf blade short (often 2-6 cm long) and about midlength or below on culm; panicles mostly congested or open, 3.5-7.0 cm long; spikelets 7-13 mm long, with (3-) 5-7 florets, mostly violet; glumes often pilose-ciliate near tip; lower glume (2-) 2.5-3.5 (-4) mm long; upper glume 3.5-5.0 mm long; lowermost lemmas (4-) 4.5-6.0 (-6.5) mm long, densely to moderately densely pilose (trichomes 0.2-0.7 mm long) or only partially pubescent, mostly violet or proximal part green, and with awns 0.5-1.6 (-2.5) mm long; anthers (2.3-) 2.5-3.0 mm long.

Chromosome number : $2n = 42$ (see Löve and Löve (1975) for 11 references).

Festuca richardsonii is a circumpolar plant (see maps in Porsild (1957), as F. rubra subsp. cryophila). In North America it occurs in Alaska, northwestern British Columbia, Yukon, Northwest Territories (including the Arctic Ocean coast and the southern part of the Canadian Arctic Archipelago), along the seacoast of Hudson's Bay, James Bay, northern Quebec and Labrador, and extends southward into Alberta and beyond on the eastern declivities of the Rocky Mountains. I have found no specimens of F. richardsonii in British Columbia west of the Rocky Mountain crests except those of the extreme northern part of the province and transitional forms along the Pacific coast. Festuca richardsonii grows in a variety of habitats : on sands, gravels, stoney soil, and silts of river banks, bars and flats, glacial outwash (near glaciers), and beaches; sand dunes; muskegs; solifluction slopes, scree slopes and other dry, open areas in the mountains.

This much-named taxon is often regarded as a subtaxon of F. rubra. It is morphologically different from typical F. rubra sensu stricto from Europe in leaf sclerenchyma pattern, leaf blade vestiture, panicle size and shape, lemma vestiture, awn length, habitat, geography, and other characters. It also differs from other members of the F. rubra complex. Because of these morphological differences and its large, mostly exclusive geographical range, F. richardsonii is here recognized as a species.

Along the periphery of F. richardsonii's range, forms transitional between F. richardsonii and F. rubra subsp. rubra (see Alexeev, 1982b) occur. Along the northern Pacific coast of North America, forms occur which are transitional between F. richardsonii and other members of the F. rubra complex. According to Hultén (1964), F. richardsonii has a series of types which belong to an arctic-montane area. Some of this series is given in Hultén (1964) and Alexeev (1982b). Alexeev (1982b) concluded that F. rubra var. alpina (type from Kamtschatka), F. kirelowii (type from Dzungaria), F. rubra var. alaica, and F. eriantha (type from northeastern Asia) were morphologically transitional between F. richardsonii and F. rubra subsp. rubra. I have viewed one specimen (typus) of F. kirelowii from "Songaria" and refer it to F. richardsonii; but I have not seen material of these other types. I have examined material from arctic Norway and arctic U.S.S.R. (near type region of F. rubra subsp. arctica); these specimens and other specimens from the Arctic Ocean coast of Canada (type material of F. richardsonii), Alaska, Yukon, British Columbia and Greenland are morphologically similar F. richardsonii. One variation is seen in some specimens (in ALA) from the Mount McKinley area of Alaska; these are usually tall

(up to 60 cm) and the lemmas vary from being densely pilose with trichomes to 0.6 mm long, to shorter pubescent only along the sides with trichomes to about 0.4 mm long. Hultén (1964) included, with doubt, *F. baicalensis* in his arctic-monane series. I have examined one specimen of *F. baicalensis* (Griseb.) Tzvel. from Lake Baikal; it has longer panicles, glumes and lemmas than any *F. richardsonii* specimens I have seen, and I do not regard it as part of *F. richardsonii*.

6. *Festuca rubra* L. subsp. *vallicola* (Rydb.) Pavlick, stat. nov. *F. vallicola* Rydb., Mem. N.Y. Bot. Gard. 1 : 57. 1900. HOLOTYPE : Rydberg 2108, Silver Bow, Monana (NY) ; Isotype (US). *F. rubra* L. subsp. *rubra sensu* Piper, Contrib. U.S. Natl. Herb. 10 : 20. 1906, et auct., pro parte.

Rhizomatous, mostly not caespitose, with only a few basal shoots (sometimes caespitose with 2-several culms); culms (20-) 25-70 cm tall, slender (about 1.0 mm wide), striate, mostly pale green; basal leaves deep green, conduplicate, smooth to slightly scabridulous abaxially; culm leaves 3-6 cm long, conduplicate or explanate; sheaths narrow, closely hugging the culm; panicle mostly narrow, 5-8 cm long; spikelets with 4-7 florets, 8-11 mm long; lower glume 2-3 mm long; upper glume 4-5 mm long, acute to acuminate; lemmas 5-6 mm long, pale green with violet borders, and with awns 1.0-2.5 (-4) mm long; anthers 2.0-2.6 mm long.

Chromosome number : Unknown.

Subspecies *vallicola* occurs in the mountains (above 1000 m elevation in southern British Columbia) of the North American Cordillera from the Yukon border area to Wyoming. It grows in moist situations such as wet meadows, lake margins, etc., and is also found in disturbed soil such as on road verges.

This is a neglected taxon of moist areas in the mountains. Road verge specimens which otherwise are morphologically similar to and referable to subsp. *vallicola*, often are more caespitose. Hybridization with road verge plantings of European *F. rubra* subtaxa is suggested.

7. *Festuca rubra* L. subsp. *rubra*, Sp. Pl. 1 : 74. 1753. TYPE : "Habitat in Europae pratis siccis". No lectotype has been selected for this European taxon. I am indebted to M. Kerguélen, Institut National de la Recherche Agronomique, Guyancourt, France, a student of *Festuca*, for pointing out (personal comm.) the problems of typification of this taxon; he states that "The suitable sheet seems labelled 'Laponia' and is very possibly an arctic '*F. rubra*' and not the *F. rubra*

subsp. rubra of western European floras!" ; also, in European floras, F. rubra subsp. rubra is not a well defined taxon, often a mixture of F. rubra subsp. rubra and F. rubra subsp. juncea (Hack.) Richt. For identification of subsp. rubra specimens introduced to North America, I have examined a limited number of European specimens and have used the works of Piper (1906), Saint-Yves (1925), Hubbard (1968), Hitchcock (1969) and Markgraf-Dannenberg (1980).

Usually loosely caespitose grass, rhizomatous, with culms 40-90 cm tall, and basal tufts 8-22 cm tall; basal leaf sheaths shredding into fibres at base, pubescent above; leaves mostly conduplicate, with usually 7 small sclerenchyma strands and no costal sclerenchyma, abaxially green or glaucous, smooth (minutely roughened or scabridulous), with scabrous or pubescent costae; Panicles lanceolate, open, 7-12 cm long; spikelets 9-14.5 mm long, with 5-8 florets; lower glumes 3.0-4.5 mm long; upper glumes 4.5-6.4 mm long; lemmas lanceolate, (5-) 6.0-7.5 mm long, green with red-violet borders (or sometimes mostly red-violet), scabrid at apices, sometimes along sides, acuminate, with awns 0.6-3.2 (-4.0) mm long; anthers 2.4-3.5 mm long.

Chromosome number : $2n = 42$ (see Löve and Löve, 1975, for 28 references).

Subspecies rubra has been widely introduced in British Columbia as a highway verge soil binder, lawn grass and pasture grass. It is found throughout the southern half of British Columbia (including Vancouver Island; the Lower Mainland; Kootenay, Cariboo, Prince George and Peace River Districts) and along the Alaska Highway. It is a plant of highway verges and other disturbed sands and gravels (e.g. spits, gravel bars in rivers), lawns, pastures, and to some extent moist meadows and hillside grasslands.

In British Columbia, subsp. rubra shows much morphological variation, and hybridization with other taxa of the F. rubra complex, such as subsp. vallicola and other introduced European forms and cultivars, is probable.

Also introduced from Europe :

8. Festuca rubra L. subsp. arenaria (Osbeck) Syme in Sowerby, Engl. Bot. ed. 3, 11 : 147. 1872. F. arenaria Osbeck, Utkast Til Fl. Hall. : 8. 1788, and in Retz., Dissert. Sist. Suppl., 1 : 4. 1805. F. rubra [var.] β arenaria (Osbeck) Fries, Fl. Hall. : 28. 1818.

I have seen one specimen of subsp. arenaria f. glabra Auquier (Lejeunia, nouv. ser. 57 : 17. 1971) on the coast of Vancouver

Island (specimen : Pavlick 84-29, 24 July, 1984, sandy, gravelly beach, Goose Spit (near Comox, B. C.)). (V). This specimen has the distinctive leaf structure depicted for subsp. *arenaria* by Auquier (1971b); it has roundish, little carinate leaves with unequal sclerenchyma strands, and nine costae, all with sclerenchyma strands. Subspecies *arenaria* grows in sandy habitats as does subsp. *arenicola*, but the latter has more carinate leaves, often with more massive sclerenchyma strands, and leaf costae that may have some or no sclerenchyma strands, and usually shorter, non-tomentose lemmas. I have found no specimens of subsp. *arenaria* f. *arenaria* (the form with tomentose lemmas) from the Pacific coast.

9. *Festuca rubra* L. var. *planifolia* Hack., Monogr. Fest. Eur. : 140. 1882.

Specimens, thought to be introduced, which approximate the description of Hackel (1882) for var. *planifolia* are occasionally found in British Columbia (e.g. Pavlick & Taylor 79-518, Puggins Mt. Road (Peace River District), British Columbia (V)).

10. *Festuca rubra* L. subsp. *commutata* Gaud., Fl. Helv. 1 : 287. 1828. *F. rubra* var. *fallax* Hack., Monogr. Fest. Eur. : 142. 1882. *F. nigrescens* Lam., Encycl. Meth. Bot. 2 : 460. 1788.

Subspecies *commutata* is present in the flora of British Columbia as a lawn grass, and as a highway verge planting.

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