

A REVISION OF *TRisetum* AND *GRAPHEPHORUM*
(POACEAE: POOIDEAE: AVENINAE) IN NORTH AMERICA
NORTH OF MÉXICO

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ABSTRACT

A taxonomic treatment of *Trisetum* Pers. and *Graphephorum* Desv. in North America north of México is given. Eight species of *Trisetum* are recognized. Two species are endemic to the United States: *T. orthochaetum* (Montana) and *T. projectum* (California, Montana, and Nevada); *Trisetum cernuum* subsp. *cernuum*, *T. cernuum* subsp. *canescens*, *T. montanum*, *T. sibiricum*, *T. spicatum* var. *spicatum*, and *T. spicatum* var. *pilosiglume* are found in Canada and the United States; and *T. spicatum* var. *spicatum* and *T. spicatum* var. *pilosiglume* are found in Greenland. Two species, *T. aureum* and *T. flavescens*, are introduced. *Trisetum floribundum* Pilg. is chosen as a lectotype for *Trisetum* sect. *Aulacoa* Louis-Marie. The genus *Graphephorum* comprises only two species: *G. melicoides* ranging from Canada to the United States and *G. wolfii* endemic to the United States.

RESUMEN

En el presente artículo se presenta un tratamiento taxonómica para *Trisetum* Pers. y *Graphephorum* Desv. en Norteamérica norte de México. Se reconocen ocho especies de *Trisetum*. Dos de estas especies son endémicas de los Estados Unidos: *T. orthochaetum* (Montana) y *T. projectum* (California, Montana y Nevada). *Trisetum cernuum* subsp. *cernuum*, *T. cernuum* subsp. *canescens*, *T. montanum*, *T. sibiricum*, *T. spicatum* var. *spicatum* y *T. spicatum* var. *pilosiglume* se encuentran en Canadá y los Estados Unidos; y *T. spicatum* var. *spicatum* y *T. spicatum* var. *pilosiglume* se encuentran en Groenlandia. Dos especies, *T. aureum* y *T. flavescens*, han sido introducidas. *Trisetum floribundum* Pilg. se elige como lectotipo para *Trisetum* secc. *Aulacoa* Louis-Marie. El género *Graphephorum* comprende sólo dos especies: *G. melicoides*, que se encuentra desde Canadá hasta los Estados Unidos y *G. wolfii*, endémico de los Estados Unidos.

Trisetum includes approximately 40 species and several infraspecific taxa in the Americas and is distributed from Greenland (70°N) to southern South America (55°S) [Clebsch 1960; Hultén 1959; Nicora 1978, Finot 2003a, Finot et

al. 2004). There are two endemic species of *Trisetum* in the Hawaiian Islands: *T. glomeratum* (Kunth) Trin. ex Steud. and *T. inaequale* Whitney (O'Conner 1990). We recognize eight species and two varieties in North America (excluding México), 17 species in México and Central America, and 18 species and seven varieties in South America (Finot 2003a; Finot 2004; Finot et al. 2004). *Trisetum* is also present in Europe, Asia, Australia, and New Zealand (Jonsell 1980; Tsvelev 1983; Clayton & Renvoize 1986; Pohl & Davidse 1994; Tucker 1996; Edgar 1998; Soreng et al. 2003; Finot et al. 2004, 2005). The genus seems to be absent in Africa (Clayton & Renvoize 1986). Although several species were described for Africa (Steudel 1854), they were later transferred to *Helictotrichon* Besser ex Schult. & Schult. f. (Hubbard 1936; Schweickerdt 1939).

TAXONOMIC HISTORY OF NORTH AMERICAN SPECIES

One of the earliest treatments of *Trisetum* was made by Steudel (1854), who recognized five North American taxa: *T. cernuum* Trin., *T. groenlandicum* Steud. [= *T. spicatum* (L.) K. Richt. var. *spicatum*], *T. labradoricum* Steud. (*T. spicatum* var. *spicatum*), *T. molle* Kunth (*T. spicatum* var. *spicatum*), and *T. palustre* (Michx.) Torr. [= *Sphenopholis pensylvanica* (L.) Hitchc.]. Buckley (1862) described three new species for North America: *Trisetum glabrum* Buckley [= *Deschampsia danthonioides* (Trin.) Munro], *T. interruptum* Buckley [= *Sphenopholis interrupta* (Buckley) Scribn.], and *T. canescens* Buckley, sometimes referred to as a variety or subspecies of *T. cernuum* (Beal 1896; Calder & Taylor 1965), or to *Helictotrichon canescens* (Buckley) Clayton. A new species described by Scribner (1884), *T. hallii* Scribn., is now considered a synonym of *Sphenopholis interrupta* (Buckley) Scribn. (Finot et al. 2004). Beal (1896) presented a treatment of *Trisetum* in North America (those found only in México and/or countries south are marked with an asterisk) that included the following 15 species: *T. cernuum*, *T. deyeuxioides* (Kunth) Kunth*, *T. elongatum* (Kunth) Kunth, *T. filifolium* Scribn. ex Beal*, *T. hallii* Scribn., *T. ludovicianum* Vasey, *T. montanum* Vasey, *T. palustre*, *T. paniculatum* E. Fourn. [= *Trisetum viride* (Kunth) Kunth]*, *T. pratense* Pers. [= *Trisetum flavescens* (L.) P. Beauv.], *T. sandbergii* Beal, *T. sesquiflorum* Trin., *T. spicatum*, *T. toluicense* (Kunth) Kunth (= *Trisetum spicatum* var. *spicatum*), and *T. virletii* E. Fourn.* Five of these species included in Beal's treatment were later transferred to other genera: *Trisetum palustre*, *T. ludovicianum*, and *T. hallii* to *Sphenopholis* (Scribner 1906; Erdman 1965); *T. deyeuxioides* to *Peyritschia* (Finot 2003b); and *T. sesquiflorum* to *Calamagrostis* (Rozhevits 1962; Soreng & Greene 2003). Beal (1896) also described a new species, *T. sandbergii* from Mt. Stuart, Washington, now considered a synonym of *T. cernuum* Trin. (Hitchcock 1939; Hitchcock 1950; Finot 2003a). Beal (1896) recognized *T. montanum* as a valid species. It was later treated, however, as a synonym of *T. spicatum* by several authors (Hitchcock 1928; Weber 1976).

Karl Richter (1890), an Austrian botanist recognized that *Trisetum*

subspicatum (L.) P. Beauv. was an illegitimate homonym since it was based on *Aira spicata* L., and therefore, made the combination, *Trisetum spicatum*. Beal (1896) was the first North American agrostologist to use *Trisetum spicatum*. Scribner and Merrill (1902) described a new species for the flora of North America, *T. congdonii* Scribn. & Merr., a synonym of *T. spicatum* in modern treatments. Several differences between *T. congdonii* and *T. spicatum* listed by the authors included more rigid leaves, narrower glumes, more scabrous lemmas and longer awns. Since the extent of variation of *T. spicatum* is great, we feel these differences do not warrant recognition at the species level. For the central Rockies (Colorado) three species: *T. spicatum* (as *T. subspicatum*), *T. majus* Vasey ex Rydb. (= *T. spicatum*), and *T. montanum* Vasey, were reported by Rydberg (1906).

Louis-Marie (1928-29) in his taxonomic revision of *Trisetum* in America, included 15 species with several varieties in North America. In *Trisetum* subgen. *Heterolytrum* Louis-Marie sect. *Anaulacoa* Louis-Marie subsect. *Trisetum* (as "Eutriseta"), he included *Trisetum montanum* [including two varieties: *T. montanum* var. *pilosum* Louis-Marie and *T. montanum* var. *shearii* (Scribn.) Louis-Marie], *T. cernuum* [including *T. cernuum* var. *luxurians* Louis-Marie, *T. cernuum* var. *luxurians* fo. *pubescens* Louis-Marie, and *T. cernuum* var. *sandbergii* (Beal) Louis-Marie], *T. canescens* Buckley (including *T. canescens* fo. *tonsum* Louis-Marie and *T. canescens* fo. *velutinum* Louis-Marie), *T. projectum* Louis-Marie, *T. sesquiflorum*, *T. bongardii* Louis-Marie [= *Calamagrostis sesquiflora* (Trin.) Tzvelev], *T. williamsii* Louis-Marie [= *Danthonia intermedia* Vasey], *T. spicatum* [including *T. spicatum* var. *laxius* (Lange) Louis-Marie, *T. spicatum* var. *majus* Farwell, *T. spicatum* var. *molle* (Michx.) Piper, *T. spicatum* var. *brittonii* (Nash) Louis-Marie, *T. spicatum* var. *pilosiglume* Fern., *T. spicatum* var. *alaskanum* (Nash) Malte ex Louis-Marie, *T. spicatum* var. *villosissimum* Langel, and *T. congdonii*]. In *Trisetum* subsect. *Sphenophoidea* Louis-Marie he included *T. pennsylvanicum* (L.) P. Beauv. ex Roem. & Schult., *T. interruptum*, and *T. hallii*, now transferred back to *Sphenopholis* by Erdman (1965). In *Trisetum* subsect. *Grappheporum* (Desv.) Louis-Marie, Louis-Marie included *T. melicoides* (Michx.) Scribn. and *T. wolfii* Vasey [including *T. wolfii* var. *brandegei* (Scribn.) Louis-Marie and *T. wolfii* var. *brandegei* fo. *muticum* (Boland.) Louis-Marie], and in *Trisetum* Sect. *Aulacoa* Louis-Marie he included *T. floribundum* Pilg. [Lectotype here designated: = *Dielsiochloa floribunda* (Pilg.) Pilg.], and *T. trinii* (Trin.) Louis-Marie [= *Bromus berterioanus* Colla].

Hitchcock (1934) described a new species from Montana, *T. orthochaetum*. Later, Hitchcock (1939) gave a detailed account of the genus for the North American flora (including México), where 19 species were recognized under *Trisetum*. Eleven of the species listed by Hitchcock are from México and Central America, and the following eight range from the United States, Canada, and Greenland: *T. melicoides* and *T. wolfii* (here treated under genus *Grappheporum*), *T. spicatum*, *T. orthochaetum*, *T. canescens*, *T. cernuum*, *T. flavescens*, and *T.*

montanum. Finot et al. (2004) recognized 17 species of *Trisetum* in México and Central America: *T. angustum* Swallen, *T. barbatipaleum* (Hultén ex Veldkamp) Finot, *T. curvisetum* Morden & Valdes-Reyna, *T. durangense* Finot, P.M. Peterson, *T. filifolium*, *T. irazuense* (Kuntze) Hitchc., *T. ligulatum* Finot & Zuloaga, *T. martha-gonzaleziae* P.M. Peterson & Finot, *T. palmeri*, *T. pinetorum* Swallen, *T. pringlei* (Scribn. ex Beal) Hitchc., *T. rosei* Scribn. & Merr., *T. spellenbergii* Soreng, Finot & P.M. Peterson, *T. spicatum*, *T. tonduzii* Hitchc., *T. viride*, and *T. virletti*.

Hultén (1959) studied the *Trisetum spicatum* complex on a world-wide basis, and recognized several North American infraspecific taxa: *T. spicatum* subsp. *alaskanum* (Nash) Hultén, *T. spicatum* subsp. *pilosiglume* (Fernald) Hultén, *T. spicatum* subsp. *molle* (Michx.) Hultén, *T. spicatum* subsp. *majus* (Vasey) Hultén, *T. spicatum* subsp. *congdonii* (Scribn. & Merr.) Hultén, and *T. spicatum* subsp. *congdonii* var. *spicatiforme* Hultén. Later authors concluded that *T. spicatum* is polymorphic (Randall & Hilu 1986), and most of the infraspecific taxa were placed in synonymy.

Grapphephorum is a small genus endemic to North America, closely related to *Trisetum*. It differs from this genus in having the apex of the lemma entire and the dorsal awn reduced to a subapical mucro. *Grapphephorum* comprises only two species, *G. melicoides* (Michx.) Desv. and *G. wolfii* (Vasey) Vasey (Finot & Soreng 2003), sometimes treated under *Trisetum*. Clayton and Renvoize (1986) indicate *Grapphephorum* has three species but only the type species was given. One species from México, originally described as *Grapphephorum altijugum* E. Fourn. is currently accepted as *Peyritschia koelerioides* (Peyr.) E. Fourn. (Finot 2003b; Finot et al. 2004). *Grapphephorum pringlei* Scribn. ex Beal, from México, Guatemala, Costa Rica, and Panamá, was transferred to *Trisetum* by Hitchcock (1927).

MATERIAL AND METHODS

Type specimens and general collections from the following herbaria were studied: BA, BAA, BAF, C, CR, CIIDIR, CONC, F, LP, MERL, P, PR, QCA, SGO, S, SI and US. For micromorphological studies, ligules were collected from upper and basal culm leaves with a sharp razor blade and mounted in lactophenol. For leaf anatomical studies, hand cross sections and abaxial epidermis preparations were made following Metcalfe (1960). The terminology for ligule description is based mainly on Chaffey (1983, 1984). Transverse sections and abaxial epidermis of leaves were described following the terminology proposed by Ellis (1976, 1979). Observations were made with a Zeiss MC-80 microscope equipped with objectives 20×, 40×, 63×, and 100×. All grass names mentioned in this manuscript, including those in the introduction are treated in Appendix 2.

In the morphological descriptions the length given for florets was usually taken from the first or lowest floret. If there were three or more florets per spikelet then the second floret was sometimes used to calculate the range. Therefore,

when using our keys to determine North American specimens of *Trisetum* it is best to measure only the first or lowest floret.

TAXONOMIC TREATMENT
KEY FOR DISTINGUISHING THE GENERA *TRisetum*
AND *GRAPHEPHORUM* IN NORTH AMERICA

1. Lemma with lateral nerves not prolonged into apical setae, the apex entire to slightly bilobate; dorsal awn absent or reduced to a short subapical mucro; palea not gaping (palea tightly enclosed by the margins of the lemma); panicle lax, open or contracted, never spiciform _____ **Grappheporum**
1. Lemma with lateral nerves prolonged into 2(4) apical setae, the apex bidentate; dorsal awn well developed, borne on the upper half or third of the lemma; palea gaping (palea not tightly enclosed by the margins of the lemma); panicle lax or densely-flowered, contracted or open, and ovate or pyramidal, often spiciform _____ **Trisetum**

Grappheporum Desv., Nouv. Bull. Sci. Soc. Philom. Paris 2:189. 1810. TYPE: *Grappheporum melicoides* (Michx.) Desv.

Perennials, loosely caespitose or with short rhizomes. Culms 50–100 cm tall, glabrous or pilose. Leaf sheaths glabrous, scabrous, and/or pilose; blades flat, glabrous or pilose; ligule membranous. Inflorescence in panicles open or contracted, glabrous below the panicle. Spikelets 2- or 3-flowered; rachilla pilose; disarticulation above the glumes and between the florets; glumes slightly unequal, slightly shorter than the spikelet; first glume 1-nerved, lanceolate to linear-lanceolate; second glume 1- or 3-nerved, lanceolate to oval-lanceolate; lemmas with apex entire to slightly bilobate, muticous or with a reduced awn (mucro), borne immediately below the apex, the mucro not reaching the apex of the lemma; palea not gaping; stamens 3; ovary glabrous or with short apical hairs.

KEY TO THE SPECIES OF *GRAPHEPHORUM* IN NORTH AMERICA

1. Panicles 2–4 cm wide, open, lax; ovary glabrous; callus hairs about 2.5 mm _____ **1. G. melicoides**
1. Panicles 1–1.5 cm wide, contracted; ovary glabrous or with short hairs at the apex; callus hairs 0.5 mm long _____ **2. G. wolfii**

1. Grappheporum melicoides (Michx.) Desv., Nouv. Bull. Sci. Soc. Philom. Paris 2:189. 1810. *Aira melicoides* Michx., Fl. Bor. Amer. 1:62. 1803. *Poa melicoides* (Michx.) Nutt., Gen. N. Amer. Pl. 1:68. 1818. *Triodia melicoides* (Michx.) Spreng., Syst. Veg. 1:331. 1825. *Trisetum melicoides* (Michx.) Scribn., Bot. Gaz. 9:169. 1884. TYPE: CANADA. America Boreal, Michaux s.n. (HOLOTYPE: P; ISOTYPE: LE-TRIN 1864.01).

Arundo airoides Poir., Encycl. 6:270. 1804. *Deyeuxia airoides* (Poir.) P. Beauv., Ess. Agrostogr. 44, 152, 160. 1812. *Agrostis airoides* (Poir.) Raspail, Ann. Sci. Nat. (Paris) 5: 449. 1825, *nom. illeg. hom.* *Calamagrostis airoides* (Poir.) Steud., Nomencl. Bot. (ed. 2) 1:249. 1840. TYPE: U.S.A. America Septentrionalis, Michaux s.n. (HOLOTYPE: Herb. Juss., not seen).

Dupontia cooleyi A. Gray, Manual (ed. 2) 556. 1856. *Grappheporum melicoides* var. *majus* A. Gray, Proc. Amer. Acad. Arts 5:191. 1861. *Grappheporum melicoides* var. *cooleyi* (A. Gray) Scribn., Mem. Torrey Bot. Club 5(4):53. 1894. *Trisetum melicoides* subsp. *cooleyi* (A. Gray) Scribn.,

Rhodora 8(89):87. 1906. *Trisetum melicoides* var. *majus* (A. Gray) Hitchc., Rhodora 10(112):65. 1908. *Grapphephorum coolcyi* (A. Gray) Farw., Pap. Michigan Acad. Sci. 1:88. 1923. TYPE: U.S.A. MICHIGAN: (HOLOTYPE: not found).

Perennials. Culms 50–100 cm tall, glabrous. Leaf sheaths scabrous or pubescent; ligules 1.3–2 mm long, oval, glabrous dorsally, apex dentate with short cilia; blades 80–150 × 2–8 mm, flat, glabrous, sometimes pubescent adaxially. Panicles 8–20 × 2–4 cm, lax, open, nodding; branches ascending; rachis scabrous. Spikelets 6–7 mm long; rachilla hairy; the hairs 1–1.5 mm long; glumes unequal, shorter than the spikelet; keel smooth or scabrous on the upper half; first glume 4–4.5 × 0.5 mm, shorter and narrower than the second glume, lanceolate, 1-nerved; second glume 6–7 × 0.8 mm, oval-lanceolate, 3-nerved; lemmas with short and straight subapical awn (mucro), intermediate nerves not reaching the apex; apex acute, entire, not setulate or aristulate; callus hairy, the hairs about 2.5 mm long; palea shorter than the lemma, 2-nerved; apex entire; lodicules about 0.6 mm long, with the apex entire to slightly bilobate; ovary glabrous. Caryopses 3.2–3.8 mm long, glabrous; endosperm semi-liquid.

Anatomy and Micromorphology.—Ligule apices without hairs or papillate cells, composed of long cells with rounded ends; ligule epidermis composed of rectangular long cells with straight side walls, without prickle hairs or macrohairs; blades in transverse section flat to weakly keeled; adaxial face with rounded ribs, the ribs not very prominent; furrows wider than the adjacent ribs; abaxial face with ribs similar in size and shape to the adaxial ribs; vascular bundles 15, rounded, situated in the median portion of the blade; vascular bundles with adaxial and abaxial girders; marginal sclerenchyma present, small; epidermis in transverse section larger than the mesophyll, the adaxial epidermis with epidermal cells more or less rounded, thin; bulliform cells inconspicuous; prickles scarce, present only in the adaxial epidermis; stomata present in both adaxial and abaxial surfaces; abaxial epidermis with costal-intercostal zones well differentiated; intercostal zones with long cells rectangular to fusiform, with straight side walls and vertical to oblique terminal walls; intercostal short cells absent; stomata in two intercostal rows; prickles scarce; macrohairs absent; costal zone 2 or 3 cells wide, with long cells similar to the intercostal epidermal cells but shorter and narrower; short cells rectangular, with sinuous walls; prickles in rows on the costal zones.

Distribution.—Canada (Newfoundland, Ontario, Québec) and United States (Maine, Michigan, New Hampshire, New York, Vermont, Wisconsin) [Hitchcock 1939; Kartesz 1998].

Specimens examined. **CANADA. Ontario:** Township, 20 mi S of Moonbeam, 14 Aug 1959, *Morton 11449* (US). **Newfoundland:** Valley of Exploits River, Grand Falls, 12 Aug 1911, *M.L. Fernald & Wiegund 4591* (US). **U.S.A. Maine: Aroostook Co.:** along St. John River, St. Francis, 5 Aug 1893, *M.L. Fernald 187* (P); Northern Maine, St. Francis River, Aug 1902, *Eggleston 3136* (P); Wooshead Lake, 1 Sep 1868, *A.E. Smith & C.E. Smith s.n.* (P).

2. *Grappheporum wolfii* (Vasey) Vasey ex Coult., Man. Bot. Rocky Mt. 423. 1885.

Trisetum wolfii Vasey, Monthly Rep. Dept. Agric. 1874:156. 1874. TYPE: U.S.A. Colorado: Lake Co.: Twin Lakes, 1873. *J. Wolfe s.n.* (ISOTYPES: NY-232367!, US-81781!).

Trisetum subspicatum var. *muticum* Bol., Bot. California 2:296. 1880. TYPE: U.S.A. California: on the upper Tuolumne, 7500 ft. 1866, *H.N. Bolander 5019* (ISOTYPES: NY-232371!, US-867860!, US-344201!).

Perennials. Culms 50–100 cm tall, with short rhizomes. Leaf sheaths glabrous or pilose; ligules 1.5–2 mm long, truncate, glabrous dorsally, apex dentate; blades 60–200 × 3–7 mm, flat, soft; lower blades pilose abaxially, sparsely pilose adaxially; upper blades glabrous to sparsely pilose abaxially, sparsely pilose adaxially. Panicle 8–15 × 1–1.5 cm, contracted, dense, erect, tinged with purple; rachis strongly scabrous. Spikelets 6–7.5 mm long, 2- or 3-flowered; rachilla 1.5 mm long, hairy, the hairs 0.5–1.5 mm long; glumes unequal, nearly as long as the spikelet; keel scabrous towards the apex; apex acute; first glume 4.2–6 × 0.5–0.7 mm, shorter and narrower than the second glume, lanceolate, 1-nerved; second glume 5–6.5 × 0.8–0.9 mm, as long or shorter than adjacent floret, 3-nerved; lower floret 5–5.5 mm long; upper florets shorter; lemma glabrous to slightly scabrous towards the apex; apex acute to slightly bidentate, hyaline, muticous or with a short subapical mucro 1–2.2 mm long, borne at 1–1.3 mm below the apex; callus short hairy, the hairs about 0.5 mm long; palea about 4 mm long, shorter than the lemma, 2-nerved, the nerves scabrous; lodicules 0.7–0.8 mm long; apex with two 2 teeth, sometimes with a third smaller tooth between them; anthers 0.7–0.8 mm long; ovary glabrous, sometimes with hairs near the apex. Caryopses 2.4–3 mm long, with or without hairs at the apex; endosperm solid.

Anatomy and micromorphology.—Ligule apices with stiff hairs and papillate cells; ligule epidermis composed of rectangular long cells; short cells present; prickle hairs scarce; stomata and macrohairs absent; blades in transverse section V-shaped, symmetric, keeled, the keel with a well developed sclerenchymatic tissue; adaxial ribs absent; central vascular bundle free, without adaxial sclerenchyma; second order vascular bundles with I-shaped sclerenchyma girders; third order vascular bundles free, with small strands of adaxial or abaxial sclerenchyma; marginal sclerenchyma small; bulliform cells conspicuous, in fan-shaped groups; macrohairs absent; abaxial epidermis with costal-intercostal zonation present; intercostal zones with fusiform to rectangular long cells, with lateral walls straight; short cells and stomata present; prickles and macrohairs absent; costal zones with long cells rectangular, narrower than the intercostal cells; short cells rectangular, with sinuous side walls.

Distribution.—A species endemic to western United States (California, Colorado, Idaho, Montana, New México, Nevada, Oregon, Utah, Washington, and Wyoming) [Hitchcock 1939; Kartesz 1998].

Specimens examined. **U.S.A. CALIFORNIA: Mono Co.:** Ravine Creek, 3200 m, 21 Aug 1954, *Krapovickas 8102* (SI); Yosemite National Park, 9600 ft, 1 Aug 1934, *Bartholomew s.n.* (US); J.R. Swallen 1937 (P). **COLORADO: Sequachi Co.:** Marshall Pass, 10800 ft, 27 Jul 1896, *Clements 200* (US); Buffalo Pass, 10500 ft, 14 Aug 1898, *Shear & Bessey 1482* (US). **NEVADA: Elko Co.:** just above Angel Lake, East Humboldt Mountain, 8000 ft, 24 Jun 1958, *P.H. Raven & O.T. Solbrig 1340* (SI); Ponderosa Mountain, above Leiglis Lake, 7000 ft, 26 Jul 1901, *Merrill & Wilcox 348* (P). **NEW MEXICO:** Castilla Valley, 4 Sep 1913, *E.O. Wootton s.n.* (US). **WASHINGTON: Spokane Co.:** 21 Jun 1889, *W. Suksdorf s.n.* (P); *W. Suksdorf 949* (P).

Trisetum Pers., Syn. Pl. 1:97. 1805. *Trisetarium* Poir., Encycl. Suppl. 5: 365. 1817, *nom. superfl.*, *Rebentischia* Opiz, Lotos 4:104. 1854, *nom. superfl.*, non P.A. Karsten 1869. TYPE: *Trisetum flavescens* (L.) P. Beauv., Ess. Agrostogr. 88, 153, t. 18, f. 1. 1812.

Acrospelion Besser ex Schult. & Schult. f., Syst. Veg. Mant. 3:526, 1827. LECTOTYPE (designated by L.K.G. Pfeiffer, Nom. 1:38. 8 Dec. 1781.): *Avena distichophylla* Vill. [= *Trisetum distichophyllum* (Vill.) P. Beauv.]

Rupestrina Prov., Fl. Canad.:689. 1862. TYPE: *Rupestrina pubescens* Prov. [= *Trisetum spicatum* (L.) Richt.].

Perennials and annuals, caespitose, sometimes shortly rhizomatous and/or stoloniferous. Culms 16–120 cm tall, erect to geniculate at base, glabrous or pubescent. Leaf sheaths glabrous or pubescent, longer or shorter than the internodes; blades flat, conduplicate, convolute or involute, soft rarely rigid; ligule membranous. Inflorescence in panicles contracted or open, lax or densely-flowered, spiciform, ovate, or pyramidal; the rachis glabrous, scabrous or pubescent. Spikelets (1-)2- to 4-flowered, short pedicellate; rachilla pubescent or glabrous, usually prolonged beyond the upper floret; disarticulation above the glumes and between the florets; glumes heteromorphic, lanceolate to ovate-lanceolate, equal or unequal, first glume 1-nerved, usually shorter and narrower than the second, second glume 1- or 3-nerved; lemmas lanceolate, (3-)5-(7-) nerved, usually awned dorsally or muticous, with apex and margins hyaline, glabrous or pubescent, slightly keeled and compressed, rarely terete; apex with 2- to 4 apical setae or short awns, bidentate, or 2-toothed; central awn from the upper third, rarely the middle, of the subapical portion of the lemma; awn exerted, geniculate or merely divaricate; callus short pilose; palea not tightly enclosed by the margins of the lemma (gaping), 2-keeled, hyaline, usually shorter than the lemma; stamens 3, anthers 0.5–3 mm long; lodicules 2, membranous, often apically lobed; ovary glabrous or with short and shining trichomes near the apex; endosperm solid or liquid, soft or hard. Caryopses compressed, soft; hilum short, punctiform. Basic chromosome number $x = 7$.

KEY TO SPECIES OF *TRISETUM* IN NORTH AMERICA

1. Plants delicate annuals; known only from a single introduction in Camden, New Jersey _____ **3. T. aureum**
1. Plants perennial; widespread.
 2. Panicles lax, open; glumes shorter than the spikelet (Sect. *Trisetum*).
 3. Ovary and caryopsis hairy near the apex.

4. Awns 3.5–4 mm long, straight, shorter than the lemma; apex of the lemma shortly bidentate; first glumes 4–6 mm long, never rudimentary _____ **7. T. orthochaetum**
4. Awns 6–16 mm long, geniculate, one to three times as long as the lemma; apex of the lemma ending in two setae 0.5–1.5 mm long; first glumes 0.5–5 mm long, sometimes rudimentary.
5. Panicles few-flowered, loose; branches capillary, the lower ones usually naked on the lower third; leaf blades glabrous _____ **4a. T. cernuum** subsp. **cernuum**
5. Panicles densely-flowered, narrow; branches closely appressed, the lower ones with spikelets to near base; leaf blades canescent to sparsely pilose _____ **4b. T. cernuum** subsp. **canescens**
3. Ovary and caryopsis glabrous near the apex
6. Spikelets 2–4-flowered; panicles usually gold-yellowish, somewhat contracted; spikelets 5–9 mm long; lemmatal awns 5–9 mm long; anthers 2–3 mm long.
7. Lemmas only dorsally scabrous _____ **9. T. sibiricum**
7. Lemmas uniformly scabrous _____ **5. T. flavescens**
6. Spikelets 2- or 3-flowered; panicles green sometimes tinged with purple, loose; spikelets 4.5–6 mm long; lemmatal awns 3.5–4 mm long; anthers 0.8–1.2 mm long _____ **6. T. montanum**
2. Panicles contracted, spiciform to narrow but always densely-flowered; glumes only a little shorter than the spikelet (Sect. *Trisetraera*, in part).
8. Panicles 2.5–7(–10) cm long, densely spiciform _____ **10. T. spicatum**
8. Panicles 8–23 cm long, open, loose, few-flowered to spiciform and interrupted with short ascending branches.
9. Lemmatal awns 7–12 mm long, weakly twisted, geniculate; ligules about 2.5 mm long, glabrous or scabrous dorsally; ovary hairy near apex _____ **4b. T. cernuum** subsp. **canescens**
9. Lemmatal awns about 5.5 mm long, not twisted or geniculate, diversely curved; ligules 0.35–1.5 mm long, densely pilose dorsally; ovary glabrous _____ **8. T. projectum**

3. *Trisetum aureum* (Ten.) Ten., Fl. Napol. 2:378. 1820. *Koeleria aurea* Ten., Tratt. Fitogn. 1:58. 1806. *Trisetaria aurea* (Ten.) Pignatti, Arch. Bot. (Forlì) 31: 51. 1955. TYPE: (HOLOTYPE: NAP?).

Delicate annuals, caespitose; culms 18–30 cm tall, erect, spreading or geniculate at base, glabrous. Leaf sheaths glabrous or pubescent, shorter than the internodes; ligule 0.8–1.3 mm long, hyaline, apex obtuse, margins decurrent; blades 2–8 cm long, 1.2–3 mm wide, glabrous to pubescent, the hairs less than 0.2 mm long. Panicles 1–5 × 0.8–3 cm, pyramidal to ovoid, contracted, densely flowered, often lobed, shining yellowish or light brownish; branches 0.6–3 cm long, closely appressed and ascending, naked below; rachis glabrous. Spikelets 2.6–3.3 mm long, 2- or 3-flowered; pedicels 0.2–1.6 mm long; rachilla 0.6–1.5 mm long, covered with stiff hairs, the hairs 0.3–1.2 mm long; glumes unequal, the second glume longer than the spikelet, scaberulous on the keel; first glume 2.1–2.6 mm long, linear-lanceolate, shorter and narrower than the second glume, 1-nerved, apex acuminate; second glume 2.8–3.3 mm long, ovate-lanceolate, 1- or

3-nerved, apex acute; lemmas 1.8–3 mm long, glabrous or scattered pilose, rarely scaberulous, ovate, hyaline, the apex bidentate with two setae 0.1–0.3 mm long; awn 1.3–3.5(–6) mm long, slightly bent, scaberulous, borne just above the middle; callus obtuse, mostly glabrous; paleas 1.5–2.8 mm long, shorter than the lemma, hyaline, 2-nerved, the apex bidentate with two teeth 0.2–0.4 mm long; anthers 1.2–1.6 mm long; ovary with a few short hairs near the apex. Caryopsis not seen.

Distribution.—*Trisetum aureum* is introduced in North America and occurs natively in the Mediterranean Region of Europe in Greece, Italy, Jugoslavia, and Sicilia.

Comments.—We are not in a position to critically evaluate the generic status of the assemblage of approximately 15 species that are sometimes segregated as *Trisetaria* Forssk. (sensu Clayton & Renvoize 1986). This taxon is treated as *Trisetum aureum* in the Flora of France by Kerguelen (1999) and as *Trisetaria aurea* by Doğan (1985) in the Flora of Turkey.

Specimens examined. **U.S.A. New Jersey:** Camden, ballast, *I.C. Martindale* s.n. (US).

4a. *Trisetum cernuum* Trin. subsp. *cernuum*, *Mém. Acad. Imp. Sci. St.-Petersbourg*, Sér. 6, Sci. Math. 1:61. 1830. *Avena cernua* (Trin.) Kunth, *Rev. Gen.* 1, suppl. 26, 1833. TYPE: U.S.A. ALASKA: Sitka, 1826, *J.F.G. von Eschscholtz* s.n. (HOLOTYPE: LE-TRIN 1889-01!; ISOTYPES: BAA-3366!, NY-232366!, P!, US-81779 fragm. ex LE-TRIN!).

Avena nutkaensis J.Presl, *Reliq. Haenk.* 1(4–5):254. 1830. *Trisetum nutkaensis* (J.Presl) Scribner & Merr. ex Davy, *Univ. Calif. Publ. Bot.* 1:63. 1902. TYPE: CANADA. BRITISH COLUMBIA: Vancouver Island, Nootka, *T. Haenke* s.n. (ISOTYPES: LE-TRIN-1929.01!; US- 865598 fragm.).

Trisetum sandbergii Beal, *Grasses N. Amer.* 2:378. 1896. *Trisetum cernuum* var. *sandbergii* (Beal) Louis-Marie, *Rhodora* 30:214. 1928. TYPE: U.S.A. WASHINGTON: Mt. Stuart, 7000–8000 ft, *Sandberg & Leiberg* 823 (HOLOTYPE: MSC?; ISOTYPES, NY-431712!, GH, WS).

Trisetum cernuum var. *luxurians* Louis-Marie, *Rhodora* 30:213. 1928. TYPE: U.S.A. OREGON: Seaside, 11 Aug 1899, *C.L. Shear & F.L. Scribner* 1705 (HOLOTYPE: US-867917!).

Trisetum cernuum fo. *pubescens* Louis-Marie, *Rhodora* 30:213. 1928. *Trisetum cernuum* fo. *pubescens* G. Jones, *Univ. Wash. Publ. Biol.* 5:108. 1936, hom. illeg. superfl. TYPE: U.S.A. CALIFORNIA: Humboldt Co.: Eureka, 30 May 1920. *Anonymous* s.n. (HOLOTYPE: UC-212883).

Perennials, with stolons and rhizomes. Culms 35–85 cm tall, glabrous, sometimes geniculate, with 2–4 nodes. Leaf sheaths longer or shorter than the internodes, glabrous or rarely pilose; ligules 1.3–7 mm long, membranous, longer in the upper leaves, oval, fimbriate, ciliate at the apex, glabrous or pilose dorsally; blades 100–220 × 3.5–12 mm, flat, soft, glabrous or sparsely pubescent on the adaxially. Panicles 6–30 × 2–5 cm, lax, open, loose, few-flowered, green or purplish; branches capillary, the lower ones usually naked on lower third; rachis glabrous. Spikelets 4.5–12 × 2–4 mm, 2- or 3-flowered, not overlapping; pedicels 1–4.5 mm long, capillary, flexuous, glabrous or scabrous; rachilla 1.5–2 mm long, covered with stiff hairs, the hairs 1–2 mm long; glumes shorter than the spikelet, very unequal to subequal in length and very unequal in width; first glumes 0.5–5 × 0.1–0.5 mm, linear-lanceolate, attenuate, 1-nerved, sometimes rudimen-

tary, narrower than the second glume, the margins hyaline; second glumes 3–7.5 × 0.5–1 mm, oval-lanceolate, 3-nerved; first florets 5–8.5 × 0.7–1 mm; lemma linear-lanceolate, glabrous, scabrous towards the apex, sometimes tinged with purple; apex with two setae 0.5–1.5 mm long; awns 6–16 mm long, curved, not twisted nor geniculate, scabrous, borne on the upper third at 2–2.5 mm below the apex; callus obtuse, hairy, the hairs 0.2–0.7 mm long; paleas 4–5.7 mm long, shorter than the lemma, hyaline, 2-nerved, the nerves scabrous; apex bidentate; lodicules 0.7–0.8 mm long, bilobulate at the apex; anthers 0.5–1.5 mm long; ovary with short, curved and shining hairs near the apex; ovary hairy near the apex. Caryopses 3.5–5 × 1 mm, hairy at the apex; endosperm semi-liquid.

Anatomy and micromorphology.—Ligule apices composed of hairs and papillate cells; ligule epidermis composed of rectangular long cells, rarely fusiforms, with straight walls; short cells present; prickle hairs present; stomata absent; blades in transverse section flat, keeled; adaxial side with rounded ribs; furrows less than one half the leaf thickness; sclerenchyma as adaxial and abaxial I-shaped girders in the first and second order vascular bundles; marginal sclerenchyma present; bulliform cells in fan-shaped groups between vascular bundles; abaxial leaf epidermis composed of fusiform to hexagonal long cells, with straight side walls; short cells present in intercostal zones; prickle hairs absent to very few, often limited to the costal zones; macrohairs absent; stomata in 0–2 intercostal rows.

Distribution.—*Trisetum cernuum* subsp. *cernuum* is found in North America and southern South America (southern Chile and Argentina, from 38°S to 55°S south of the Strait of Magellan). In North America it is found in southern Alaska (Chicagof Islands, Yakutat Bay, 59°32'N, 139°37'W), Canada (Alberta, British Columbia) and the continental United States (Washington, Oregon, Idaho, Montana and northern California, 36°N).

Specimens examined. **CANADA. Alberta:** 10 mi SW of Pincher Creek, 9 Aug 1950, *W.G. Dore* 12479 (US); Waterton Lakes National Park, 5500 ft, 20 Aug 1939, *Mosg* 555 (US); Waterton Lakes National Park, Spruce trail to Carthew Pass, 5500 ft, E shore of Cameron Lake, 1 Aug 1956, *Hermann* 13048 (US); moist coniferous woods near Cameron Lake, 5450 ft, 26 Jul 1953, *Breitung* 16778 (US). **British Columbia:** Mainland opposite Kaien Island, 19 Jun 1937, *McLake* 4329 (US); Mts. near Ainsworth, Kootenay Lake, 2800 ft, 7 Jul 1890, *Macoun* 107 (US); Mt. Revelstoke Road, 3 mi NE Revelstoke, 22 Jul 1956, *Hermann* 12914 (US); Stikine Glacier, 8 Aug 1916, *Cooper* 16 (US); Galloway Rapids a few miles S of Prince Rupert, 18 Jul 1954, *Calder, Saville & Ferguson* 13166 (US); Maroon Mountain Trail, 54°48'24.1"N, 128°44'01.8"W, 600–1600 m, 23 Jul 2004, *Peterson, Saarela & Smith* 18723 (US); Cypress Provincial Park, N of Vancouver, 49°23'37.3"N, 123°11'43.9"W, 896 m, 29 Jul 2004, *Peterson & Saarela* 18754 (US); Vancouver Island, vicinity of Ucleulet, 13 Jul 1909, *Macoun* s.n. (US); vicinity of Namaimo, 23 Jun 1908, *Macoun* s.n. (US); Vancouver Island, *Macoun* 28 (US); Jun–Jul 1901, *Rosendahl & Brand* 129 (US); Queen Charlotte Islands, Skidigate, 29 Jul 1910, *Spreadborough* s.n. (US). **U.S.A. Alaska:** Sitka, 16 Jul 1905, *Piper* 4649 (US); 22 Jun 1909, *Hitchcock* 4042 (US); Chichagof Island, Hoonah, 15 Jul 1932, *Norberg* 211 (US); Yes Bay, 9 Jul 1895, *Howell* 1716 (US); Alaska, 25 Jul 1899, *Coville & Kearney* 2512 (US); Yakutat, 2 Sep 1904, *Piper* 4650 (US); Lituya Bay, 10 ft, 20 Jun 1932, *Taylor* T-119 (US); Juneau, 25

Jun 1909, *Hitchcock* 4065 (US); Cordova, 1-3 Jul 1909, *Hitchcock* 4121 (US). **California:** *Bolander* 29 (P); 1870, *Bolander* 4 (P). **Humboldt Co.:** Eureka, 22 May 1900, *Tracy* 800 (US); Open woods, E shore of Fallen Leaf Lake, Mt. Tallac, Lake Tahoe, 7000-9500 ft, 6-8 Aug 1908, *Hitchcock* 3161 (US); Mts. about the head waters of the Sacramento River, 7500 ft, 1 Sep 1882, *Pringle* 509 (US); Sequoia National Park and Sierra National Forest, near spring, S of Alta Meadow, 3 Aug-9 Sep 1908, *Hitchcock* 3359 (US). **Siskiyou Co.:** S of Happy Camp, wooded banks of Swillup Creek at point of junction with Klamath River, 1 Jun 1942, *Bectle & Stebbins Jr.* 3450 (US); **Mendocino Co.:** near Mendocino, 0-500 ft, May 1898, *Brown* 764 (US). **Humboldt Co.:** Northern Coast Ranges of California, Eureka, in woods, 200 ft, 30 May 1920, *Tracy* 5335 (US); Humboldt Bay, 100 ft, May 1901, *Chandler* 1176 (US); Spruce Cove, Trinidad, 200 ft, n.d., *H.E. & S.T. Parks* 7551 (US); Redwood forest, 5 mi N of Oriskany on US Hwy 101, 26 May 1941, *Stebbins Jr. & Church* 3107 (US); Bald Mountain, between High Prairie and Snow Camp, 3500 ft, 5 Jul 1914, *Tracy* 4546 (US). **Idaho: Nez Perce Co.:** Nez Perce National Forest, Poet Creek Campground and vicinity, 5000 ft, 22 Jul 1988, *Peterson* 4794 (US); just N of Idaho boundary, 21 Jun 1938, *Eastham* 39 (US); Moist meadows, Jun 1892, *Sandberg* 369 (US); Lolo trail and junction of White Sandy Creek with Lochsa Fork of Clearwater River, 25-29 Jul 1908, *Chase* 5163 (US); Coeur D'Alene Range of the Bitterroot Mountains, 2728-4000 ft, *Chase* 5003 (US); between Burke & Upper Glidden Lake, 20 Jul 1908, *Chase* 5062 (US). **Montana:** MacDonald Creek, Little Kootenai, Glacier National Park, 8 Jul 1914, *Hitchcock* 12274 (US), *Hitchcock* 1447 (P); moist ditch, edge of forest, 7 Jul 1940, *Swallen* 6466 (US). **Missoula Co.:** Lolo Hot Springs, 3900-4000 ft, 23-24 Jul 1908, *Chase* 5080 (US). **Oregon:** 1880, *Howell* s.n. (US); 1881, *Howell* 79 (US); western Oregon, small mountains streams, Jun 1880, *Howell* s.n. (P); Seaside, 11 Aug 1899, *Shear* 1785 (P). **Siskiyou Co.:** S of Happy Camp Wooded banks of Swillup Creek at junction with Klamath River, 1 Jun 1942, *Bectle & Stebbins Jr.* s.n. (US); moist woods, 24 Oct 1881, *Pringle* 130 (US); Dales Blue Mts., Jul 1902, *Griffiths & Hunter* 128 (US). **Coos Co.:** wooded hillside, 16-18 Jul 1908, *Hitchcock* 2807 (US); Gearhart, *Hitchcock* s.n. (US); border of damp coniferous woods, small tufts, 25-50 ft, 1-2 Jul 1908, *Chase* 4904 (US); Gearhart to Tillamook Head, west moist side of hill, 25-50 ft, 1-2 Jul 1908, *Chase* 4920 (US); Cascade Mts., 4000 ft, Jul 1887, *Cusick* 6 (US); Jun-Aug 1881, *Howell* 869 (US); Camas Prairie, shady places, 9 Jul 1902, *Griffiths & Hunter* 53 (US); Jacksonville, 8 Jun 1904, *Hunter* 542 (US); Mountain stream banks, 1900, *Cusick* 2426 (P). **Washington:** 1889, *Piper* 846 (US); Cascade Mts., 1889, *Vasey* s.n. (US); upper valley of the Nesqually, 8 Sep 1893, *Allen* 42 (US); Seattle, May 1890, *Piper* s.n. (US). **Klickitat Co.:** Bingen, 5 Jun 1919, *Suksdorf* 10226 (US); open woods, Jun 1885, *Suksdorf* s.n. (P). **St. Chelan Co.:** along Peshastin Creek below Blewett, 2000 ft, 25 Jun 1932, *Thompson* 8582 (US). **Chehalis Co.:** near Montesano, 200 ft, 7 Jun 1898, *A.A. & E.G. Heller* 3904 (US). **Clallam Co.:** Olympic Mts., Jun 1900, *Elmer* 1946 (US).

KEY TO SUBSPECIES OF *TRisetum CERNUM*

1. Panicles few-flowered, loose; branches capillary, the lower ones usually naked on the lower third; leaf blades glabrous _____ **4a. *T. cernuum*** subsp. ***cernuum***
1. Panicles densely-flowered, narrow; branches closely appressed, the lower ones with spikelets to near base; leaf blades canescent to sparsely pilose _____ **4b. *T. cernuum*** subsp. ***canescens***

4b. *Trisetum cernuum* subsp. ***canescens*** (Buckley) Calder & R.L. Taylor, *Canad. J. Bot.* 43:1389. 1965. *Trisetum canescens* Buckley, *Proc. Acad. Nat. Sci. Philadelphia* 1862:100. 1862. *Trisetum elatum* Nutt. ex A. Gray, *Proc. Acad. Nat. Sci. Philadelphia* 14:337. 1862, *nom. inval.* *Trisetum cernuum* var. *canescens* (Buckley) Beal, *Grass. N. Amer.* 2:380. 1896. *Helictotrichon canescens* (Buckley) Clayton, *Kew Bull.* 40:728. 1985. TYPE: U.S.A. OREGON: Columbia Plains, *T. Nuttall* s.n. (HOLOTYPE: PH).

Trisetum canescens fo. *tonsum* Louis-Marie, *Rhodora* 30:216. 1928. TYPE: U.S.A. CALIFORNIA: Trinidad Co.: Buckeye Mt., 15 Jul 1914, *H.S. Yates* 522 (HOLOTYPE: UC; ISOTYPE: US-893773).

Trisetum canescens fo. *velutinum* Louis-Marie, Rhodora 30:216. 1928. TYPE: U.S.A. CALIFORNIA: Lassen's Peak, Jul 1879, R.M. Austin s.n. (HOLOTYPE: GH).

Perennials. Culms 40–120 cm tall, glabrous, nodes 3. Leaf sheaths pubescent or upper portions glabrous; ligules about 2.5 mm long, dentate, glabrous or scabrous dorsally; blades 45–300 × 2–8 mm, flat, scabrous or canescent, sometimes sparsely pilose and ciliate on the margins. Panicles 8–23 × 1–3 cm, contracted, narrow, densely-flowered; rachis scaberulous; branches closely appressed, the lower ones with spikelets to near base. Spikelets 7.5–9 mm long, 2- or 3-flowered; pedicels scaberulous; rachilla 1.5–2 mm long, covered with stiff hairs, the hairs 1.5–2 mm long; glumes shorter than the spikelet, unequal, green or tinged with purple; first glumes 3.2–6 × 0.2–0.4 mm, linear-lanceolate, subulate, usually × as long as than the second glume, narrower than second, 1-nerved; second glumes 4.5–7 × 0.8–1 mm, oval to oval-lanceolate, 3-nerved; first floret 5–9 mm long; lemma glabrous, minutely scabrous towards the apex, with the margins and apex hyaline; apex 2-awned, the apical awns 0.7 mm long; awns 7–12 mm long, weakly twisted, geniculate, borne on the dorsal upper third, at 2–3 mm from the apex; callus pilose, the hairs 0.5–1 mm long, rachilla 1.7–3 mm long, pilose; paleas about 6.5 mm long, 2-nerved, the nerves scabrous; anthers 1.2–1.8 mm long; ovary hairy near the apex. Caryopses hairy at the apex.

Anatomy and micromorphology.—Ligule apices truncate, minutely dentate with hairs and papillate cells, the epidermis is composed of rectangular to fusiform long cells, with straight side walls; short cells present; dorsal surface of the ligule densely covered with hooks; macrohairs absent; blades V-shaped in transverse section, symmetric, slightly keeled; bulliform cells in fan-shaped groups; adaxial side with rounded ribs and furrows less than one half of the blade thickness; vascular bundles with adaxial and abaxial I-shaped girders; marginal sclerenchyma not well developed; abaxial epidermis with fusiform long cells and straight side walls; short cells on the costal zones with rectangular and sinuose side walls; stomata in two rows near the costal zones; hooks present; macrohairs present only on the adaxial epidermis.

Distribution.—Western Canada and United States. It reaches its boreal distribution at Vancouver (50° 55'N) and its austral distribution in California, U.S.A. (34°N). In the United States it is found in the states of Washington, Montana, Oregon, Idaho, Nevada, Utah, Arizona, and California, primarily between 47° N in Washington St. and 34° N in California.

Comments.—Clayton (1985) transferred *T. canescens* to *Helictotrichon*, probably because of the presence of hairs at the apex of the ovary. This character, however, is also present in the following species of *Trisetum*: *T. ambiguum* Rúgolo & Nicora, *T. cernuum* subsp. *cernuum*, *T. caudulatum* var. *corraeae* Nicora, *T. durangense*, and *T. longiglume* Hack. var. *longiglume*. All other characters in *Trisetum cernuum* subsp. *canescens* (hilum punctiform, lodicules apically lobed) distinguish it from *Helictotrichon* (hilum linear, lodicules acute at the apex).

The strong affinity between *T. cernuum* and *T. canescens* was first noticed by Beal (1896), who subordinated *T. canescens* to *T. cernuum* with the varietal rank. Louis-Marie (1928-29) did not accept Beal's treatment and suggested *T. canescens* was allied with *T. flavescens* rather than with *T. cernuum*. Nevertheless, *T. flavescens* has glabrous ovaries and caryopses whereas *T. cernuum* subsp. *cernuum* and *T. cernuum* subsp. *canescens* both have short hairs near the apex of the ovaries and caryopses.

Specimens examined. **CANADA. British Columbia:** Kaslo, Kootenay, 27 Jun 1914, *McHenry* 9130 (US); 15 May 1889, *Macoun* 42 (US); Vancouver Island, 27 Jun 1887, *Macoun* 141 (US); Vicinity of Victoria, 2 Jul 1908, *Macoun* 80985 (US); on damp soil, 13 Jun 1887, *Macoun* 50 (US); Vicinity of Victoria, 18 Jun 1908, *Macoun* s.n. (US). **U.S.A. California:** San Francisco, *Bolander* s.n. (US); Santa Cruz, 1887, *Ander-son* s.n. (US). **San Bernardino Co.:** San Bernardino Mts., 21 Jul 1902, *Abrams* 2772 (P); Mts. near head waters of the Sacramento River, 7500 ft. 1 Sep 1882, *Pringle* s.n. (P). **Butte Co.:** Jonesville, 1600 m, 21 Jul 1932, *Copeland* s.n. (CONC). **Inyo Co.:** Pine Creek, Sierra Nevada, near Round Valley, 8000 ft, 10 Jul 1932, *Duran* 3333 (CONC). **Santa Clara Co.:** Congress Springs, shady ravine, 22 Jun 1908, *Hitchcock* 2645 (US); Yosemite National Park, 17-25 Aug 1908, *Hitchcock* 3347 (US); Angel Island, 13 Apr 1901, *Davy* 6899 (US). **Marin Co.:** Mt. Tamalpais, 26 Apr 1893, *Davy* 139 (US); Point Reyes Peninsula, Jun-Jul 1900, *Davy* 6779 (US). **Trinity Co.:** Head of Rush Creek, 20 Jul 1914, *Yates* 536 (US); Davis Creek, 5 Jul 1894, *Davy* s.n. (US). **Humboldt Co.:** Eureka, Samoa, open woods, fixed dunes, 13 Jul 1915, *Hitchcock* 13078 (US). **Syskiyou Co.:** South Fork of Shasta River, Mount Eddy, Shasta Forest, 11-12 Aug 1915, *Eggleston* 11636 (US); Dry soil, pine and cedar woods, 10 Jul 1927, *Swallen* 727 (US); Buck's Ranch, 5000 ft, 13 Jul 1900, *Leiberg* 5124 (US); Near seashore in unprotected places, 1860-67 Geological Survey of California, *Bolander* 6077 (US). **Idaho:** Moscow Mts., moist slope, edge of woods, 8 Jun 1940, *Swallen* 6016 (US); Coeur D'Alene Mts., 950 m, 1 Jul 1895, *Leiberg* 1132 (US). **Latah Co.:** in open woods, 6 Jul 1894, *Piper* 1924 (US). **Montana:** Belton, Rocky woods, 2 Jul 1914, *Hitchcock* 1446 (P), *Hitchcock* 11222 (US); E Fork of Bitterroot River, 4-5 Aug 1908, *Chase* 5208 (US). **Missoula Co.:** Granite Creek drainage, ca. 3.1 air mi SW of Lolo Hot Springs, 4480 ft, 18 Jul 1986, *Shelly & King* 1229 (US); Bitterroot Mts., shaded place in pine woods, 23-24 Jul 1908, 3900-4000 ft, *Chase* 5196 (US); Glacier National Park, damp woods, McDonald Creek, Little Kootenai, 6000 ft, 8 Jul 1914, *Hitchcock* 11264 (US); Columbia Falls, moist places in dry woods, 17 Sep 1909, *Hitchcock* 4946 (US). **Flathead Co.:** 1 3/4 mi NE of Rogers Ranch, Douglas fir-lodgepole pine slope above Camas Creek, 4000 ft, 5 Sep 1955, *Hermann* 12460 (US); Columbia Falls, 1892, *Williams* 958 (US). **Nevada. Amador Co.:** 18 Jun 1896, *Hansen* 1748 (P). 25 Jun 1896, *Hansen* 1763 (P). 30 Jun 1896, *Hansen* 2088 (P). **Oregon:** Sauvie's Island, May 1886, *Howell* s.n. (P); Willamette Slough, 31 May 1881, *Howell* s.n. (P); Crater Lake, 25 Aug 1902, *Cusick* 2976 (P); Columbia River, Bridal Veil to Multnomah Falls, 46-100 ft, 27-28 Jun 1908, *Chase* 4840 (US). **Klamath Co.:** moist ground in pine woods, 4 Jun 1904, *Applegate* 3151 (US); Portland, 6 Jul 1902, *Sheldon* 9.10811 (US); Siskiyou, 21 Jul 1908, *Hitchcock* 2925 (US). **Douglas Co.:** exposed rocky summit of Harshberger Mt., 6200 ft, 13 mi NW Union Creek, 29 Jul 1955, *Hermann* 119779 (US); Hood River, 1 Jul 1908, *Hitchcock* 2757 (US); Sheep Ranch between Remote and Camas Valley, 19 Jul 1908, *Hitchcock* 2859 (US); Fort Klamath, low ground, open woods, 29 Jul 1908, *Hitchcock* 3005 (US); Camas Prairie, 1 Jul 1902, *Griffiths & Hunter* 52 (US). **Utah: Salt Lake Co.:** Salt Lake City, Red Butte Canyon, 21 Jul 1909, *Piper* 1906 (US). **Washington: Clallam Co.:** Olympic Mts., Aug 1900, *Elmer* 1944 (P, US); Head of Mainen Creek, Olympic National Forest, 5500 ft, 20 Jun 1934, *Cliff* 106 (US); Olympic Mts., Aug 1900, *Elmer* 1945 (P); Washington, 1898, A.A. & E.G. *Heller* 3931b (P). **Grays Harbor Co.:** Montesano, 200 ft, 11 Jun 1898, A.A. & E.G. *Heller* 3931 (P, US); Columbia River, 17 Jun 1883, *Suksdorf* s.n. (P); Washington Territory, 1883, *Suksdorf* 57 (US). **Klickitat Co.:** dry grounds, Columbia River, 17 Jun 1883, *Suksdorf* 611 or 967 (US); Swamp near Seattle, 20 May 1890, *Talcott* s.n. (US); 1883, *Vasey* 30 (US); 1889, *Vasey* s.n. (US); Cascade Mts., 1889, *Vasey* s.n. (US); 1889, *Suksdorf* 1104 (US). **Klickitat Co.:** Bingen, 5 Jun 1919,

Suksdorf 10221 (US); Seattle, 12 Jun 1891, *Piper s.n.* (US); Blue Mountains, 23 Jun 1897, *Horner 540* (US); Browns Island, Friday Harbor, 28 Jun 1909, *Beattie 3334* (US); Dry point, SE of Friday Harbor, 22 Jun 1909, *Beattie 3319* (US); 1883, *Vasey 19* (US); 1883, *Suksdorf 58* (US); Mt. Baker, rocky slope on upper pass of Church Mt. Glacier, 11–12 Aug 1914, *Hitchcock 11633* (US). **Klickitat Co.:** Mt. Stuart, Aug 1898, *Elmer 1143* (P, US); Blue Mountains, 17 Jul 1897, *Horner 654* (US); Blue Mts., near Walla Walla, 29 Jun 1899, *Shear 1612* (US); Seattle, Jun 1890, *Piper s.n.* (US), 1889, *Piper 845* (US). **Chelan Co.:** moist creek bottoms near Leavenworth, 16 Jun 1931, *Thompson 6752* (US). **Spokane Co.:** east of Rockford, pine woods along road, 20 Jun 1940, *Swallen 6242* (US). **Ferry Co.:** moist banks of Barnaby Creek at its confluence with the Columbia River, 1290 ft, 30 May 1940, *Rogers 573* (US). **Kitsap Co.:** Port Orchard, 29 May 1938, *Eyerdam 1524* (US). **Chelan Co.:** yellow pine slopes of Tip Top, 4000 ft, *Thompson 10785* (US). **Whitman Co.:** near Pullman, *Swallen 6242c* (US); Ashford, wood border, 7–11 Jul 1908, *Chase 4947* (US); Eastern Washington, 13 Jun 1902, *Griffiths & Cotton 238* (US). **Walla Walla Co.:** Blue Mts., 29 Jun 1899, *Shear 1600* (US); 22 Jun 1895, *Cloud s.n.* (US); low ground, 21 Jun 1897, *Suksdorf 2665* (US).

5. *Trisetum flavescens* (L.) P. Beauv., Ess. Agrostogr. 88, 153, t. 18, f.1, 1812. *Avena flavescens* L., Sp. Pl. 80. 1753. *Trisetaria flavescens* (L.) Baumg., Enum. Stirp. Transsilv. 3:263. 1816. *Rebentischia flavescens* (L.) Opiz, Lotos 4:104. 1854, *nom. inval.* *Trisetaria flavescens* (L.) Marie, Bull. Soc. Hist. Nat. Afrique N. 33(4):92. 1942, *nom. illeg. hom.* TYPE: *Herb. A. Van Royen no. 913.7-458* (LECTOTYPE: LINN-97.14, designated by Cope in Cafferty et al., Taxon 49:247. 2000).

Trisetum pratense Pers., Syn. Pl. 1:97. 1805. *Trisetum flavescens* subsp. *pratense* (Pers.) Asch. & Graebn., Syn. Mitteleur. Fl. 2:265. 1899. TYPE: Europe.

Perennials. Culms (20–)80–110 cm tall, glabrous, with 2–5 nodes. Leaf sheaths shorter than the internodes, glabrous or the lower ones sparsely pilose; ligules 0.5–2 mm long, minutely dentate, ciliate, glabrous dorsally, truncate; blades (3–) 100–160 × 2–4 mm, flat, glabrous abaxially, scabrous and sparsely pilose adaxially. Panicles 5–18 × 2–8 cm, lax, open or contracted, golden-yellow, bright. Spikelets 5–7(–8.5) mm long, (1–)2–3(–4)-flowered; rachilla about 1.2 mm long, pilose, the hairs 1–1.5 mm long; glumes shorter than the spikelet, unequal, bright, scabrous on the keel; first glumes 2–4 × 0.1–0.2 mm, linear-lanceolate, subulate, usually about one half of the length of the adjacent floret, 1-nerved; second glumes 4–6.6 × 1 mm, oval-lanceolate, 3-nerved, covering about two thirds of the adjacent floret, rarely as long as the spikelet; lemmas 4–6 mm long, scabrous; apex 2-dentate and 2-awned, awned dorsally on the upper 1/3–1/4; dorsal awns 5–9 mm long, geniculate and twisted; callus with short hairs, the hairs about 0.5 mm long; palea shorter than the lemma, hyaline, 2-nerved, the nerves scabrous; apex 2-dentate or 2-setulate; ovary glabrous; anthers 2–3 mm long. Caryopses 2–3 mm long, compressed, glabrous; endosperm liquid.

Anatomy and micromorphology.—Ligule apices composed mostly of hairs, papillate cells only rarely present (Chaffey 1994); blades in transverse section flat, symmetric, without a well developed keel; adaxial side with wide, low ribs; furrows as wide as the adjacent ribs, less than one half of the leaf thickness; first order vascular bundles with adaxial and abaxial girders; smaller bundles with adaxial and abaxial sclerenchymatic strands; marginal sclerenchyma very small; bulliform cells in fan-shaped groups of 5–7 cells situated at the bases of the furrows; abaxial epidermis with the intercostal zone composed of rectan-

gular to slightly fusiform long cells, with side walls slightly undulate; stomata in two rows in each intercostal zone; prickles present; macrohairs absent; costal zones with short cells in silico-suberose couples and long cells shorter and narrower than the long intercostal cells.

Distribution.—Canada and the United States. Native to Europe, *T. flavescens* was introduced in North and South America (Argentina, Chile). This species has been reported in California, Kansas, Massachusetts, Mississippi, Missouri, New Jersey, New York, Oklahoma, Vermont, and Washington (Kartesz 1998).

Specimens examined. **CANADA. Yukon:** Arctic Coast west of Mackenzie River Delta, 69°12'N, 138°30'W, 23–25 Jul 1938, *Porsild* 7122 (S). **U.S.A. California: Humboldt Co.:** edge of field at Blue Lake, 12 Jul 1911, *Tracy* 3527 (US). **Missouri:** Introduced along railroad at Coutney, 6 Jun 1891, *Bush* s.n. (US). **Vermont:** Charlotte, *Pringle* 242 (US), Jun 1978, *Hosford* s.n. (US). **Washington:** Walla Walla, seed farm, 31 May 1900, *Leckenby* 19a (US).

6. *Trisetum montanum* Vasey, Bull. Torrey Bot. Club 13:118. 1886. *Trisetum canescens* unranked *montanum* (Vasey) Hitchc., Proc. Biol. Soc. Wash. 41:160. 1928. *Trisetum spicatum* subsp. *montanum* (Vasey) W.A. Weber, Phytologia 33(2):106. 1976. TYPE: U.S.A. NEW MÉXICO: San Miguel Co.: Las Vegas, Jul 1881, *G.R. Vasey* s.n. (ISOTYPES: NY-232365f, NY-232368f, NY-232369f, US-81777f, US-156883f, US-868271f).

Trisetum argenteum Scribn., Bull. Div. Agrostol., U.S.D.A. 11:49–50, f. 8. 1898, nom. illeg. hom. *Trisetum shearii* Scribn., Cir. Div. Agrostol. U.S.D.A. 30:8. 1901. *Grappheporum shearii* (Scribn.) Rydb., Bull. Torrey Bot. Club 32(11):602. 1905. *Trisetum montanum* Vasey var. *shearii* (Scribn.) Louis-Marie, Rhodora 30: 213. 1928. TYPE: U.S.A. COLORADO: below Silverton, among rocks, Las Animas Canyon, 2700 m, 4 Aug 1897, *C.L. Shear* 1214 (HOLOTYPE: US-747299f; ISOTYPES: US-747298f, US-747300f, US-868267f).

Trisetum montanum var. *pilosum* Louis-Marie, Rhodora 30:212. 1928. TYPE: U.S.A. New México: San Miguel Co.: near Cowels, 8200 ft, 26 Jul 1908, *Standley* 4536 (HOLOTYPE: GH; ISOTYPES: US fragm. ex GHf, S).

Perennials. Culms 50–70 cm. tall, glabrous. Leaf sheaths shorter than the internodes, glabrous or pilose; ligules about 3 mm long, truncate, dentate, glabrous dorsally; blades 100–150 × 3–10 mm, flat, glabrous or pilose. Panicles 10–24 cm long, lax, open to more or less contracted; rachis and pedicels scaberulous. Spikelets 4.5–6 mm long, 1–5 cm wide, 2–3(–4)-flowered; pedicels up to 2.5 mm long; rachilla about 0.8 mm, pilose, the hairs less than 0.5 mm long; glumes shorter than the spikelet, unequal, thin, hyaline; first glumes 3–3.5 × 0.4–0.5 mm, linear-lanceolate to lanceolate, about two thirds the length of the second glume, 1-nerved; second glumes 4–4.5 × 0.6–0.8 mm, oval to oval-lanceolate, 3-nerved; lower florets about 4 × 0.6 mm; lemmas glabrous; apex shortly two-awned, hyaline, awned on the upper third or fourth, approximately at 1–1.5 mm below the apex; awns 3.5–4 mm long, scabrous, diversely curved but not strongly twisted nor geniculate; callus with short hairs, the hairs about 0.1 mm long; paleas about 4 mm long, shorter than the lemma, 2-nerved, the nerves scabrous; apex shortly bisetulate; lodicules 0.5–0.8 mm long, apex bilobulate; anthers 0.8–1.2 mm long; ovary glabrous. Caryopses glabrous; endosperm semi-liquid.

Distribution.—Canada and United States. *Trisetum montanum* occurs in Arizona, California, Colorado, Idaho, Montana, New México, Utah, and Wyoming at 7500–11000 ft.

Comments.—This species is related to *T. cernuum*. Beal (1896) mentioned that *T. montanum* has been erroneously interpreted as an opened-panicle form of *T. spicatum*. Hitchcock (1928) considered this species as a variety of *T. canescens*, but later, (Hitchcock 1939, 1950) treated it as a valid species. Hitchcock (1950) distinguished it from *T. canescens* by its smaller culms with shorter and denser panicles, narrower blades, thinner glumes and lemmas, and more delicate awns. It also differs from *T. cernuum* var. *canescens* by having a glabrous ovary.

Specimens examined. **CANADA. Alberta:** Waterton Lakes National Park, 6000–7500 ft, 5 Aug 1950, *Breitung* 14039 (S); 30 Jul 1950, *Breitung* 13955 (S); crevices in argillite bluff, 5600 ft, Bertha Lake trail, W of Waterton Lake, 3 Aug 1956, *Hermann* 13080 (US); Banff National Park, Johnson Valley Trail Head, 51°15'24.6"N, 115°51'26.3"W, 1443 m, 3 Jul 2004, *Peterson, Saarela & Smith* 18397 (US). **Yukon:** 3600 ft, upper Rose River Valley, 17 Jul 1944, *Porsild & Breitung* 10468 (S). **U.S.A. Arizona:** Mt. Graham, 32°48'N, 109°45'W, 9500 ft, 12 Aug 1934, *Kearney & Peebles* 9970 (US). **Apache Co.:** wet, black, loam soil near edge of Milk Creek, aspen, yellow pine, Engelmann spruce association; Milk Canyon, Escudilla Mountain, 8 mi E of Nutrioso; 8500 ft, 24 Aug 1951, *Parker* 7533 & *McClintock* (US). **California:** Yosemite National Park, Tioga Pass, 14 Jul 1926, *Kraus* s.n. (S). **Colorado:** 1892, *Patterson* s.n. (US); 8000–9000 ft, 1875, *Patterson* 26 (US); Rocky Mts., 40–41°S, 1868, *Vasey* 636 (US); Aspen zone, Silverplume Clear Creek Cañon, 10000 ft, 18 Aug 1896, *Holm* s.n. (S); Idaho Springs, shady canyon, 27 Aug 1895, *Shear* 720 (US), 28 Aug 1895, *Rydberg* 2481 (US); Twin Lakes, 1873, *Wolfe* 669 (US); Animas Canyon below Silverton, 9100 ft, open rocky slopes, in moist sandy soil, 4 Aug 1897, *Shear* 1218 (US); Near Pagosa Peak, 11 Aug 1899, *Baker* 95C (US); Ouray, springy ground, above Box Canyon, 30–31 Aug 1906, *Hitchcock* 2229 (US); Around Minnehaha, Pikes Peak, 3 Sep 1906, *Hitchcock* 2330 (US); 2600 m, 13 Aug 1901, *FE & ESClements* 261 (US); Jack Brook, above Minnehaha, lower slopes of Pikes Peak, 8800 ft, 14 Aug 1924, *Bucigalupi* s.n. (US); Castle Canyon, near Minnehaha, 10000 ft, 16 Aug 1913, *Dachkowskii-Stokes* s.n. (US). **Chaffe Co.:** Buena Vista, Cottowood Lake, 7700 ft, 15 Aug 1916, *Shear* 1001 (US). **Clear Creek Co.:** Rocky, wooded slope, Chicago Creek, 9000 ft, 4 Sep 1944, *J.H. Ehlers & L.S. Ehlers* 8297 (US). **Gunnison Co.:** Gothic, road to Judd Falls lookout, 1 Jul 1954, *Wilkens* 10084a (US); Saguache and Hinsdale Cos., Gunnison Basin, damp lodgepole-pine woods, valley of the Slate River, about four mi NW of Crested Butte, 13 Jul 1960, *Burrell* 10260 (US). **Hinsdale Co.:** E facing slope of Wager Gulch, a 1–2 mi S of the road up the Lake Fork and some 6 miles SW of Lake San Cristobal, 10800 ft, 14 Aug 1965, *Barrel & Spongberg* 270a-65 (US); mountains near the head waters of Clear Creek, near Empire, 8500–11000 ft, 6 Sep 1892, *Patterson* s.n. (US); Athens, Rocky Mts., 1862, *Hall* s.n. (US); Pen Gulch, 1884, *Vasey* s.n. (US); Colorado, 1878, *Jones* s.n. (US); South Park, 1873, *Wolf & Rothrock* s.n. (US); Idaho Springs, 28 Aug 1895, *Rydberg* 2481, 2491 (US); Pikes Peak, moist soil, 10000 ft, 24 Jul 1896, *Williams* 2223 (US); Moist soil, in shade along stream, Spanish Peaks, 25 Jul 1928, *Swallen* 1296 (US); Rocky fir wood. Dark Canyon, trail to Cameron's Cone from Calfway, 9000 ft, 28 Aug–3 Sep 1908, *Chase* 5320 (US); Near Pagosa Peak, 9000 ft, Aug 1899, *Baker* 223 (US); Moist woods near Pagosa Peak, 8 Aug 1899, *Baker* 27 (US); Pikes Peak, 14 Jul 1896, *Williams* 2177 (US); Georgetown, 17–20 Aug 1895, *Rydberg* 2394 × (US); Garland, moist shady gulch, 30 Jul 1900, *CL & Wm Shear* 71 (US); Idaho Springs, moist soil, mountain side, 27 Aug 1895, *Shear* 718 (US). **La Plata Co.:** spruce woods near Lewis Creek, 2 mi W of Eagle Pass, La Plata Mountains, 11000 ft, 14 Aug 1936, *Rollins* 1522 (US). **Idaho:** Payette National Forest, 9 mi E of McCall, frequent in loam soil, *Pinus, Pseudotsuga, Larix* forest across stream from Lake Fork campsite, 12 Jul 1953, *Holmgren & Tillet* 9561 (US); **Montana:** Glacier National Park, McDonald Creek and Little Kootenai, 17 Jul 1914, *Hitchcock* 1441 (S). **Madison Co.:** in aspens, Cottonwood Road, Gravelly

Range, 12 Jul 1940, *Swallen* 6509 (US). **New México:** 17–21 Aug. 1915, *Hitchcock* 1445(S); Mts of Las Vegas, 1881, *Vasey* 21 (P); Las Vegas, Jul 1881, *Vasey* s.n. (P); Vicinity of Santa Fe, Sandia Mt., 3200 m, 19 Aug 1926, *Arsène & Benedict* 16376 (P). **Taos Co.:** Rio Pueblo, 8500 ft, 11 Aug 1910, *Wooton* s.n. (US). **San Miguel Co.:** Indian Creek, Santa Fe Forest, 2400 m, 16 Aug 1923, *Eggleston* 19051 (US); Clouderoft, rich soil, open pine woods, 17–21 Aug 1915, *Hitchcock* 13287 (US); Pecos River National Forest, Winsor Creek, 8500 ft, 28 Jul 1908, *Standley* 4576 (US); Sandia Mountains, Las Apuestas Canyon, in woods, 7900 ft, in woods, *Ellis* 40 (US). **Utah:** Wasatch Mt., 2700 m, 4 Sep 1907, *Tidstrom* 482-a (S); Abajo Mts., near Spring Creek, 2700–3000 m, 17–20 Aug 1911, *Rydberg & Garrett* 9825 (US).

7. *Trisetum orthochaetum* Hitchc., *Amer. J. Bot.* 21:134, f. 3. 1934. TYPE: U.S.A. MONTANA: Missoula Co.: Bitterroot Mts., near Lolo Hot Springs, collected in boggy meadow, 23–24 Jul 1908, *A. Chase* 5129 (HOLOTYPE: US-1535753).

Perennials. Culms up to 110 cm tall, glabrous, with 3 nodes, erect. Leaf sheaths glabrous; ligules 1.5–3.4 mm long, truncate, dentate to erose, sparsely ciliate; blades 80–200 × 3–7 mm, flat, scabrous. Panicles 17–19 × 2–3 cm, lax, the branches in distant whorls; rachis glabrous. Spikelets 6.5–9 mm long, 2- or 3-flowered; pedicels 2–4 mm long, scabrous; rachilla 1–1.5 mm long, hairy, the hairs up to 2 mm long; glumes shorter than the spikelet, 1/2–3/4 as long as the spikelet, unequal; first glumes 4–6 × 0.4–0.6 mm, lanceolate, 1-nerved; second glumes 5–6.5 × 1–1.2 mm, oval-lanceolate, 3-nerved; first floret 5–6 mm long, the upper ones 4.5–4.7 mm long; lemma glabrous to slightly scabrous, obscurely 5-nerved; apex bidentate, awned dorsally on the upper third or fourth, about 1.5 mm from the apex; awn 3.5–4 mm long, nearly straight, scabrous, purple; callus obtuse with short hairs, the hairs 0.3–0.4 mm long; paleas 4–5.5 mm long, as long as 3/4 the length of the lemma, hyaline, 2-nerved, the nerves scabrous; anthers 0.8–1 mm long; ovary densely hairy at the apex. Caryopses not seen.

Anatomy.—Leaf blades in transverse section expanded, flat or U-shaped, the keel not well developed; adaxial surface with low ribs, the furrows between them as wide as the ribs; median vascular bundle with sclerenchyma strongly developed towards the keel and adaxial girders I-shaped; first order bundles with adaxial and abaxial girders, alternating with second order bundles without sclerenchyma associated with strands in both epidermises; marginal sclerenchyma small; bulliform cells inconspicuous; abaxial epidermis with intercostal zones composed of fusiform long cells; stomata in two rows in each intercostal zone; costal zones with long cells narrower than intercostal long cells; short cells with sinuous walls; macrohairs absent.

Distribution.—Endemic to the United States, known only from northwestern Montana.

Comments.—*Trisetum orthochaetum* is easily recognized by its nearly straight awn. It is closely related to *T. cernuum*, in having a lax, open inflorescence with the glumes shorter than the spikelet and a hairy ovary.

Specimens examined. **U.S.A. Montana: Missoula Co.:** Bitterroot Mts., Granite Creek drainage, SW of Lolo Hot Springs, E of Granite Creek Rd., about 2 mi S of junction with road 4209, 4480 ft, 18 Jul 1986, *Shelley & King* 1230 (US).

8. ***Trisetum projectum*** Louis-Marie, *Rhodora* 30(359):217–218. 1928. *Trisetum cernuum* Trin. var. *projectum* (Louis-Marie) Beetle, *Leafl. W. Bot.* 4:228. 1946. *Trisetum spicatum* (L.) K. Richt. var. *projectum* (Louis-Marie) J.T. Howell, *Wasmann J. Biol.* 37(12):22. 1979. TYPE: U.S.A. CALIFORNIA: Fresno Co.: Sierra Nevada, Dinkey Cr. 5300 ft, 25 Jun 1900, H. M. Hall & H. P. Chandler 359 (HOLOTYPE: UC; ISOTYPES: GH, NY, US-390573).

Perennials, caespitose. Culms 35–90 cm tall, glabrous; nodes 2. Leaf sheaths pilose; ligules 0.35–1.5 mm long, oval, dentate and ciliate at the apex, densely pilose dorsally; blades 80–130 × 2–3 mm, flat, soft, involute towards the apex, densely pilose on both surfaces, the hairs about 1.2 mm long. Panicles 9–23 × 2–3 cm, spiciform, interrupted, with short ascending branches, exserted, pale-yellow, shiny; rachis scabrous. Spikelets 6–6.5 mm long, 2-flowered, open at the apex; pedicels scabrous; rachilla about 1.5 mm long, pubescent, the hairs about 0.5 mm long; glumes acute, translucent; first glumes 5–5.5 × 0.5–0.7 mm, as long as or shorter than the spikelet, 1-nerved; second glumes 6.5–8 × 0.8–1 mm, longer than the spikelet, 3-nerved; first florets about 5 mm long; lemma glabrous, delicate and hyaline; apex ending in two setae about 1 mm long; awns about 5.5 mm long, borne on the upper third at 2 mm below the apex, not twisted nor geniculate, diversely curved; paleas about 3.5 mm long, shorter than the lemma, 2-nerved, the nerves scabrous; apex 2-dentate; lodicules 0.6–0.8 mm long; apex 2-lobulate; anthers 1–1.5 mm long; ovary glabrous. Caryopses not seen.

Anatomy and micromorphology.—Ligule apices with stiff hairs; ligule epidermis composed of long cells with straight walls, prickle hairs and macrohairs; short cells and stomata not observed; blades in transverse section expanded, flat, keeled; ribs present in both sides, rounded, low, separated by wide furrows; first order bundles with I-shaped girders; second order bundles alternating with the first order bundles, with or without sclerenchymatous strands; marginal sclerenchyma very small; bulliform cells inconspicuous; macrohairs present in both epidermises, abundant; abaxial epidermis composed of long cells somewhat fusiform, with straight lateral walls; intercostal short cells absent; stomata in four rows in each intercostal zone.

Distribution.—Endemic to the United States (California, Montana, and Nevada). This is the first report of *T. projectum* for Montana.

Comments.—*Trisetum projectum* has been treated as a variety of *T. canescens* (Hitchcock 1950), *T. cernuum* (Beetle 1946), and *T. spicatum* (Howell 1979). *Trisetum projectum* differs from *T. cernuum* subsp. *canescens* by having glabrous ovaries and spiciform panicles. Louis-Marie (1928–29) noted that *T. projectum* had been mistaken for *T. canescens*, from which it differs by its denser, interrupted, bright and pale-yellow panicles, glabrous lemmas, pilose blades, and glabrous ovaries. Hitchcock (1950) considered *T. projectum* to be a synonym of *T. canescens* because he thought there were intermediate forms, however, spiciform panicles and the glabrous ovaries are consistent characters of the former species. *Trisetum projectum* differs from *T. spicatum* by having less dense

panicles, glabrous culms below the panicles (hairy in *T. spicatum*), and very unequal glumes, first glumes narrower than the second (glumes subequal in width in *T. spicatum*), and second glumes usually longer than the spikelet (shorter than the spikelet in *T. spicatum*). Howell (1979) separated *T. projectum* from *T. spicatum* by its densely pubescent or velutinous foliage.

Specimens examined. **U.S.A. California:** two mi NE of Mather, on trail to Cottonwood Meadow, dry woods of *Pinus ponderosa* and *Quercus kelloggii*, 5500 ft, 9 Jul 1947, *Stebbins Jr.* 3827 (US); Soda Springs, 9 Aug 1901, *Kennedy & Dotcn* 264, 265 (US); Sequoia National Forest, mountain meadow, 15 Jul 1927, *Swallen* 790 (US), above Cahoon Meadow, 16 Jul 1927, *Swallen* 797 (US); Lake Tahoe Region, 600 ft, 25 Jul 1907, *Pendleton & Reed* 1247 (US); Near Donner Creek, vicinity of Truckee, 14–16 Jul 1913, *Hitchcock* 10500 (US); Yosemite National Park, Upper Loyall Canyon, 9500 ft, 17–25 Aug 1908, *Hitchcock* 3307 (US); Tahoe, open dry woods, 6225–7000 ft, 5 Aug 1908, *Hitchcock* 3082 (US). Lake Tahoe, Jul 1901, *Hitchcock* s.n. (US); Southeastern California to Southern Utah, 9400 ft, 1987, *Purpus* 5264 (US); Sierra Nevada, near Donner Lake, 1865, *Torrey* 584 (US); Summit Lake, 6695 ft, 27 Aug 1948, *H & V. Bailey* 2924b (US); Yosemite Valley, 4060 ft, 5 Jul 1909, *Jepson* 3136 (US); dry woods along Line Creek, Huntington Lake, 23 Jul 1923, *Swallen* 853 (US). **Montana:** Spanish Creek Basin, moist woods, 16 Jul 1896, *Williams* 2060 (US). **Nevada:** Glenbrook, Lake Tahoe, 6000–8000 ft, 8 Aug 1908, *Hitchcock* 3184 (US).

9. *Trisetum sibiricum* Rupr., Beitr. Pflanzenk. Russ. Reiches 2:65. 1845. *Avena ruprechtii* Griseb., Fl. Ross. 4(13):418. 1852. *Trisetum ruprechtii* (Griseb.) Steud., Syn. Pl. Glumac. 1:226. 1854, *nom. superfl.* *Trisetum flavescens* var. *sibiricum* (Rupr.) Ohwi, Bot. Mag. (Tokyo) 45 (532):192. 1931. *Trisetum bifidum* subsp. *sibiricum* (Rupr.) T. Koyama, Grass. Jap. Neighb. Reg. 533. 1987. TYPE: MALAYA. Zemlya tundra (LECTOTYPE: LE, designated by Tsvelev p. 384. 1983 as "Terra parva Samojedorum, fl. Belaja, leg. Ruprecht").

Trisetum sibiricum subsp. *litorale* Rupr. ex Roshev, Izv. Bot. Sada Akad. Nauk. SSSR 21:90. 1922. *Trisetum sibiricum* var. *litorale* (Rupr. ex Roshev.) Rupr. ex Roshev, Fl. URSS 2:254. 1934. *Trisetum litorale* (Rupr. ex Roshev.) Czer., Sosud. Rast. SSSR 390. 1981, *hom. illeg.* TYPE: RUS-SIA. Litt. Oceani, glac. Kambalnitz, Peninsula Kanin, 13–14 Aug, *Ruprecht* s.n. (LECTOTYPE: LE, designated by Tsvelev p.385. 1983; ISOLECTOTYPE: LE).

Perennials with small short rhizomes. Culms 16–40(–100) cm tall, erect, glabrous below the panicles, nodes 4, glabrous or subglabrous. Leaf sheaths glabrous, ciliate at the apex; ligules 1–1.5 mm long, truncate, dentate, ciliate, dorsally glabrous; blades 25–150 × 1.5–4 mm, flat, glabrous abaxially, scabrous to sparsely pilose adaxially, ciliate at the margin, with prominent adaxial ribs. Panicles 3–5.5(–20) × 1.5–2.5 cm, contracted, not spiciform, golden-yellow, not very dense, bright, somewhat lax and drooping; rachis glabrous. Spikelets 7–9 mm long, 2- or 3-flowered; pedicels scabrous; rachilla 1.2–1.4 mm long, densely hairy, the hairs 0.5–2 mm long; glumes shorter than the spikelet or the upper glumes equaling the florets, unequal both in length and width, hyaline towards the apex; first glumes (2.5–)4.5–5.5 × 0.3 mm, linear-lanceolate, 1-nerved; second glumes (4.5–)6.8–7 × 0.8–1 mm, oval-lanceolate, 3-nerved; first florets 5–8 mm long; lemma glabrous, keeled, dorsally scabrous only along the midnerve; apex ending in two setae; callus with hairs about 0.2 mm long; awns 6–8 mm long, borne dorsally on the upper third of the lemma, twisted, 1 or 2 times geniculate; paleas about 6 mm long, shorter than the lemma in the lower florets, longer

than the lemma in the upper florets, almost smooth on the nerves; apex bisetulate; lodicules about 0.8 mm long, trilobulate at the apex; anthers 2–2.5 mm long; ovary glabrous. Caryopses not seen.

Chromosome number.— $2n = 14$ (Tateoka 1967, 1978; Frey 1992, 1993).

Anatomy and micromorphology.—Ligule apices composed of hairs and papillate cells; ligule epidermis composed of long cells with straight lateral walls; prickle hairs, macrohairs and stomata not observed; blades in transverse section expanded, V-shaped, with low and rounded ribs; furrows less than one half of the leaf thickness; abaxial surface without ribs; median bundle with a sclerenchymatic strand at the keel; first order vascular bundles with sclerenchymatic I-shaped girders; second order bundles free, alternating between the first order bundles; marginal sclerenchyma very small; bulliform cells not forming well defined fan-shaped groups; abaxial epidermis composed of fusiform long cells with straight side walls; short intercostal cells absent; stomata present; prickle hairs and macrohairs not observed.

Distribution.—*Trisetum sibiricum* is found in Alaska (U.S.A.) and Yukon (Canada) between 68° and 63° N and from the Bering Strait to Yukon. It is also widely distributed in Asia (Central Asia, Siberia, Mongolia, China), and Occidental Europe (Frey 1992).

Comments.—*Trisetum sibiricum* has been treated by some authors as a variety of *T. flavescens*. The characters that separate both species were clearly established by Frey (1992) who mentioned the lower sheaths pubescence, leaf blade width, prominent venation of the blades, awn geniculation, and color of the panicle to differentiate this species from *T. flavescens*. In addition, *T. sibiricum* has lemmas that are scabrous only along the midnerve in contrast to the uniformly scabrous lemmas of *T. flavescens*.

Specimens examined. **U.S.A. Alaska:** Brooks Range, Lake Peters, 24–26 Aug 1960, *Hultén s.n.* (S); Port Clarence, 65°05'N, 18 Jul 1879, *Kjellman s.n.* (S); NW Coast, Ogotoruk Creek, 30–31 Jul 1960, *Hultén s.n.* (S); Bering Strait District, Cape Thompson, 68°08'N, 165°57'–59'W, sea level to 800 ft, top of bird cliffs, 27 Jul 1959, *Johnson, Viereck & Melchior 534* (US); vicinity of Ogotoruk Creek, 68°05'–12'N, 165°30'–48'W, sea level to 1000 ft, 20 Aug 1960, *H.R. & H.P. Melchior 286a* (US); Ogotoruk Creek Drainage, 68°05'–12'N, 165°32'–47'W, sea level to 1000 ft, solifluction slope, 5 Aug 1960, *Johnson RJ-130* (US); Teller, Port Clarence, Bering Strait, 6–20 Aug 1949, *Scanman 5410* (S); Port Clarence, 22–26 Jul 1879, *Kjellman s.n.* (S); Seward Peninsula, 65°16'N, 166°20'W, 24 Aug 1926, *A.E. & R.T. Porsild s.n.* (S); Norton Sound, Volcanic hills behind Pastolik, 63°08'N, 163°W, 1000 ft, 21 Jul 1926, *A.E. & R.T. Porsild 893* (S); White Mts., 900 m, 1 Jul 1953, *Gjaerevoll 294* (S); Ukinyik Creek, 68°43'N, 165°45'W, 1 Aug 1960, *Viereck & Bucknell s.n.* (S), 68°43'–47'N, 165°45'–166°12'W, sea level – 2000 ft, 1 Aug 1960, *Viereck & Bucknell 4436* (US).

10a. *Trisetum spicatum* (L.) K. Richt. var. *spicatum*, Pl. Eur. 1:59. 1890. *Aira spicata* L. Sp. Pl. 1:64. 1753. *Aira subspicata* L., Syst. Nat. ed. 10. 2:873. 1759, nom. illeg. superfl. *Avena airoides* Koeler, Descr. Gram. 298, 1802, nom. illeg. superfl. *Trisetum subspicatum* (L.) P. Beauv., Ess. Agrost. 88. 149. 1812, nom. illeg. superfl. *Trisetaria airoides* (Koeler) Baumg., Enum. Stirp. Transsilv. 3:265. 1816, nom. illeg. superfl. *Trisetum airoides* (Koeler) P. Beauv. ex Roem. & Schult., Syst. Veg. 2:666. 1817, nom. illeg. superfl. *Koeleria subspicata* (L.) Reichb., Fl. Germ. Excurs. 49.

- 1830, nom. illeg. superfl. *Koeleria spicata* Reichb. ex Willk. & Lange, Prodr. Fl. Hispan. 1:72. 1861, nom. inval. *Trisetaria spicata* (L.) Paunero, Anales Jard. Bot. Madrid 9:516. 1959. TYPE: SWEDEN. LAPLAND: 1732, *Linnaeus s.n.* [LECTOTYPE: designated by Edgar & Conner, in Edgar p. 556 (1998), LINN-85:7!; ISOTYPE: S!].
- Trisetum molle* Kunth, Rev. Gram. 1:101, 1829, nom. nov., as comb., but basionym hom. illeg. *Avena mollis* Michx., Fl. Bor. Amer. 1:72, 1803, nom. illeg. hom. *Trisetum subspicatum* var. *molle* (Kunth) A. Gray, Manual (ed. 2) 572. 1856. *Rupestrina pubescens* Prov., Fl. Canada 689. 1862. *Trisetum spicatum* var. *molle* (Kunth) Beal, Grass. N. Amer. 2:377. 1896. *Trisetum spicatum* subsp. *molle* (Kunth) Piper, Contr. U.S. Natl. Herb. 11:125. 1906. *Trisetum spicatum* var. *michauxii* St. John, Fl. S.E. Washington 62. 1937, nom. superfl. *Koeleria canescens* Torr. ex Trin., Mém. Acad. Imp. Sci. Saint-Petersbourg, Sér. 6, Sci. Math., Seconde Pt. Sci. Nat. 4.2(1):13. 1836, nom. inval. *Trisetum spicatum* subsp. *molle* (Michx.) Hultén, Svensk Bot. Tidskr. 53:216. 1959, isonym. TYPE: CANADA: Am. Bor., *herb. Sprengel* (SYNTYPE: LE-TRIN-1927.02!); *anonymous s.n.* (SYNTYPE: US-865596 fragm.); Montreal, *Michaux s.n.* (SYNTYPE: P!; US-photo ex P!).
- Melica triflora* Bigelow, New England J. Med. Surg. 5:334. 1816. *Trisetum triflorum* (Bigelow) Å. Löve & D. Löve, Univ. Colorado Stud. Ser. Biol. 17:7. 1965. TYPE: U.S.A. NEW HAMPSHIRE: Mt. Washington, Aug. *F. Boott s.n.*
- Trisetum groenlandicum* Steud., Syn. Pl. Glumac. 1:228. 1854. TYPE: GREENLAND: prope Friedrichstal, *Ed Hohenacher s.n.* (HOLOTYPE: P; ISOTYPES: US-fragm. ex P-STEUD-435!, US-867624 fragm. ex LE!).
- Trisetum labradoricum* Steud., Syn. Pl. Gumac. 1:228. 1854. TYPE: CANADA: Labrador Hopedale, 1846-1848, *Albrecht s.n.* (HOLOTYPE: P; ISOTYPE: US-fragm. ex P-STEUD-438!).
- Trisetum subspicatum* var. *laxius* Lange, Consp. Fl. Groenland. 164. 1880. *Trisetum spicatum* var. *laxius* (Lange) Lindm., Skand. Fl. 2:175. 1926. *Trisetum spicatum* var. *laxius* (Lange) Louis-Marie, Rhodora 30:239. 1929. TYPE: GREENLAND: Holstensborg.
- Trisetum subspicatum* var. *villosissimum* Lange, Consp. Fl. Groenland. 164. 1880. *Trisetum spicatum* var. *villosissimum* (Lange) Louis-Marie, Rhodora 30:239. 1929. TYPE: GREENLAND: Sermilik, *Bredefford s.n.* (SYNTYPE: ?); Julianehaabs Distr., *Kornerup s.n.* (SYNTYPE: ?); Gl. Egedesminde, *Jensen s.n.* (SYNTYPE: C).
- Trisetum brittonii* Nash, Bull. New York Bot. Gard. 1(5):437. 1900. *Trisetum spicatum* var. *brittonii* (Nash) Louis Marie, Rhodora 30:239. 1939. TYPE: U.S.A. MICHIGAN: Marquette, Picnic Island. 19 Jul 1883, *N. L. Britton s.n.* (HOLOTYPE: NY-431708!; ISOTYPE: US-fragm. ex NY!).
- Trisetum alaskanum* Nash, Bull. New York Bot. Gard. 2(6):155-156. 1901. *Trisetum spicatum* var. *alaskanum* Malte ex Louis-Marie, Rhodora 30:239. 1929. *Trisetum spicatum* subsp. *alaskanum* (Nash) Hultén, Svensk Bot. Tidskr. 53:210. 1959. TYPE: CANADA. YUKON: Skagway, 28 Aug 1899, *R.S. Williams s.n.* (HOLOTYPE: NY-431709!; ISOTYPES: S-fragm. & photo ex NY!, US-377013!).
- Trisetum americanum* Gand., Bull. Soc. Bot. France 49:182. 1902. TYPE: U.S.A. COLORADO and IDAHO (SYNTYPES: ?).
- Trisetum congdonii* Scribn. & Merr., Bull. Torrey Bot. Club 29:470. 1902. *Trisetum spicatum* unranked *congdonii* (Scribn. & Merr.) Hitchc., Proc. Biol. Soc. Wash. 41:160. 1928. *Trisetum spicatum* subsp. *congdonii* (Scribn. & Merr.) Hultén, Svensk. Bot. Tidskr. 53:218. 1959. TYPE: U.S.A. CALIFORNIA: Mariposa Co.: Shadow Lake Trail, 1899, *J.W. Congdon s.n.* (HOLOTYPE: US-81772!; ISOTYPE: GH).
- Trisetum majus* (Vasey) Rydb., Bull. Colorado State Univ. Exp. Sta. 100:34. 1906. *Trisetum subspicatum* unranked *major* Vasey ex Rydb., Bull. Colorado State Univ. Exp. Sta. 100: 34. 1906, nom. inval. *Trisetum subspicatum* var. *major* Vasey, Bull. Colorado State Univ. Exp. Sta. 100:34. 1906, como sinónimo. *Trisetum spicatum* subsp. *majus* (Vasey) Hultén, Svensk Bot. Tidskr. 53:218. 1959. TYPE: U.S.A. COLORADO: Pen Gulch, 1884, *G.R. Vasey s.n.* (HOLOTYPE: US-868199!; ISOTYPE: NY-431706!).

Caespitose perennials, sometimes with short rhizomes. Culms 9–60 cm tall, erect, tomentose to densely hairy below the panicle, with hairs antrorse below the panicle, then retrorse below; nodes 1 or 2. Leaf sheaths 1–3(–6) cm long, glabrous; ligules ca. 1 mm long, finely denticulate; blades 1–5 cm × 1–1.5 mm, flat or conduplicate towards the apex, glabrous or rarely hairy or scabrous, sometimes ciliate on margins. Panicles 2.5–7(–10) × 0.5–1.5(–2) cm, spiciform, gold-purplish to brown-purple, bright, usually interrupted at the base; rachis hairy. Spikelets 4.5–6 mm long, (1–)2-flowered; pedicels hairy; rachilla 0.8–1 mm long, hairy, the hairs 0.5–1 mm long; glumes shorter than the florets, as long as 3/4 to 4/5 of the spikelet, subequal or the first a little shorter and narrower than the second glume; sometimes, the second glumes equal or a little longer than the spikelet, scabrous or less frequently ciliate on the keel; first glumes 3.7–5 × 0.5–1 mm, lanceolate, 1–3-nerved; second glumes 4.5–6 × 0.5–1.3 mm, 3-nerved; florets 3.8–5 × 0.7–0.8 mm, the second floret 4–4.5 mm long; lemmas dorsally awned, glabrous, scabrous, purplish towards the base, stramineous towards the apex; margin hyaline; apex with two setae; awn 3.5–5 mm long, borne dorsally on the upper 1/3 or 1/4, geniculate or merely curved, sometimes twisted, scabrous, purple; callus obtuse, with hairs 0.3–0.5 mm long; paleas 3–4 mm long, shorter or a little longer than the lemma, hyaline, 2-nerved, the nerves scabrous; anthers 0.5–1 mm long; lodicules ca. 0.6 mm long, hyaline; apex 2-lobed; ovary glabrous. Caryopses 2–2.8 × ca. 0.6 mm, glabrous; endosperm liquid.

Chromosome number.— $2n = 14, 28, 42$ (Holmgren & Holmgren 1977).

Distribution.—A cosmopolitan species widely distributed in Asia, America (North, Central and South America), Europe, Australia, and New Zealand (Hultén 1959; Clebsch 1960; Nicora 1978; Tovar 1993; Pohl & Davidse 1994; Zuloaga et al. 1994; Edgar 1998; Barkworth 1999; Finot 2003a, 2004; Finot et al. 2004). In North America, *T. spicatum* is found in Canada, United States, and Greenland.

Comments.—*Trisetum spicatum* is an extremely variable species, and several subspecific taxa have been described. Louis-Marie (1928–29) recognized 14 varieties for the Americas and Hultén (1959), recognized 22 infraspecific taxa, including 14 subspecies and 8 varieties. Six of the fourteen subspecies recognized by Hultén (1959) are described for North America: subsp. *alaskanum* (Nash) Hultén, subsp. *pilosiglume* (Fernald) Hultén, subsp. *molle* (Michx.) Hultén, subsp. *majus* (Vasey) Hultén and subsp. *congdonii* (Scribn. & Merr.) Hultén. However, the lack of morphological discontinuities hinders the recognition of most of the infraspecific taxa (Randall & Hilu 1986).

Specimens examined. **CANADA. Alberta:** Jasper National Park, NE slope of Mount Edith Cavell, 5800 ft, 28 Aug 1956, *Hermann 13510* (US); Jasper National Park, 7000 ft, 17 Jul 1918, *Macoun s.n.* (US); Jasper National Park, 9 mi NW of Bubbling Springs on Hwy 93 along Sunwapta River, 52°34'59.3"N, 117°44'18.1"W, 1260 m, 5 Jul 2004, *Peterson, Saarela & Smith 18427* (US); Banff National Park, 11 mi NW of Mosquito Creek at Bow Summit, 51°43'16.9"N, 116°29'37.1"W, 2072 m, 4 Jul 2004, *Peterson, Saarela & Smith 18402* (US). **British Columbia:** SSW of Fort Nelson, 57°20'N, 123°56'W, 18 Jul 1960,

C Calder & Kulckonen 27145 (SI); 13 mi NW of Pink Mountain on Hwy 97 towards ft. Nelson, 58°39'13.4"N, 124°15'14.0"W, 880 m, 7 Jul 2004, *Peterson, Saarela & Smith 18457* (US); 1 mi S of Iskut on Hwy 37 towards Meziadin Junction along Coyote Creek, 57°43'05.5"N, 129°59'15.9"W, 847 m, 20 Jul 2004, *Peterson, Saarela & Smith 18676* (US). **Newfoundland & Labrador:** base Américaine de la Péninsule d'Ongava, rève gauche Riv. Koksoak, 8-13 Jul 1948, *de la Rüe s.n.* (P). **Northwest Territories:** Arctic Coast, Cape Dalhousie, 70°20'N, 129°55'W, 7-14 Aug 1927, *Porsild 2697* (S); 62 mi NE of Eagle Plains on Dempster Hwy 5 towards Inuvik, 67°03'47.7"N, 136°10'46.0"W, 888 m, 12 Jul 2004, *Peterson, Saarela & Smith 18557* (US); 152 mi S of Inuvik on Dempster Hwy 5 towards Eagle Plains, 67°10'53.3"N, 135°48'35.7"W, 720 m, 14 Jul 2004, *Peterson, Saarela & Smith 18590* (US). **Nunavut:** Frobisher Bay, 63°45'N, 67°15'W, 15 Aug. 1964, *Swales 172* (S); Ellesmere Island, Lake Hazen, 81°49'N, 71°18'W, 27 Jul 1967, *Kewan s.n.* (S); Southampton Island, Coral Harbor, 64°08'N, 83°17'W, 1 Aug 1948, *Cody 1716* (S); West side of Bathurst Inlet, 15 Aug 1950, *Kelsall & McEwen 255* (S). **Yukon:** alpine meadows between 3000-4000 ft, Mt. Caribou, 5 mi N of Carcross, 60°14'N, 134°42'W, 17 Aug 1949, *Mitchell 4565* (SI); 12 mi S of Beaver Creek and 7 mi NE on Snag Creek Road, 62°17'42.9"N, 140°33'38.1"W, 670 m, 9 Jul 2004, *Peterson, Saarela & Smith 18489* (US); 0.5 mi E of Alska/Yukon boundary on road towards Dawson, 64°05'01.5"N, 140°58'59.8"W, 225 m, 10 Jul 2004, *Peterson, Saarela & Smith 18513* (US); 86 mi NE of Ross River on Canol Road Hwy 6 just W of MacMillan Pass, 62°46'00.4"N, 131°02'20.8"W, 1010 m, 17 Jul 2004, *Peterson, Saarela & Smith 18620* (US); 143 mi NE of Ross River on Canol Road Hwy 6 at MacMillan Pass, 63 14 46.2 N, 130 01 45.2 W, 1382 m, 17 Jul 2004, *Peterson, Saarela & Smith 18631* (US). **GREENLAND:** 69°45'N, 13 Aug 11 Jul 1949, *de Lesse s.n.* (P); Kangåtsiak 68°18'N, 29 Jul 1997, collector illegible (P); Godthåbsfjord, Ivnajaugtoq, 64°46'N, 50°40'W, 100 m, 20 Jul 1976, *Hansen & Fredskild 1079* (S); Ivnajaugtoq, 64°44'N, 50°44'W, 250 m, 2 Aug 1976, *Fredskild s.n.* (S); Isortuarsstptasia, N of Semilik, 63°45'N, 50°19'W, 480-500 m, 17 Aug 1976, *Fredskild 5924* (S); Skjoldungen distr., Eqalungmiut (Dronning Marias Dal) 63°28'N, 41°55'W, 14 Aug 1970, *Astrup & Nielsen 842* (CTES). **U.S.A. Alaska:** Juneau, 25 Jun 1909, *Hitchcock 1442* (P); Lake Iliamna Region, 1902, *Gorman 67* (P). **California:** Sierra Nevada, just S of Red Mountain, 21 Aug 1991, *Peterson, Annable & Weinpahl 10438* (US); White Mts., 30 Jul 1930, *Duran 505* (P). **Inyo Co.:** Mount Whitney region, 12200 ft, 20 Aug 1937, *Sharsmith 3302* (S); Inconsolable Range above Thunder & Lightning Lake, ca. 12000 ft, 14 Aug 1927, *Howell 24113* (S). **Colorado:** Rocky Mt., 39°41'N, 1862, *Hall & Harbour 625* (P). **Hinsdale Co.:** 16.6 mi W of Lake City on Henson Creek road to Ouray, 38°57'N, 107°34'W, 3750 m, 23 Sep 1992, *Peterson & Annable 12128* (US); Clear Creek Co. 17.7 km from Echo Lake Lodge on road to Mt. Evans, 29 Aug 1989, *Peterson & Annable 7783, 7784* (US); meadow just E of Summit Lake, 14.5 Km from Echo Lake Lodge on Mt. Evans Road, 4230 m, 29 Aug 1989, *Peterson & Annable 7786* (US); vicinity of Mount Carbon, 3400 m, 6 Aug 1910, *Tidestrom 3971* (S); Bottomless Pit, Pikes Peak, 31 Aug 1913, *Hitchcock 1443* (P); Independence Pass, 6 Aug 1955, *Gentry 2393* (S); Trail Ridge, Rocky Mountain National Park, 12000 ft, 20 Jul 1963, *Jones 36964* (S). **Idaho:** **Custer Co.:** Sawtooth Wilderness Area, along Baron Creek, 2000-2400 m, 11-12 Aug 1955, *Morton 8326* (P). **Elmore Co.:** River Lake, 8000 ft, 23 Aug 1947, *F. & L. Meyer 2283* (S). **Montana:** **Park Co.:** Henderson Mt., vicinity of Cooke City, 5 Sep 1948, *Witt 1410* (S). **Nevada:** Ely, along stream, upper part of Timber Creek, 13 Aug 1913, *Hitchcock 1444* (P). **New México:** Pen Gulch Col., 8000 ft, 1884, *Vasey* (US 868199, possible type of *Trisetum majus* Vasey); vicinity of Las Vegas, Solitario, 7 Sep 1926, *Arsène 17891* (P); vicinity of Santa Fe, 3600 m, 12 Aug 1926, *Arsène & Benedict 16238* (P). **Utah:** **Grand Co.:** La Sal Mts., 2000 ft, 29 Jul 1924, *E. & L. Payson 4045* (S). **Washington:** **Clallam Co.:** Olympic Mts., Aug 1900, *Elmer 1947* (P); **Pierce Co.:** Mount Rainier National Park, 5000 ft, 16 Aug 1947, *Rose 47174* (S).

KEY TO THE VARIETIES OF *TRISETUM SPICATUM*

1. Glumes glabrous _____ **10a. *T. spicatum* var. *spicatum***
1. Glumes hairy _____ **10b. *T. spicatum* var. *pilosiglume***

10b. *Trisetum spicatum* var. *pilosiglume* Fernald, *Rhodora* 18:195. 1916. *Trisetum spicatum* subsp. *pilosiglume* (Fernald) Hultén, *Svensk Bot. Tidskr.* 53:215. 1959. TYPE: CANADA.

NEWFOUNDLAND: Island off Pike's Arm, 19 Jul 1911, *M.L. Fernald, Wiegand & Bartram* 4593 (HOLOTYPE: GH; ISOTYPES: CAN-33298, 5-fragm. ex GH; US-1024249).

Perennials. Culms about 20 cm tall, densely hairy below the panicle, the hairs antrorse near the panicle, retrorse below. Leaf sheaths densely hairy; blades 40–60 × 2–3 mm, flat, densely hairy. Panicles 2.5–5 × 0.8–1.2 cm, spiciform, dense, tinged with green and purple; rachis densely hairy. Spikelets about 5 mm long, 2- or 3-flowered; pedicels hairy; rachilla about 0.8 mm long, the hairs about 0.5 mm long; glumes shorter than the spikelet, hairy, ciliate on the keel, acute, green on the back, the margins and apex purplish; first glumes 3.5–3.8 × 0.5 mm, 1-nerved; second glumes about 5 × 1 mm, longer and wider than the first glume, 3-nerved; lemma glabrous or shortly pilose towards the apex, dorsally awned on the upper third; apex with two setae; callus obtuse with hairs; paleas about 4 mm long, shorter or as long as the lemma; lodicules about 0.8 mm long; apex bilobulate, one of the lobes larger than the other; anthers about 0.8 mm long; ovary glabrous.

Chromosome number.— $2n = 14$ (Frey 1992).

Distribution.—This subspecies constitutes the boreal form of the species. It occupies the northeastern region of North America, south of Greenland, East of Canada (Newfoundland, Nova Scotia, Quebec, Manitoba, Ontario, and Saskatchewan), and northeastern United States (Maine, Michigan, Minnesota, New Hampshire, Vermont). Its northern limits are found at 61°N in southern Greenland (Neria), from where it extends to Newfoundland and Quebec, and northeast to the United States.

Specimens examined. **CANADA. Manitoba:** Hudson Bay, 14 Aug 1939, *E.C. Abbe & L.B. Abbe* 3885 (S); Great Whale River, 8 Aug 1959, *E. Hultén s.n.* (S). **Nova Scotia: Victoria Co.:** rock crevices along river Salmon River, 5 Jul 1949, *Smith, Collins, Bruce & Sampson* 2647 (US). **Ontario:** shore of Lake Superior at Heron Bay South, ca. 6 mi southeast of Marathon, 31 Jul 1961, *E.G. Voss* 10448 (S). **Quebec:** Lac Mistassini, Ile Manitounouk (rive sud-est), 365–415 m, 12 Jul 1944, *Rousseau & Rouleau* 99 (US); East Coast of Hudson Bay, sedimentary slopes near sea level at Boat Opening, Manitounouk Sound, 14 Aug 1939, *E.C. & L.B. Abbe* 3863 (US); Lac Mistassini, Pointe Dutilly (Ile Manitounouk), 365–415 m, 23–25 Jul 1945, *Rousseau* 1867 (US); Ile D'Anticosti, rivière La Loutre, eboulis argilo-calcaires, 6 Aug 1926, *F. Marie-Victorin & Rolland-Germain* 25883 (US); calcareous cliffs and taus, Gros Morne, 7 Jul 1931, *Fernald & Weatherby* 2424 (US); E coast of Hudson Bay, Great Whale River, 16 Aug. 1939, *E.C. & L.B. Abbe* 4259 (US); Canadian Sub-Arctic Flora, Lac Mistassini et îles du centre, Quebec, 10–17 Aug 1943, *Dutilly & Lepage* 11522, 11483 (US); Ile d'Anticosti, Rivière Vaureal, 27 Jul 1925, *M. Victorin & R. Germain* 20550 (P); Falaises de la Montagne St. Alban, pres du Cap-Rosier, 19 Jul 1923, *Marie-Victorin, Brunel, Rolland-Germain & Rousseau* 17770 (US); rock crevices near Mt. St. Pierre, 27 Aug 1947, *Swallen* 9778 (US); Bill of Portland Island, 13 Sep 1939, *Dutilly, O'Neill & Duman* 87875 (US); Cape Jones Island, 54°27'N, 80°04'W, 17 Sep 1939, *Dutilly, O'Neill & Duman* 97124 (US); Fort Harrison, 58°24'N, 78°20'W, 7–8 Sep 1939, *Dutilly, O'Neill & Duman* 87650 (US); Fort George, 53°50'N, 79°06'W, 21–27 Sep 1939, *Dutilly, O'Neill & Duman* 97209 (US). **Newfoundland:** recueillis en 1816–1819, 1820, collector not indicated, no date (P); Northern shores of Notre Dame Bay, 20 Aug 1911, *Fernald & Wiegand* 4495 (P); Labrador, 27 Jul 1923, *Sablou* 16 (US); Region of St. John Bay, 19 Jul 1929, *Fernald, Long & Fogg, Jr.* 1289 (S); Roma Bay, 27 Jul 1930, *Janssan* 248 (S); Labrador, 10 Jul 1937, *Potter* 7867 (S); Labrador, Hopedale, 10 Jul 1937, *Potter* 7865 (US); Western Newfoundland, St. John Bay, dry gravelly or shingly

limestone barrens, Old Port Au Choix, 19 Jul 1929, *Fernald, Long & Fogg Jr.* 1289 (US); Silurian area of Northwest coast, dry limestone barrens, Brig Bay, 6 Aug 1924, *Fernald, Long & Dunbar* 26276 (US); Labrador, rocky hill, Battle Harbor, 13 Aug 1928, *Hitchcock* 23871 (US); Labrador, Central Range of the Torngat, Scree slide from top of Precipice Ridge to Komaktorvil Lake, 59°12'N, 64°20'W, 29 Jul 1931, *Abbe* 75 (US); Western Newfoundland, Lower Humber Valley, Hannah's Head, 12 Jul 1929, *Fernald, Long & Fogg, Jr.* 1288 (US); Labrador, *Sornburger* 240 (US); Labrador Peninsula, Battle Harbor, Aug 1912, *Birdseye s.n.* (US); Newfoundland, Western Newfoundland, St. John Bay, Doctor Brook, 24 Aug 1925, *Wiegand & Gilbert, Jr.* 27454 (US); Newfoundland, Straits of Belle Isle, dry horizontal limestone, Rock Marsh, Flower Cove, 30 Jul 1924, *Fernald, Long, Dunbar* 26275 (US); Western Newfoundland, Bonne Bay, limestone ledges and talus, Shag Cliff, 9 Aug 1929, *Fernald, Long & Fogg, Jr.* 1291 (US); Labrador, Hopedale Region, Near the beach by the old Eskimo village, Hopedale, in *Salix-Empetrum* mat, 55°27'N, 60°10'W, *Abbe & Hogg* 74 (US); Labrador, West Blanc Sabes, 27 Jul 1893, *Waghorne* 16 (US); Western Newfoundland, Bonne Bay, turf limestone crest, 650 m, Killdevil, 23 Aug 1929, *Fernald, Long & Fogg, Jr.* 1293 (US). **Saskatchewan:** Lake Athabaska, small island near base of Cornwall Bay, 59°27'N, 108°27'W, *Raup* 6545 (US). **GREENLAND:** 62°30'N, 12 Jul 1878, *Kornerup* 17 (S); Neria, 61°33'N, 24 Jul 1928, *Eugenius s.n.* (S). Sermilik Fjord, 60°37'N, 44°42'W, 30 m, 8 Aug 1962, *C. Hansen, K. Hansen & Petersen* 191 (S); Kangerdluk, 60°13'N, 44°19'W, 10 Jul 1966, *Gravesen & C. Hansen s.n.* (S); Disko, Igdlorssuit, Prins Christians Sund, 60°10'N, 21 Jul 1925, *AE & MP Porsild s.n.* (US); Disko, ca. Neria 61°33'N, 24 Jul 1928, *Eugenius s.n.* (US); East Greenland, Grant Fjord (Clavering Fjord), Payer Land, 12 Aug 1939, *Bartlett* 415 (US); Disko, ca. Neria 61°33'N, 19 Jul 1926, *Eugenius s.n.* (US); Angmagssalik, 65°N, 21 Aug 1939, *Bartlett* 429 (US). **U.S.A. Maine:** Maine, Mt. Katahdin, North Basin, 13 Jul 1900, *Fernald s.n.* (US). **Michigan:** Isle Royal, 7 Aug 1901, *Stuntz & Allen* 48 (US). **Minnesota:** Lake Co.: exposed rocks, Beaver Bay Is., 11 Jul 1938, *Fasset & Curtis* 19562 (US). **New Hampshire:** Mt. Washington, 1882, *Faxon s.n.* (US). **Vermont:** Smugglers Notch, Mt. Mansfield, in turf of *Saxifraga*, etc., 24 Jun 1935, *Torrey et al.* 2361 (US).

APPENDIX 1

Subgeneric treatment of *Trisetum* in North America.**Trisetum****Trisetum** subgen. **Trisetum****Trisetum** subgen. **Trisetum** sect. **Trisetum**, TYPE:

Trisetum flavescens (L.) P. Beauv.

Species included: *T. cernuum* var. *cernuum*, *T. cernuum* var. *canescens*, *T. montanum*, *T. orthochaetum*, *T. flavescens*, *T. sibiricum*.

Trisetum subgen. **Trisetum** sect. **Trisetaera**

Asch. & Graebn., TYPE: *Trisetum spicatum* (L.) K. Richt.

Species included: *Trisetum projectum*, *T. spicatum* var. *spicatum*, *T. spicatum* var. *pilosiglume*.

APPENDIX 2

Numerical index of the species.

- | | |
|---|---|
| 1. <i>Grappheporum melicoides</i> | 7. <i>T. orthochaetum</i> |
| 2. <i>G. wolfii</i> | 8. <i>T. projectum</i> |
| 3. <i>Trisetum aureum</i> | 9. <i>T. sibiricum</i> |
| 4a. <i>Trisetum cernuum</i> var. <i>cernuum</i> , | 10a. <i>T. spicatum</i> var. <i>spicatum</i> , |
| 4b. <i>T. cernuum</i> var. <i>canescens</i> | 10b. <i>T. spicatum</i> var. <i>pilosiglume</i> |
| 5. <i>T. flavescens</i> | |
| 6. <i>T. montanum</i> | |

APPENDIX 3

Index of exsiccatae.

Abbe 75 (10b); Abbe E.C. & L.B. 3863 (10b), 3885 (10b), 4259 (10b); Abbe & Hogg 74 (10b); Abrams 2772 (4b); Allen 42 (4a); Anderson s.n. (4b); Applegate 3151 (4b); Arsène 17891 (10a); Arsène & Benedict 16238 (10a), 16376 (6); Astrup & Nielsen 842 (10a); Austin s.n. (4b).

Bacigalupi s.n. (6); Bailey 2924b (8); Baker 27 (6), 95C (6), 223 (6); Barrell 10260 (6); Barrel & Spongberg 270a-65 (6); Bartholomew s.n. (2); Bartlett 415 (10b), 429 (10b); Beattie 3319 (4b), 3334 (4b); Beetle & Stebbins Jr. 3450 (4a), s.n. (4a); Birdseye s.n. (10b); Bolander 4 (4a), 29 (4a), 5019 (2), 6077 (4b), s.n. (4b); Boott s.n. (10a); Breitung 13955 (6), 14039 (6), 16778 (4a); Britton s.n. (10a); Brown 764 (4a); Bush s.n. (5).

Calder & Kulckonen 27145 (10a); Calder, Saville & Ferguson 13166 (4a); Chandler 1176 (4a); Chase 4840 (4b), 4904 (4a), 4920 (4a), 4947 (4b), 5003 (4a), 5062 (4a), 5080 (4a), 5129 (7), 5163 (4a), 5196 (4b), 5208 (4b), 5320 (6); Clements 200 (2); Clements, F.E. & E.S. 261 (6); Cliff 106 (4b); Cloud s.n. (4b); Cody 1716 (10a); Cooper 16 (4a); Copeland s.n. (4b); Coville & Kearney 2512 (4a); Cusick 6 (4a), 2426 (4a), 2976 (4b).

Dachkowski-Stokes s.n. (6); Davy 139 (4b), 6779 (4b), 6899 (4b), s.n. (4b); de la Rüe s.n. (10a); de Lesse s.n. (10a); Dore 12479 (4a); Duran 505 (10a), 3333 (4b); Dutilly & Lepage 11522, 11483 (10b), 87650 (10b), 87875 (10b), 97124 (10b), 97209 (10b), 98124 (10b).

Eastham 39 (4a); Eggleston 3136 (1), 11636 (4b), 19051 (6); Ehlers, J.H. & L.S. 8297 (6); Ellis 40 (6); Elmer 1143 (4b), 1944 (4b), 1945 (4b), 1946 (4a), 1947 (10a); Eugenius s.n. 19 Jul 1926 (10b), s.n. 24 Jul 1928 (10b); Eyerdam 1524 (4b).

Fasset & Curtis 19562 (10b); Faxon s.n. (10b); Fernald 187 (1), s.n. (10b); Fernald & Weatherby 2424 (10b); Fernald & Wiegand 4495 (10b), 4591 (1); Fernald, Long & Dunbar 26276 (10b), 26275 (10b); Fernald, Long & Fogg Jr. 1289 (10b), 1288 (10b), 1289 (10b), 1291 (10b), 1293 (10b); Fernald, Wiegand & Bartram 4593 (10b); Fredskild 5924 (10a), s.n. (10a).

Gentry 2393 (10a); Gjaerevoll 294 (9); Gorman 67 (10a); Gravesen & Hansen s.n. (10b); Griffiths & Cotton 238 (4b); Griffiths & Hunter 52 (4b), 53 (4a), 128 (4a).

Haenke s.n. (4a); Hall s.n. (6); Hall & Chandler 359 (8); Hall & Harbour 625 (10a); Hansen 1748 (4b), 1763 (4b), 2088 (4b); Hansen & Fredskild 1079 (10a); Hansen, Hansen & Petersen 191 (10b); Heller 3931 (4b), 3931b (4b), 3904 (4a); Hermann 119779 (4b), 12460 (4b), 12914 (4a), 13048 (4a), 13080 (6), 13510 (10a); Hitchcock 1441 (6), 1442 (10a), 1443 (10a), 1444 (10a), 1445 (6), 1446 (4b), 1447 (4a), 2229 (6), 2330 (6), 2645 (4b), 2757 (4b), 2807 (4a), 2859 (4b), 2925 (4b), 3005 (4b), 3082 (8), 3161 (4a), 3184 (8), 3307 (8), 3347 (4b), 3359 (4a), 4042 (4a), 4065 (4a), 4121 (4a), 4946 (4b), 10500 (8), 11222 (4b), 11264 (4b), 11633 (4b), 12274 (4a), 13078 (4b), 13287 (6), 23871 (10b), s.n. (4a), s.n. Jul 1901 (8); Holm s.n. (6); Holmgren & Tillet 9561 (6); Horner 540 (4b), 654 (4b); Hosford s.n. (5); Howell 79 (4a), 869 (4a), 1716 (4a), 24113 (10a), s.n. 31 May 1881, (4b), s.n. 1880 (4a); Hultén 542 (4a), s.n. 8 Aug 1959 (10b), s.n. 30–31 Jul 1960 (9), s.n. 24–26 Aug 1960 (9).

Jansan 248 (10b); Jensen s.n. (10a); Jepsen 3136 (8); Johnson RJ-130 (9); Johnson, Viereck & Melchior 534 (9); Jones 36964 (10a), s.n. (6).

Kearney & Peebles 9970 (6); Kelsall & McEwen 255 (10a); Kennedy & Doten 264, 265 (8); Kevan s.n. (10a); Kjellman s.n. 18 Jul 1879 (9), s.n. 22–26 Jul 1879 (9); Kornerup 17 (10b); Krapovickas 8102 (2); Kraus s.n. (6).

Leckenby 19a (5); Leiberg 1132 (4b); 5124 (4b); Linnaeus s.n. (10a). Macoun 28 (4a), 42 (4b), 50 (4b), 107 (4a), 141 (4b), 80985 (4b), s.n. 18 Jun 1908 (4b), s.n. 23 Jun 1908 (4a), s.n. 13 Jul 1909 (4a), s.n. 17 Jul 1918 (10a).

Marie-Victorin & Rolland-Germain 20550 (10b), 25883 (10b); Marie-Victorin, Brunel, Rolland-Germain & Rousseau 17770 (10b); Martindale s.n. (3); McHenry 9130 (4b); McLake 4329 (4a); Melchior 286a (9); Merrill & Wilcox 348 (2); Meyer 2283 (10a); Michaux s.n. (1); Mitchell 4565 (10a); Morton 11449 (1), 8326 (10a); Mosg 555 (4a).

Norberg 211 (4a); Nuttall s.n. (4b).

Parker 7533 & McClintock (6); Parks H.E. & S.T. 7551 (4a); Patterson 26 (6), s.n. 1892 (6); Payson 4045 (10a); Pendleton & Reed 1247 (8); Peterson 4794 (4a), 7783 (10a); Peterson & Annable 12128 (10a), 7784 (10a), 7786 (10a); Peterson, Annable & Weinpahl 10438 (10a); Peterson & Saarela 18754 (4a); Peterson, Saarela & Smith 18397 (6), 18402 (10a), 18427 (10a), 18457 (10a), 18489 (10a), 18513 (10a), 18557 (10a), 18590 (10a), 18620 (10a), 18631 (10a), 18676 (10a), 18723 (4a); Piper 845 (4b), 846 (4a), 1906 (4b), 1924 (4b), 4649 (4a), 4650 (4a), s.n. May 1890 (4a), s.n. Jun 1890 (4b), s.n. 12 Jun 1891 (4b); Porsild 893 (9), 2697 (10a), 7122 (5), s.n. 21 Jul 1925 (10b), s.n. 24 Aug 1926 (9); Porsild & Breitung 10468 (6); Potter 7865 (10b), 7867 (10b); Pringle 130 (4a), 242 (5), 509 (4a), s.n. (4b); Purpus 5264 (8).

Raup 6545 (10b); Raven & Solbrig 1340 (2); Rogers 573 (4b); Rollins 1522 (6); Rose 47174 (10a); Rosendahl & Brand 129 (4a); Rousseau 1867 (10b); Rousseau & Rouleau 99 (10b); Ruprecht s.n. (9); Rydberg 2394 × (6), 2481 (6), 2481 (6), 2491 (6), s.n. Jun 1880 (4a), s.n. May 1886 (4b); Rydberg & Garrett 9825 (6).

Sablou? 16 (10b); Sandberg 369 (4a); Sandberg & Leiberger 823 (4a); Scamman 5410 (9); Sharsmith 3302 (10a); Shear & Bessey 1482 (2); Shear 1001 (6), 1214 (6), 1218 (6), 1600 (4b), 1612 (4b), 1785 (4a), 718 (6), 720 (6), 71 (6); Shear & Scribner 1705 (4a); Sheldon 9.10811 (4b); Shelley & King 1229 (4b), 1230 (7); Smith, A.H. & C.E. Smith s.n. 1 Sep 1868 (1); Smith, Collins, Bruce & Sampson 2647 (10b); Sornburger 240 (10b); Spreadborough s.n. (4a); Standley 4536 (6), 4576 (6); Stebbins Jr. 3827 (8); Stebbins Jr. & Church 3107 (4a); Stuntz & Allen 48 (10b); Suksdorf 57 (4b), 58 (4b), 611 or 967 (4b), 949 (2), 1104 (4b), 2665 (4b), 10221 (4b), 10226 (4a), s.n. 17 Jun 1883 (4b), s.n. Jun 1885 (4a), s.n. 21 Jun 1889 (2); Swales 172 (10a); Swallen 1296 (6), 1937 (2), 6242 (4b), 6242c (4b), 6466 (4a), 6509 (6), 727 (4b), 790 (8), 797 (8), 853 (8), 9778 (10b), 6016 (4b).

Talcott s.n. 20 May 1890 (4b); Taylor T-119 (4a); Thompson 10785 (4b), 6752 (4b), 8582 (4a); Tidestrom 3971 (10a), 482-a (6); Torrey 584 (8); Torrey et al. 2361 (10b); Tracy 3527 (5), 4546 (4a), 5335 (4a), 800 (4a).

Vasey 19 (4b), 21 (6), 30 (4b), 636 (6), s.n. Jul 1881 (6), s.n. 1884 (10a), s.n. 1884 (6), s.n. 1889 (4b), s.n. 1889 (4a), s.n. Jul 1881 (6); von Eschscholtz s.n. (4a); Voss 10448 (10b); Viereck & Bucknell 4436 (9), s.n. 1 Aug 1960, (9).

Waghorne 16 (10b); Wiegand & Gilbert, Jr. 27454 (10b); Wilkens 10084a (6); Williams 2060 (8), 2177 (6), 2223 (6), 958 (4b), s.n. 28 Aug 1899, (10a); Witt 1410 (10a); Wolf & Rothrock s.n. 1873 (6); Wolfe 669 (6), s.n. 1873 (2); Wootton s.n. 4 Sep 1913 (2), s.n. 11 Aug 1910 (6).

Yates 522 (4b), 536 (4b).

APPENDIX 4

List of names and synonyms. **Accepted names** are present in bold, *synonyms* are italicized.

Acrospelion Besser ex Schult. & Schult.f. =

Trisetum

Agrostis airoides (Poir.) Raspail = **Grappheporum melicoides**

Aira melicoides Michx. = **Grappheporum melicoides**

Airaspicata L. = **Trisetum spicatum** var. **spicatum**

Aira subspicata L. = **Trisetum spicatum** var. **spicatum**

Arundo airoides Poir. = **Grappheporum melicoides**

Avena airoides Koel. = **Trisetum spicatum** var. **spicatum**

Avena cernua (Trin.) Kunth = **Trisetum cernuum** subsp. **cernuum**

Avena distichophylla Vill. = **Trisetum distichophyllum**

Avena flavescens L. = **Trisetum flavescens**

Avena mollis Michx. = **Trisetum spicatum** var. **spicatum**

Avena nutkaensis J. Presl = **Trisetum cernuum** subsp. **cernuum**

Avena ruprechtii Griseb. = **Trisetum sibiricum**

Bromus berterianus Colla

Calamagrostis airoides (Poir.) Steud. =

Grappheporum melicoides

- Calamagrostis sesquiflora* (Trin.) Tzvelev
Danthonia intermedia Vasey
Deschampsia danthonioides (Trin.) Munro
Deyeuxia airoides (Poir.) P. Beauv. =
Grapphephorum melicoides
Dielsiochloa floribunda (Pilg.) Pilg.
Dupontia cooleyi A. Gray = **Grapphephorum melicoides**
Grapphephorum Desv.
Grapphephorum altijugum E.Fourn. = **Peyritschia koelerioides**
Grapphephorum cooleyi (A. Gray) Farw. =
Grapphephorum melicoides
Grapphephorum melicoides (Michx.) Desv.
Grapphephorum melicoides var. *cooleyi* (A. Gray) Scribn. = **Grapphephorum melicoides**
Grapphephorum melicoides var. *majus* A. Gray =
Grapphephorum melicoides
Grapphephorum pringlei Scribn. ex Beal = **Trisetum pringlei**
Grapphephorum shearii (Scribn.) Rydb. = **Trisetum montanum**
Grapphephorum wolfii (Vasey) Vasey ex Coult.
Helictotrichon Besser ex Schult. & Schult. f.
Helictotrichon canescens (Buckley) Clayton =
Trisetum cernuum subsp. *canescens*
Koeleria aurea Ten. = **Trisetum aureum**
Koeleria canescens Torr. ex Trin. = **Trisetum spicatum** var. *spicatum*
Koeleria spicata Reichb. ex Willk. & Lange =
Trisetum spicatum var. *spicatum*
Koeleria subspicata (L.) Reichb. = **Trisetum spicatum** var. *spicatum*
Melica triflora Bigelow = **Trisetum spicatum** var. *spicatum*
Peyritschia E. Fourn.
Peyritschia deyeuxioides (Kunth) Finot
Peyritschia koelerioides (Peyr.) E. Fourn.
Poa melicoides (Michx.) Nutt. = **Grapphephorum melicoides**
Rebentischia Opiz = **Trisetum**
Rebentischia flavescens (L.) Opiz = **Trisetum flavescens**
Rupestrina Prov. = **Trisetum**
Rupestrina pubescens Prov. = **Trisetum spicatum** var. *spicatum*
Sphenopholis Scribn.
Sphenopholis interrupta (Buckley) Scribn.
Sphenopholis pensylvanica (L.) Hitchc.
Triodia melicoides (Michx.) Spreng. = **Grapphephorum melicoides**
Trisetaria Forssk.
Trisetaria airoides Baumg. = **Trisetum spicatum** var. *spicatum*
Trisetaria aurea (Ten.) Pignatti = **Trisetum aureum**
Trisetaria flavescens (L.) Baumg. = **Trisetum flavescens**
Trisetaria spicata (L.) Paunero = **Trisetum spicatum** var. *spicatum*
Trisetarium Poir. = **Trisetum**
Trisetum Pers.
Trisetum airoides (Koel.) P.Beauv. ex Roem. & Schult. = **Trisetum spicatum** var. *spicatum*
Trisetum alaskanum Nash = **Trisetum spicatum** var. *spicatum*
Trisetum ambiguum Rügolo & Nicora
Trisetum americanum Gand. = **Trisetum spicatum** var. *spicatum*
Trisetum sect. *Anaulacoa* Louis-Marie = **Trisetum** subg. **Trisetum** sect. **Trisetum**
Trisetum argenteum Scribn. = **Trisetum montanum**
Trisetum angustum Swallen
Trisetum sect. *Aulacoa* Louis-Marie = **Dielsiochloa** Pilg.
Trisetum aureum (Ten.) Ten.
Trisetum barbatipalelum (Hultén ex Veldkamp) Finot
Trisetum bifidum subsp. *sibiricum* (Rupr.) Trisetum Koyama = **Trisetum sibiricum**
Trisetum bongardii Louis-Marie = **Calamagrostis sesquiflora**
Trisetum brittonii Nash = **Trisetum spicatum** var. *spicatum*
Trisetum canescens Buckley = **Trisetum cernuum** subsp. *canescens*
Trisetum canescens Buckley fo. *tonsum* Louis-Marie = **Trisetum cernuum** subsp. *canescens*
Trisetum canescens Buckley fo. *velutinum* Louis-Marie = **Trisetum cernuum** subsp. *canescens*
Trisetum canescens montanum (Vasey) Hitchc. = **Trisetum montanum**
Trisetum caudatum var. *correae* Nicora
Trisetum cernuum Trin.
Trisetum cernuum var. *canescens* (Buckley) Beal = **Trisetum cernuum** subsp. *canescens*
Trisetum cernuum subsp. *canescens* (Buckley) Calder & R.L.Taylor

Trisetum cernuum Trin. subsp. **cernuum**

Trisetum cernuum Trin. var. *luxurians* Louis-Marie
= **Trisetum cernuum** subsp. **cernuum**

Trisetum cernuum Trin. var. *luxurians* fo. *pubescens*
Louis-Marie = **Trisetum cernuum** subsp.
cernuum

Trisetum cernuum Trin. var. *projectum* (Louis-
Marie) Beetle = **Trisetum projectum**

Trisetum cernuum fo. *pubescens* G. Jones =
Trisetum cernuum subsp. **cernuum**

Trisetum cernuum fo. *pubescens* Louis-Marie =
Trisetum cernuum subsp. **cernuum**

Trisetum cernuum var. *sandbergii* (Beal) Louis-
Marie = **Trisetum cernuum** subsp. **cernuum**

Trisetum congdonii Scribn. & Merr. = **Trisetum**
spicatum var. **spicatum**

Trisetum curvisetum Morden & Valdes-Reyna
Trisetum deyeuxioides (Kunth) Kunth =
Peyritschia deyeuxioides

Trisetum distichophyllum (Vill.) P. Beauv.

Trisetum durangense Finot & P.M. Peterson

Trisetum elatum Nutt. ex A. Gray = **Trisetum**
cernuum subsp. **canescens**

Trisetum elongatum (Kunth) Kunth =
Sphenopholis interrupta

Trisetum subsect. *Eutriseta* Louis-Marie =
Trisetum subg. **Trisetum** sect. **Trisetum**

Trisetum filifolium Scribn. ex Beal

Trisetum flavescens (L.) P. Beauv.

Trisetum flavescens subsp. *pratense* (Pers.) Asch.
& Graebn. = **Trisetum flavescens**

Trisetum flavescens var. *sibiricum* (Rupr.) Ohwi =
Trisetum sibiricum

Trisetum floribundum Pilg. = **Dielsiochloa**
floribunda

Trisetum glabrum Buckley = **Deschampsia**
danthonioides

Trisetum subsect. *Graphephorum* (Desv.) Louis-
Marie = **Graphephorum**

Trisetum groenlandicum Steud. = **Trisetum**
spicatum var. **spicatum**

Trisetum hallii Scribn. = **Sphenopholis**
interrupta

Trisetum subgen. *Heterolytrum* Louis-Marie =
Trisetum subg. **Trisetum** sect. **Trisetum**

Trisetum interruptum Buckley = **Sphenopholis**
interrupta

Trisetum irazuense (Kuntze) Hitchc.

Trisetum labradoricum Steud. = **Trisetum**
spicatum var. **spicatum**

Trisetum ligulatum Finot & Zuloaga

Trisetum litorale (Rupr. ex Roshev.) Czer. =
Trisetum sibiricum

Trisetum longiglume Hack. var. **longiglume**

Trisetum ludovicianum = **Sphenopholis**
pensylvanica

Trisetum majus (Vasey) Rydb. = **Trisetum**
spicatum var. **spicatum**

Trisetum martha-gonzaleziae P.M. Peterson &
Finot

Trisetum melicoides (Michx.) Scribn. =
Graphephorum melicoides

Trisetum melicoides subsp. *cooleyi* (A. Gray)
Scribn. = **Graphephorum melicoides**

Trisetum melicoides var. *majus* (A. Gray) Hitchc. =
Graphephorum melicoides

Trisetum molle Kunth = **Trisetum spicatum** var.
spicatum

Trisetum montanum Vasey

Trisetum montanum Vasey var. *pilosum* Louis-
Marie = **Trisetum montanum**

Trisetum montanum Vasey var. *shearii* (Scribn.)
Louis-Marie = **Trisetum montanum**

Trisetum nutkaensis (J.Presl) Scribner & Merr. ex
Davy = **Trisetum cernuum** subsp. **cernuum**

Trisetum orthochaetum Hitchc.

Trisetum palmeri Hitchc.

Trisetum palustre (Michx.) Torr. = **Sphenopholis**
pensylvanica

Trisetum paniculatum E. Fourn. = **Trisetum viride**

Trisetum pennsylvanicum (L.) P. Beauv. ex Roem.
& Schult. = **Sphenopholis pensylvanica**

Trisetum pinetorum Swallen

Trisetum pratense Pers. = **Trisetum flavescens**

Trisetum pringlei (Scribn. ex Beal) Hitchc.

Trisetum projectum Louis-Marie

Trisetum rosei Scribn. & Merr.

Trisetum ruprechtii (Griseb.) Steud. = **Trisetum**
sibiricum

Trisetum sandbergii Beal = **Trisetum cernuum**
subsp. **cernuum**

Trisetum sesquiflorum Trin. = **Calamagrostis**
sesquiflora

Trisetum shearii Scribn. = **Trisetum montanum**
Trisetum sibiricum Rupr.

Trisetum sibiricum subsp. *litorale* Rupr. ex Roshev.
= **Trisetum sibiricum**

Trisetum sibiricum var. *litorale* (Rupr. ex Roshev.)
Rupr. ex Roshev. = **Trisetum sibiricum**

- Trisetum spellenbergii** Soreng, Finot & P.M. Peterson
Trisetum sect. *Sphenophoidea* Louis-Marie = **Sphenopholis**
Trisetum spicatum (L.) K. Richt.
Trisetum spicatum subsp. *alaskanum* (Nash) Hultén = **Trisetum spicatum** var. **spicatum**
Trisetum spicatum var. *alaskanum* (Nash) Malte ex Louis-Marie = **Trisetum spicatum** var. **spicatum**
Trisetum spicatum var. *brittonii* (Nash) Louis Marie = **Trisetum spicatum** var. **spicatum**
Trisetum spicatum (unranked) *congdonii* (Scribn. & Merr.) Hitchc. = **Trisetum spicatum** var. **spicatum**
Trisetum spicatum subsp. *congdonii* (Scribn. & Merr.) Hitchc. = **Trisetum spicatum** var. **spicatum**
Trisetum spicatum subsp. *congdonii* (Scribn. & Merr.) Hultén = **Trisetum spicatum** var. **spicatum**
Trisetum spicatum var. *laxius* (Lange) Lindm. = **Trisetum spicatum** var. **spicatum**
Trisetum spicatum var. *laxius* (Lange) Louis-Marie = **Trisetum spicatum** var. **spicatum**
Trisetum spicatum subsp. *majus* (Vasey ex Rydb.) Hultén = **Trisetum spicatum** var. **spicatum**
Trisetum spicatum var. *michauxii* St. John = **Trisetum spicatum** var. **spicatum**
Trisetum spicatum var. *molle* (Kunth) Beal = **Trisetum spicatum** var. **spicatum**
Trisetum spicatum subsp. *molle* (Michx.) Hultén = **Trisetum spicatum** var. **spicatum**
Trisetum spicatum subsp. *molle* (Kunth) Piper = **Trisetum spicatum** var. **spicatum**
Trisetum spicatum var. *molle* (Michx.) Piper = **Trisetum spicatum** var. **spicatum**
Trisetum spicatum subsp. *montanum* (Vasey) W.A. Weber = **Trisetum montanum**
Trisetum spicatum subsp. *pilosiglume* (Fernald) Hultén = **Trisetum spicatum** var. **pilosiglume** Fernald
Trisetum spicatum var. **pilosiglume** Fernald
Trisetum spicatum var. *projectum* (Louis-Marie) J. Howell = **Trisetum projectum**
Trisetum spicatum var. *spicatifforme* Hultén = **Trisetum spicatum** var. **spicatum**
Trisetum spicatum var. **spicatum**
Trisetum spicatum var. *villosissimum* (Lange) Louis-Marie = **Trisetum spicatum** var. **spicatum**
Trisetum subspicatum (L.) P. Beauv. = **Trisetum spicatum** var. **spicatum**
Trisetum subspicatum P. Beauv. = **Trisetum spicatum** var. **spicatum**
Trisetum subspicatum var. *laxius* Lange = **Trisetum spicatum** var. **spicatum**
Trisetum subspicatum fo. *maidenii* Gand. = **Trisetum spicatum** var. **spicatum**
Trisetum subspicatum var. *major* Vasey = **Trisetum spicatum** var. **spicatum**
Trisetum subspicatum var. *molle* (Kunth) A. Gray = **Trisetum spicatum** var. **spicatum**
Trisetum subspicatum var. *muticum* Bol. = **Graphephorum wolfii**
Trisetum subspicatum var. *villosissimum* Lange = **Trisetum spicatum** var. **spicatum**
Trisetum toluicense (Kunth) Kunth = **Trisetum spicatum** var. **spicatum**
Trisetum tonduzii Hitch.
Trisetum triflorum (Bigelow) Á. Löve & D. Löve = **Trisetum spicatum** var. **spicatum**
Trisetum trinii (Trin.) Louis-Marie = **Bromus berterioanus**
Trisetum subgen. **Trisetum**
Trisetum subgen. **Trisetum** sect. **Trisetaera** Asch. & Graebn.
Trisetum subgen. **Trisetum** sect. **Trisetum**
Trisetum viride (Kunth) Kunth
Trisetum virletii E. Fourn.
Trisetum williamsii Louis-Marie = **Danthonia intermedia**
Trisetum wolfii var. *brandegei* (Scribn.) Louis-Marie = **Graphephorum wolfii**
Trisetum wolfii fo. *muticum* (Bol.) Louis-Marie = **Graphephorum wolfii**
Trisetum wolfii subsp. *muticum* (Bol.) Scribn. = **Graphephorum wolfii**
Trisetum wolfii Vasey = **Graphephorum wolfii**

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