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A new taxonomic concept for *Bromus danthoniae* including comments on *Bromus* sectt. *Bromus* and *Triniusia* (Poaceae)

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Abstract

Based on morphological analyses of the awns a taxonomic approach to *Bromus* sect. *Bromus* is presented. Based on the original publication *B. macrostachys* var. *triaristatus* and *B. pseudodanthoniae* are stated as homotypic synonyms of *B. danthoniae*. *B. turcomanicus* and *B. danthoniae* subsp. *rogersii* are treated as synonyms of *B. danthoniae*. *Bromus* sect. *Triniusia* as a synonym of *Bromus* sect. *Bromus* and the reduction of the genus *Boissiera* as synonym of *Bromus* are confirmed.

Key Words: Taxonomy; Poaceae, *Boissiera*, *Bromus*, sect. *Bromus*, sect. *Triniusa*, *Bromus danthoniae*.

Zusammenfassung

Nach einer morphologischen Analyse der Grannen wird eine taxonomische Gliederung von *Bromus* sect. *Bromus* präsentiert. Basierend auf den Originalpublikationen sind *B. macrostachys* var. *triaristatus* und *B. pseudodanthoniae* homotypische Synonyme von *B. danthoniae*. *B. turcomanicus* und *B. danthoniae* subsp. *rogersii* sind synonym zu *B. danthoniae*, *Bromus* sect. *Triniusia* ist synonym zu sect. *Bromus*. Der Einschluss der Gattung *Boissiera* in *Bromus* wird bekräftigt.

Introduction

The genus *Bromus* L. includes more than 150 annual to perennial species (Clayton et al. 2015) with a wide range of distribution in all continents (Fortune et al. 2008, Saarela et al. 2007). There are different approaches to classify *Bromus* s.l.: in sections (Hitchcock 1935; Smith 1970; Bor 1970; Pavlick 1995; Planchuelo & Peterson 2000; Oja 2006, 2007; Saarela et al. 2006, 2007; Saarela 2008), subgenera (Stebbins 1981; Acedo & Llamas 1999, 2001) or even as different genera (Tzvelev 1976, 1989; Catalan et al. 1997; Spalton 2002, 2004).

Smith (1970) reviewed the nomenclature and taxonomy of *Bromus* and accepted six sections based on differences in spikelet structure: sect. *Bromus*, sect. *Genea* Dumort., sect. *Pnigma* Dumort., sect. *Ceratochloa* (P. Beauv.) Griseb., sect. *Nevskiella* (V.I.Krecz. & Vved.) Tournay, and sect. *Neobromus* (Shear) Hitchc.

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Smith (1969) based on serological data, chromosomal, morphological and physiological evidence transferred *Boissiera squarrosa* (Sol.) Nevski to *Bromus pumilio* (Trin.) P.M.Sm. Afterward Smith (1985b) based on different dispersal mechanism increased the number of sections to seven including sect. *Boissiera* (Hochst. ex Steud.) P.M.Sm.. These results have been adopted by recent workers such as Oja & Jaasaka (1998) and Saarela et al. (2007). Scholz (1998) accepted an eighth section *Triniusia* (Steud.) Nevski and addressed the wrong interpretation of sect. *Neobromus* in Flora Iranica by Bor (1970). The latter section with species such as *B. berteroanus* Colla is distributed in pacific coasts of N and S of America (Saarela et al. 2007). *Bromus* sect. *Mexibromus* Saarela, P.M. Peterson & Valdés-Reyna was recently described by Saarela et al. (2014). It includes three species endemic to México and Guatemala, and differs from other sections of *Bromus* by its 3 (–5)-nerved lemmas.

Starting with the study of material for a new treatment of the Flora Iranica area, it became clear that it was necessary to check the delimitation of species within sect. *Bromus* and consequently the related sections *Boissiera* and *Triniusa*. a general survey of the genus in Iran can be found in Naderi & Rahiminejad (2015).

History

In the treatment by Scholz (1998), section *Triniusia* contained two species: *B. danthoniae* Trin. with three subspecies: subsp. *danthoniae*, subsp. *pseudodanthoniae* (Drobov) H.Scholz and subsp. *rogersii* H.Scholz), and *B. turcomanicus* H.Scholz which was characterized by three awns in the lemma apex (one central and two lateral). Scholz (1998) differentiated the taxa based on the shape of awns and of the apical lemma lobes, and width of lemma.

There is a lot of misunderstanding of names, as earlier authors did not go back to the original literature. E.g. all – either not checking the original or not being able to read and comprehend the German text – overlooked, that Hackel (1879) introduced *Bromus macrostachys* var. *triaristatus* as a nom. nov. and stat. nov. for *Bromus danthoniae*. Drobov (1925) wanted to give species level to this taxon again and published *B. pseudodanthoniae* Drobov – a mere nomen superfluum. Scholz (1998) made a combination of this illegitimate name as subspecies again. Other authors placed *B. pseudodanthoniae* as a synonym of *B. macrostachys* and *B. lanceolatus* respectively (Krechetovich & Vvedenskii 1934, Cope 1982), and Tzvelev (1976) accepted both taxa with the invalid *B. danthoniae* var. *uniaristatus* Melderis and *B. pseudodanthoniae*.

Material & Methods

Besides field studies of the variety of *Bromus danthoniae* approximately 300 sheets which belong to *B. danthoniae* were investigated in the herbaria of the Research Institute of Forests and Rangelands of Tehran [TARI]*, the University of Isfahan, the Natural History Museum of Vienna [W] and the Botanical Garden and Botanical Museum of Berlin [B]. The material includes specimens from Turkey, Iraq, Iran, Turkmenistan, Afghanistan and Pakistan. The types of *B. turcomanicus*, *B. danthoniae* subsp. *rogersii*, and the specimens

* The acronyms follow Thiers (2015).

studied by HACKEL (1879, especially *B. macrostachys* var. *triaristatus*: Péronin 217 and Kotschy 750) were reexamined as well as specimens of *Bromus lanceolatus* ROTH and *Bromus pumilio* (TRIN.) P.M.SM.

Following previous studies in *Bromus* (e.g. SCHOLZ 1981, 1998) minute structures of the spikelets were dissected. The study concentrated on the following morphological characters: spikelet length, length and width of lemma, insertion distance of awn from the apex, the tip shape and the incision depth, the number and shape of awns from the lower to upper lemmas, and the compression degree of spikelet. A similar study was carried out by KESHAVARZI et al. (2009), who checked a large number of characters for *Bromus danthoniae* var. *danthoniae*, var. *lanuginosus* and var. *uniaristatus*, but didn't include type specimens. ARYAVAND (2002) studied a large number of species and concentrated the analysis on supraspecific classification.

Results & Discussion

Populations of *B. danthoniae* have been visited and analysed in diverse habitats ranging from very humid, moderate to very arid conditions. In wet habitats the vegetative organs such as leaves are consequently wider and longer in the reproductive organs, the spikelets are smaller and particularly immature, and the awns are somewhat straight. In fact all spikelets of *B. danthoniae* don't have the upper lemmas with 3 awns and it is difficult to find the two extra lateral awns (or awnlets) in herbarium observation. We conclude that the size and shape of spikelet and awns of *B. danthoniae* are not suitable for taxonomic differentiation on species or subspecies level. KESHAVARZI et al. (2009) distinguished three varieties within *B. danthoniae*, of which in our treatment var. *lanuginosus* is included in var. *danthoniae*, as it is based on the only character of hairiness; their var. *uniaristatus* needs renaming as the name is illegitimate.

Several herbarium sheets, e.g. Mozaffarian 63107 [TARI] and Mozaffarian 62313 [TARI], show that the characteristics selected by SCHOLZ (1998) for distinguishing subsp. *pseudodanthoniae* do not withstand critical evaluation. In these specimens, spikelets are strongly laterally compressed with three to five twisted, recurved or spreading awns, but lemmas width are 3.5–5 mm (less than 6 mm); in other specimens the spikelets are terete (not compressed) but lemmas width are more than 6 mm. On the other hand some specimens have two different spikelets showing the characters ascribed to subsp. *danthoniae*, subsp. *pseudodanthoniae* or subsp. *rogersii* simply because of differences in maturity. In fact, all figures of spikelets in the study of SCHOLZ (1998; page 145, figs. 1–4) belong to *B. danthoniae* var. *danthoniae.*

We also studied the type of *B. turcomanicus*. This was the only specimen of this taxon when described. Recently MEMARIANI et al. (2012) gave a small distribution area in Khorassan, accepting *B. danthoniae*, *B. pseudodanthoniae* and *B. turcomanicus* as distinct species. SCHOLZ (1998) separated and distinguished this species based on: blunt apical lemma lobes and its central awn inserted at less than 2 mm below apex. The latter character has also been observed in *B. danthoniae* (i.e. in specimens with sharply acute apical lemma lobes), the former character in the type specimen was not identical to the holotype's figure in SCHOLZ (1998, fig. 4) - the character shows an intermediate status. This meant that the lower lemmas at the apex are obtuse, somewhat truncate and always

dentate-slightly incised, but the upper lemmas go to more acute-laciniate apex. The type seems to be an immature plant in accord with the shape of awn's bud.

As a result of this study we reduce *B. turcomanicus* and *B. danthoniae* subsp. *rogersii* to synonyms of *B. danthoniae.*

Intermediate characters

Our morphological observations show that there is a transitional series of appearing and producing awns in the lemma apex of the spikelets from *Bromus lanceolatus* Roth to *B. danthoniae* and finally *Bromus pumilio* (Trin.) P.M.Sm.

Intermediate plants betwen *B. lanceolatus* and *B. danthoniae* have been named *B. macrostachys* var. *triaristatus* or *B. danthoniae* var. *uniaristatus*. Increasing the number of awns begins at the uppermost lemma from 1 in *B. lanceolatus* to (2–) 3–5 (–6) in *B. danthoniae* or even to (5–) 7–9 in *B. pumilio*, which in turn initiates the incision of the lemma apex from bifid/blunt-acute dents to laciniate/sharply acute-acuminate ones. These changes along with the projection of 9 awns over 9 lemma's veins prevent *B. pumilio* from forming keeled lemma.

Figure 1 shows the transition of appearing and producing awns in the lemma apex. The detailed morphological characters of some specimens of *B. danthoniae* in Fig. 1 (a–i) show the variation of the number of awns. The number of awns show complete overlap and are not suitable for distinction and therefore section *Triniusia* is merged with section *Bromus*, the value of sect. *Boissiera* needs further investigations. The spikelet structure shown in Fig. 1, a_{1-2} morphologically is one of the most confusing populations, perhaps they belong to *B. danthoniae* but show similarity to *B. lanceolatus*.

At the moment it is generally accepted that the spikelets of *B. lanceolatus* and other species of section *Bromus* only possess 1 awn or are awnless. However the emerging of awns continues, they come out of the lateral veins (sometimes hidden), first like a tooth, then like an awnlet and finally like a true awn. At the end of this morphological series there are 2, 3 to 5 awns (Fig. 1 b_{1-2}–h_{1-2}), or even 6 awns, so that the lowermost or second lemma of spikelet in the Fig. 1 i_{1-2} includes 1 central, 4 (2 long + 2 short) lateral and 1 minute awn which hadn't been reported before to science. *B. danthoniae* in previous studies was described with 3 (–5) awns, in our conception the description has to be changed to (2–) 3–5 (–6) awns.

The present paper provides a more natural system with two varieties within *B. danthoniae*, one of them morphologically more similar to *B. lanceolatus*. The relationship between *B. lanceolatus* and *B. danthoniae* remains unsound.

Non-morphological evidence

There is some other data that support this morphological approach: Smith (1969) physiologically discussed the reasons of the increase of awns and degree of its reflexion. *B. danthoniae* and *B. pumilio* could be well-adapted in dry habitats, increase of their awns protects them against grazing, and when the leaves wither, the chlorenchyma of flat adaxial surface of the awns act as supplementary photosynthetic organs and reserves carbohydrate for the developing caryopsis. A comparable interpretation has been found

for the outer involucral bracts of species of *Carlina* L. sect. *Corymbosae* MEUSEL & KÄSTNER (Asteraceae) in dry habitats (MEUSEL & KÄSTNER 1990: 103). SMITH (1972) by serological technique showed a closely relationship among *B. danthoniae*, *B. lanceolatus* and *B. pumilio*. The electerophoretic patterns indicated that *B. pumilio* may be less related to the two former species. AINOUCHE & BAYER (1997) using the ITS sequences demonstrated that section *Bromus* is monophyletic and the consensus tree of phylogenetic analysis considering both diploid and tetraploid taxa supported the similarity of the Mediterranean *B. lanceolatus* and the western Asian to eastern Mediterranean *B. danthoniae* as possibly vicariant species. They also pointed out that *B. danthoniae* could be a possible progenitor of *B. lanceolatus*. OJA (1998) by isoenzyme data alluded to a similarity of *B. danthoniae* to some species of section *Bromus*. Molecular evidence of SAARELA et al. (2007) based on nuclear and chloroplast DNA illustrated that section *Triniusia* including *B. danthoniae* subsp. *danthoniae* and subsp. *pseudodanthoniae* are nested within section *Bromus*; however material of *B. pumilio* was not available in their study. This showed that section *Bromus* will be paraphyletic, if *B. danthoniae* is treated in a distinct section. SMITH (1985b) based on morphology and dispersal mechanism transferred *B. pumilio* to the monotypic section *Boissiera* which was supported by the allozyme study of OJA & JAASKA (1998). The results display a conspicuous tendency of agreement with the presented morphological observations, but the taxonomic consequences have not been published.

Nomenclature and synonymy

All references to the Code refer to MCNEILL et al. (2012), = connects synonyms, ≡ connects homotypic synonyms.

***Bromus* L.,** Species Plantarum 1: 76 (1753).

Sect. *Bromus*
Lectotype (SMITH 1970): *B. secalinus* L.

= *Bromus* sect. *Triniusia* (STEUD.) NEVSKI, Trudy Sredne-Aziatsk. Gosud. Univ., ser. 8b (Bot.) 17: 23 (1934).
Type species: *B. danthoniae* TRIN.

= *Bromus* "sect. Neobromus" auct., non (SHEAR) HITCHC. (1935); e.g. BOR in RECHINGER, Fl. Iranica 70: 130 (1970).

***Bromus lanceolatus* ROTH**, Catal. Bot. 18 (1797).
Type: based on seed of unknown origin sent by Roemer to Roth under the name *B. canariensis* [holo B, destroyed; lecto (designated by SCHOLZ 1998) BREM photo!; iso B-Willd. 2139/1 (cited by SMITH 1985a); iso LE (cited by TZVELEV 1976)]
Annotation: Differing character: All lemmas with 1 awn.

= *Bromus macrostachys* DESF., Fl. Atlant. 1: 96 (1798).
Type: Habitat in Atlante prope Tlemseu [n.v.].

***Bromus danthoniae* TRIN.**, Verz. Pfl. Cauc. Casp. Meer: 24 (1831).
≡ *Triniusa danthoniae* (TRIN.) STEUD. , Syn. Pl. Glumac. 1: 328 (1854).
≡ *B. macrostachys* DESF. var. *triaristatus* HACK., Flora 62: 155 (1879).
≡ *B. pseudodanthoniae* DROBOV, Feddes Repert. 21: 39 (1925), nomen illeg. (Code § 52.1)

≡ *B. danthoniae* Trin. subsp. *pseudodanthoniae* (Drobov) H. Scholz, Willdenowia 28: 146 (1998), nomen illeg. (Code § 40.1).

Type: Azerbaijan, in collibus lapidosis aridis prope pag. Swant, 22.6.1830, C. Meyer s.n. [holo LE, iso LE].

Annotation: Hackel (1879) proposes var. *triaristatus* with: „....., so bin ich nicht im Stande, irgendwo eine Grenze zwischen *Bromus macrostachys* Dsf. und *B. Danthoniae* Trin. zu ziehen, und kann letzteren nur als eine merkwürdige Varietät (*triaristata*) des ersteren betrachten, ...“ [translation: “..., therefore I am not able to find a borderline between *Bromus macrostachys* and *B. danthoniae*, and consider the last one as strange variety (*triaristata*) of the first one, ...”]. Therefore var. *triaristatus* is “stat nov. and nom nov.” for *B. danthoniae* as variety within *B. macrostachys*.

Drobov (1925) in the description of *B. pseudodanthoniae* gives as synonym “*Bromus macrostachys* Desf. var. *triaristatus* Boiss., Flora Orientalis 5: 652”. This is a wrong citation, but supposed to be a mere writing error. Boissier (1884) in that place gives the correct citation “*Bromus macrostachys* Desf. var. *triaristatus* Hack.”. No matter of the intention, Drobov including var. *triaristatus* actually included the homotypic *B. danthoniae* - in this way creating a nomen illegitimum (Code § 52.1). The type is the same as for *Bromus danthoniae* (Code § 7.5).

Drobov (1925) cites no type specimen (which would be of no importance for Code § 7.5), *B. pseudodanthoniae* is described from “Turkestania”, todays Uzbekistan (near Tashkent). Tzvelev (1976) only says “lectotype in Tashkent”, without details.

var. *danthoniae* – Fig. 1 f–i.

Differing character: Spikelets laterally compressed or terete, glabrous or pubescent; most lemmas 3-6 awns; the first or second rarely only 1 awn.

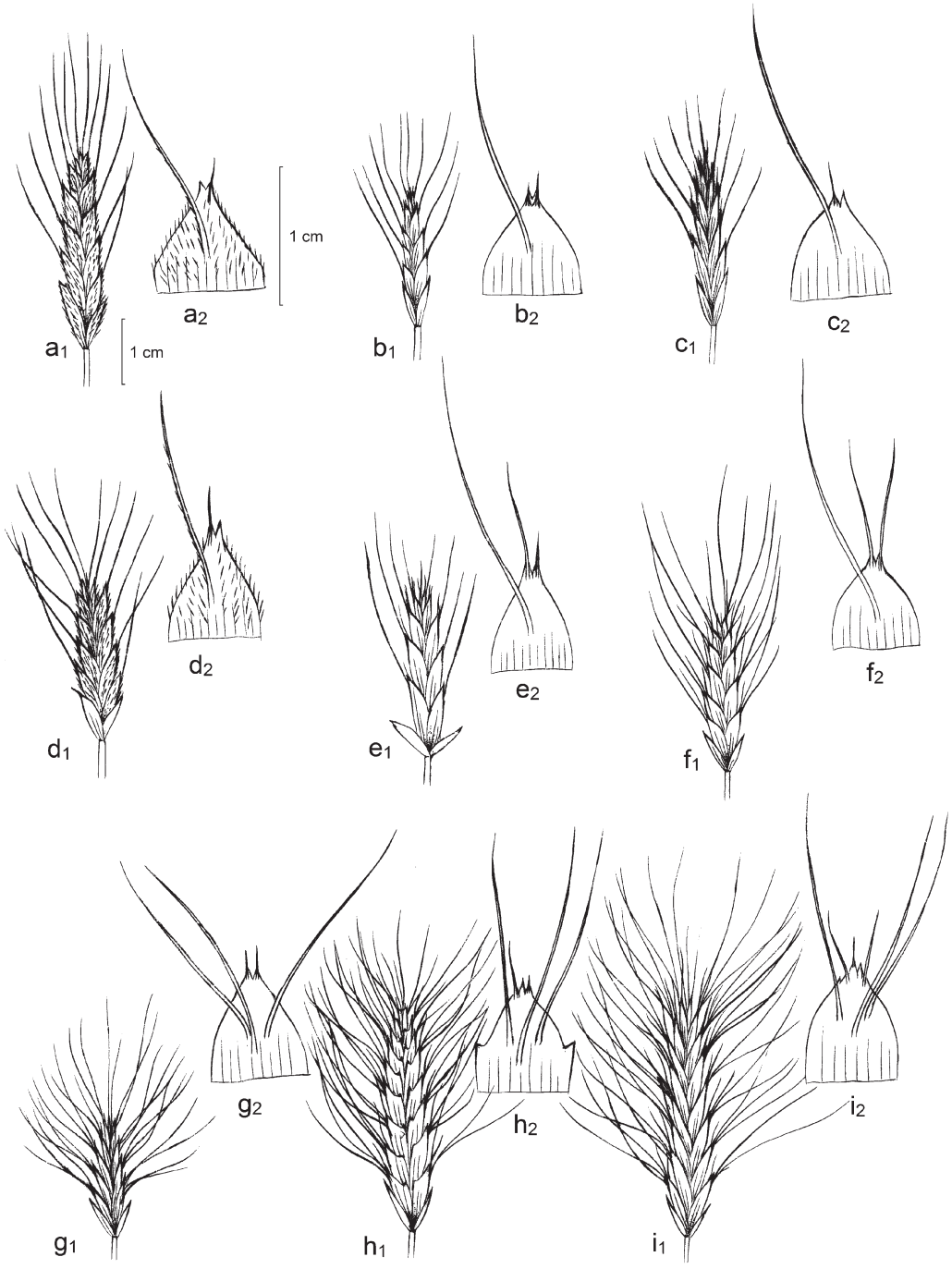
= *B. danthoniae* Trin. var. *lanuginosus* Roshev., Trudy Glavn. Bot. Sada 38: 135 (1926).
Type: no type designated [n.v.].

= *B. danthoniae* Trin. subsp. *rogersii* C.E. Hubbard ex H. Scholz, Willdenowia 28: 147 (1998).

Fig. 1: The gradual appearing of the awn insertion in apex of the lemma of *Bromus danthoniae*. ▶ a–e: var. *pauciaristatus*, f–i: var. *danthoniae*. a_1–i_1) spikelet structure, a_2-i_2) awns status in apex of the lemma.

a–e: var. *pauciaristatus*: a: most lemmas with one awn, only the uppermost lemma plus one minute awn (awnlet): 5. 5. 2011, Naderi s.n. [University of Isfahan]; b: most lemmas with 1 awn, only the uppermost lemma plus two minute awns (awnlets): Naderi & Hosseini 1065 [University of Isfahan]; c: most lemmas with one awn, the upper lemmas plus one minute awn (awnlet): Naderi 1129 [University of Isfahan]; d: most lemmas with one awn, the uppermost lemma with two awns: Hamzeh’ee et al. 95177 [TARI]; e: some lemmas with one awn, the upper lemmas with two awns plus one minute awn (awnlet): Naderi & Jafari 1062 [University of Isfahan];

f–i: var. *danthoniae*: most lemmas with three awns (one central and two lateral awns), the morphological characters of this specimen are more common in the field: Naderi & Hosseini 1056 [University of Isfahan]; g: most lemmas with three awns, the lowermost, second or third lemma with three awns plus two minute awns (awnlets): Eftekhari 80 [TARI]; h: most lemmas with four awns, the lowermost, second or third lemma with awns plus one or two minute awns (awnlets): Dini & Arazm 10454 [TARI]; i: most lemmas with five awns (one central and four (two long + two short) lateral awns), the lowermost or second lemma with five awns plus one minute awn (awnlet): Riazi 5038 [TARI].


1 cm
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c2
d1
d2
e1
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f1
f2
g1
g2
h1
h2
i1
i2

Type: Prov. Bamian, Band-i Amir, ad lacum Band-i Gholaman, ca. 2800 m, ca. 34°23' N, 67°17' E, 16. 7. 1962, Rechinger 18477 [holo B!; iso W 1963-0001351!].
Annotation: The name *Bromus rogersii* on two sheets of Rechinger 18477 was in 1963 ascribed by Bor to C.E. Hubbard, but this name was never published. Scholz (1998) wanted to give the honour of naming this taxon to Hubbard and cited the name as "(C.E. Hubbard ex) H. Scholz".

= *B. danthoniae* Trin. var. *submuticus* Mouterde, Nouv. Fl. Liban Syrie 1: 127 (1966).
Type: Syria, Palmyre, Tell Daba, Pabot [G photo!].

= *B. pseudodanthoniae* Drobov var. *pubiglumis* Tzvelev, Spisok Rast. Gerb. Fl. SSSR 19: 61 (1972).
Type: Tajikistan, in valle fl. Kafirnigan, in segetis prope pag. Shurion-Bash, 21. 5. 1947, n° 902, Varivzeva & Nepli [LE].

= *B. turcomanicus* H.Scholz, Willdenowia 28: 148 (1998).
Type: Turkmenistan: Prov. Ashabad, Gaudan, 27. 5. 1898, Litwinow 2304 [W 1940-0022852!].

var. *pauciaristatus* Naderi, var.n. – Fig. 1 a–e.
Description: Spikelets laterally compressed or terete, glabrous or pubescent; most lemmas 1 awn; at least one spikelet of panicle in its upper lemmas more than 1 awn, or 1 awn with 1 or more minute awns (awnlets).
Holotype: Iran, Tehran, Darband [Derbent], Kotschy 750 [W 0041169!].

= *B. danthoniae* Trin. var. *uniaristatus* Melderis, Ark. Bot., ser. 2, 5 (1): 63 (1960), nom. inval. (no type designated, Code § 40.1); based on specimens from Lebanon (Samuelsson 1372, 1372a, 2243, 5712, 5715).
Original specimen seen: Lebanon, Djebel el Kenisseh, 5.6.1933, G. Samuelsson 5715 [FR 0030163, as "isolectotype". scan!].

Sect. *Boissiera* (Hochst. ex Steud.) P.M.Sm., Notes Roy. Bot. Gard. Edinburgh 42 (3): 492 (1985).
≡ *Boissiera* Hochst. ex Steud., Syn. Pl. Glum. 1: 200 (1855).

***Bromus pumilio* (Trin.) P.M.Sm.**, Feddes Repert. 79: 338 (1969). – Fig. Bor (1968), Fl. Iraq 9: 129, pl. 44 (1968), as *Boissiera squarrosa*.
≡ *Pappophorum pumilio* Trin., Mém. Acad. Sci. Pétersb. ser. 6, Sci. Math. 1: 92 (1830).
≡ *Boissiera pumilio* (Trin.) Hack., Denkschr. Akad. Wiss. Wien, Math.-Nat. Kl. 50: 9 (1885).
Type: Iran, prov. Azerbaijan, Khoi, prope Seidchodzi, 17. 6. 1828, Szowits [LE].
Differing character: Lemma (5–) 7–9 awns**.**
Annotation: at the moment *B. pumilio* is placed in sect. *Boissiera* following Oja & Jaasaka (1998) and Saarela et al. (2007). The status of this section needs critical evaluation.

= *Pappophorum squarrosum* Sol., Nat. Hist. Aleppo, ed. 2, 2: 244 (1794), non *B. squarrosus* L. (1753).
≡ *Boissiera squarrosa* (Sol.) Nevski, Trudy Sredne-Aziatsk. Gosud. Univ. (Acta Univ. Asiae Med.) ser. 8b (Bot.) 17: 30 (1934).
Type: Syria, Russel [BM].

Specimens seen

Bromus danthoniae var. *danthoniae* (selected specimens)

Iraq: Distr. Kut al-Imara, Badra, 12.–13.4.1957, Rechinger 9182 [W 1960-0024055; – 16 km SE Badra, 12.–13.4.1957, Rechinger 13963 [W 1960-0023270]; – 30 km SE Badra, 12.–13.4.1957, Rechinger 9155 [W 1960-0024168]; – Distr. Amara (Mesopotamia), Shatt at-Tib, 50–200 m, 32°30' N, 47°10' E, 27.–28.3.1957, Rechinger 14179 [W 1960-0023275]; – Distr. Mosul (Kurdistan), ad confines Turciae prov. Hakari, in ditione pagi Sharanish, in montibus calc. a Zakho septenterionem versus, ca. 1100 m, 4.–9.7.1957, Rechinger 12022 [W 1960-0023236], 12056 [W 1960-0023236]; – Distr. Sulaimaniya (Kurdistan), in ditione pagi Penjwin, 1400 m, 19–20.6.1957, Rechinger 12304 [W 1960-0023263]; – Inter Sulaimaniya et Dokan, in jugo prope Surdash, ca. 1000 m, 14.6.1957, Rechinger 10100 [W 1960-0023260]; – Inter Kirkuk et Sulaimaniya, in saxosis calc. angustriarum Darband-i Bazian prope Chamchamal, 13.6.1957, Rechinger 12196 [W 1960-0023241]; – Qara Anjir, 27 km a Kirkuk orientem versus, ca. 600 m, 13.6.1957, Rechinger 10019 [W 1960-0023262]; – inter Ana et Al. Qaium, 13.4.1972, Hamid 392/8 [B].

Iran: Golestan: Golestan National Park, 23–26 km E Tang-e Rah, 37°25' N, 55°45', 900–1000 m, in alveo arenoso-glareoso, 4–5.6.1975, Rechinger 52811 [W 1980-0003773]; – Almeh, infra refugium, 1400–1500 m, 9.6.1975, Rechinger 53200 [W 1979-0012143]; – in planitie ["dasht"] ad viam versus Almeh ducentum, N Robat-e Qareh Bill, 37°19' N, 56°26' E, 1200 m, 5.6.1975, Rechinger 52874 [W 1979-0012141]; – Gilan: inter Rasht et Qazvin, 500–600 m, 11.5.1902, Bornmüller 8403 [B]; – Azerbaijan: inter Ahar et Meshgin Shahr, 1400 m, 27.5.1958, Merton 3462 [W 1964-0016053]; – Meshkambar prope Tabriz, Mirdamadi 1697 [W 1970-0009046]; – Kurdistan: 20' N of Sanandaj, 4500 ft., 17.5.1962, Furse 2097 [W 1964-0013867]; – Bakhtiari: Kuhrang, 2200 m, 32°27' N, 50°09' E, 31.5.1959, Wendelbo 968 [W 1960-0022687]; – Ilam: Ilam, 400–450 m, 33°17' N, 46°15' E, 17.4.1963, Jacobs 6255 [W 1964-0004408]; – Lorestan: 2 km E Milavi, inter Khoarramabad et Andimeshk, ca. 2500 ft.. 20.4.1960, Bent & Wright 420-130 [W 1960-0016104], 420-134 [W 1960-0016104]; – Dorud, 20.5.1941, Koelz 17648 [W 1960-001090]; – ibid., 24.5.1941 Koelz 17738 [W 1960-0000631]; – S. Lorestan, Sheshom, 700–750 m, 33°06' N, 47°43' E, 24.4.1963, Jacobs 6396 [W 1964-0004106]; – Kermanshah: Gilan-e Gharb, 15.5.1948, Behboudi 229 [W 1964-0014460]; – Qasr-e Shirin, 23.4.1950, Behboudi 8050 E [W 1965-0019396]; – 45 km S of Kermanshah, ridge to W of Mahi-Dasht valley 15.5.1960, Bent & Wright 515-201a [W 1960-0016058]; – Khuzistan: inter Ahwaz et Molla Sani, 4.4.1974, Hübl & Holzner s.n. [W 1979-0016109]; – Sad-de Dez [Dam], NE Andimeshk, 26.4.1960, Bent & Wright 426-307 [W 1960-0016100]; – Pazanan, Gauba & Sabeti 1700 [W 1964-0014338]; – Fars: Pasargard, 15 km N Saadatabad, 2000 m, 21.5.1964, Grant 15,792 [W 1965-0017889]; – Kazerun, Gauba & Sabeti 1699 [W 1964-0014337]; – 10 km Farasaband, 23.9.1998, Weber s.n. [B]; – Hormozgan: Lar, Hadjiabad prope Tarum, ca. 900 m, 29.4.1948, Rechinger & Rechinger 3254 [W 1964-0014217]; – Kerman: Kerman, 2000 m, 2.5.1892, Bornmüller 4899 [B]; – In monte Kuh Seidin ditionis Kerman, 2000 m, 11.5.1892, Bornmüller 4895, 4896 [B]; – Montes Djamal Bariz inter Bam et Djiroft, Deh Bakri, 8.-10.5.1948, Rechinger & Rechinger 3661 [W 1960-0022927]; – inter jugum Chah Choghuk [Chafut] et Tarum, ca. 1400 m, 28.4.1948, Rechinger & Rechinger 3213 [W 1964-0014216], 7458 [W 1964-0014218]; – Baluchistan: Taftan mts., 1750m, 25.4.1977, Rechinger 54733 [W 1982-0007049, B]; – Khorasan: Golestan National Park, NW Khorasan, Mirza-Baylu planis, N Armadlu, 1200–1250 m, 37°19' N, 56°11' E, 24.5.1995, Akhani 10879 [W 2000-0007410, B]; – NW Khorasan [N Semnan], 4–5 km NW Bidak, Cheshmeh-Derazi, 1300–1500, 37°17' N, 55°53' E, 17.5.1995, Akhani 10713 [W 2000-0007380]; – montes Kopet Dagh prope Quchan, 1500 m, 14.–15.7.1937, Rechinger 1620 [W 1970-0008632, B]; – montes Kopet Dagh, Inter Quchan et jugum Alamli, 600 m, 3.6.1948, Rechinger & Rechinger 7243 [W 1960-0022966]; – Jowzak, 74 km W Bojnurd versus Gorgan, 35°26' N, 56°45' E, 1100 m, 18.6.1975 Rechinger 53741 [W 1980-0003545]; – inter Chenaran et Quchan, ca. 1200–1300 m, 2.6.1948, Rechinger & Rechinger 4724 [W 1960-0022964]; – Montes Kuh-e Nishapur, Darre Abshar supra Akhlamat [Akhlamd Olia], ca. 1600–1800 m, 30.5.1948, Rechinger & Rechinger 4635 [W 1960-0022848]; – Darrud to Jaghargh, mts. Binalud, 2100–2600 m, 3.6.2010, Naderi & Hosseini 1056 [University of Isfahan]; – inter Torbat-e Heidariyeh et Assadabad, 27.5.1948, Rechinger & Rechinger 4392 [W 1964-0014213]; – in collibus ad Turbat-e Haidari, ca. 1300 m, 27.5.1948, Rechinger & Rechinger 4331 [W 1964-0014214]; – Helali, inter Gonabad et Bejestan, 34°29' N, 58°22' E, 1250 m, 10.5.1975, Rechinger 51572 [W 1980-0003721, B]; – Semnan: In montibus prope Tuweh a Damghan boreo-occidenttem versus, 1900–2250 m, 7.6.1977, Rechinger 56483 [B]; – Turan Protected Area, in jugo inter Asb Keshan et Bargh, Tonschiefer, 35°21' N, 56°56' E, 1200 m, 2.5.1975, Rechinger 51045 [W 1978-0003581]; – ibid., 12 km SSE Razveh at trail to Kavir, ca. 1100 m, 26.4.1978, Freitag

14811 [B]; – ibid., Shakh-e Biar SW Biarjomand, 1150 m, 3.5.1978, Freitag 15054 [B]; – inter jugum Bashm et Sorkhe, ca. 1600–2200 m, 29.–30.4.1937, Rechinger 1213 [W 1970-0008633]; – Tehran: Elburz, Mt. Demavand, 2640 m, 22.7.1936, Gilli [W 1963-0001605, W 1963-0001606]; – 20' SE Firuzkuh, 7000 ft., 30.6.1962, Furse 3000 [W 1964-0013857]; – SW Sad-e Latyan, 1900 m, 21.5.1973, Bazargan & Arazm 10670 [B]; – Elburz, Gachsar, 18.6.1962, Furse 2620 [W 1965-0016491]; – Kalak, prope Karadj, 17.5.1937, Rechinger & Rechinger 138a [W 1970-0008634]; – Karadj, 1934, Bornmüller 154 [B]; – Prope Qazvin, 1300 m, 16.5.1902, Bornmüller 8407 [B].

Turcomania: Montes Kopet-dag, distr. Eshghabad, in vicinitate pagi Chuli, 700–1000 m, 15.5.1984, Vašák s.n. [W 1987-0004376]; – Prov. Ashabad, Litwinow 2243 [W 1940-0022957], 2288 [W 1940-0022839]; – Prov. Ashabad, Gaudan, 27.5.1898, Litwinow 2304 [Type of *B. turcomanicus*, W 1940-0022852].

Afghanistan: Gardez, in altoplanitie lapidosa vallis Logar 50 Km N Gardez, 2000 m, 33°37' N, 69°09' E, 2.6.1967 Rechinger 35361 [W 1968-006889]; – Mazar-i Sharif, in declivibus occidentalis jugi Shibaghlu, 34 km E Tashkurghan, 600 m, 36°43' N, 68°07' E, 10.5.1967, Rechinger 34277 [W 1968-0006892]; – Orozgan, 20.6.1960, Lindberg 936 [W 1970-0008994]; – 35 km NW Urgun versus Surmat, 2200–2400 m, 10.6.1967, Rechinger 35928 [W 1968-0006888]; – in collibus inter lacum artificiale Arghandab Reservoir et Tirin, 1400–1700 m, 23.5.1967, Rechinger 35043 [W 1968-0006891]; – Kabul, 1780 m, 21.5.1951, Gilli 645 [W 1963-0001532]; – Kabul, Band-i, Kharaghuk, 2050 m, 34°32' N, 69°06' E, 24.6.1965, Rechinger 31255 [W 1966-0001900]; – Kabul, Kuh-i Nanagak south of Gulbagh, 1830 m, 14.5.1962, Hedge & Wendelbo W.3198 [W 1963-0014940]; – Kabul, E of Korogh, 1950 m, 17.5.1950, Gilli 648 [W 1963-0001602]; – Kabul, in valle Paghman prope Kabul, 2300–2800 m, 21.6.1962, Rechinger 17126 [W 1963-0001109]; – Kabul, Aliabad, 27.5.1951, Neubauer 149 [W 1964-0014098], Neubauer 832 [W 1964-0014087]; – Kabul, iter Asamai et montes Aliabader, 3.8.1949, Gilli 647 [W 2004-0007770]; – Kabul, Koh-e Tschelsotun, 2200 m, 24.5.1950, Gilli 654 [W 1963-0001591]; – Kabul, viriditas in horto domus, 25.5.1951, Neubauer 133 [W 1964-0014099]; – Kabul, Chamane, Hashmatkhan, 1750 m, 29.6.1976, Veldkamp 7210 [W 2007-0016063]; – 5 km S Arghandeh inter Kabul et Ghazni, ca. 1900 m, 34°28' N, 68°56' E, 29.6.1962, Rechinger 17212 [W 1963-0001148]; – Prov. Bamian, Band-i Amir, ad lacum Band-i Gholaman, ca. 2800 m, ca. 34°23' N, 67°17' E, 16.7.1962, Rechinger 18477 [holotype of *B. danthoniae* subsp. *rogersii*, B; isotype W 1963-0001351]; – Bandi-i Amir, ad lacum Band-i Panir, ca. 2800 m, 34°23' N, 67°17' E, 14.7.1962, Rechinger 18335 [W 1963-0001119]; – ibid., in declivibus saxios aridis, Rechinger 18234 [W 1963-0001168]; – Bamian, Koh-i Baba, 2900 m, 21.7.1949, Gilli 657 [W 1963-0001602]; – Ghorat province, 17.3 miles W of Chagcharan, by Hari Rud, Usturkhan, 7.200 ft, 20.6.1971, Grey-Wilson & Hewer 1176 A [W 1973-0013221]; – Darrah-i Tarbolagh, Sare Bum, 2880 m, 29.7.1970, Podlech 18964 [B]; – Kandahar, ad margines deserti Registan, 20 km S Kandahar, 1000 m, 31°36' N, 65°47' E, 27.5.1967, Rechinger 35293 [W 1968-006890]; – Kandahr, 30 km E Dilaram versus Girishk, 1050 m, 24.4.1967, Rechinger 33519 [W 1968-0006893]; – Kandahar-Gebiet, ca. 900–1000 m, Kerstan 316 [W 1960-0023935]; – Kandahar, ad marginum deserti Dasht-i Margo SW Qala Bist, 820 m, 31°28' N, 64°21' E, 18.5.1967 Rechinger 34525 [W 1968-0006895], 34499 [W 1968-0006798]; – Prov. Farah, 46.8 miles of Farah, road to Dilaram, 2400 ft., 19.4.1971, Grey-Wilson & Hewer 551 [W 1973-0013182]; – Prov. Ghazni, Sang-i Masha, ca. 2500 m, ca. 33°15' N, 67°10' E, 30.6.1962, Rechinger 17477 [W 1963-0001236]; – ibid., Rechinger 17418 [W 1963-0001233]; – Jija, 900 m, 10.4.1949, Köie 4253 [B].

Pakistan: Urak-Tal, 15 miles W Quetta, 5.1958, Repp s.n. [W 1958-0019318]; – Quetta, Spin Karez prope Quetta, 1800–1900 m, 11.5.1965, Rechinger 29209 [W 1966-0001975]; – Sariab S Quetta, 30°15' N, 67°00' E, in cutis irrigates, 1700 m, 7.5.1965, Rechinger 28830 [W 1966-0001936]; – Yaro prope Bostan, 40 km NNE Quetta versus Pishin, 1450 m, 30°23' N, 67°00'E, 8.5.1965, Rechinger 28943 [W 1966-0002031].

Bromus danthoniae var. *pauciaristatus*

Turkey: Ermenek [Cilicia], Yemourdaba-Dagh, Péronin 217 [W 1916-0014645]; – Bitlis, in jugo Kuzgunkivan Gecidi inter Gevash et Reshadiye, 2200 m, 1.7.1975, Rechinger 53920 [W 1980-0003548 pro parte].

Iraq: Distr. Sulaimaniya [Kurdistan], in ditione pagi Penjwin, 19.–20.6.1957, Rechinger 12237 [W 1960-0023136].

Iran: Golestan: Gorgan, Khushyeylagh, 1750 m, 36°50.920' N, 55°20.838' E, 26.5.2011, Naderi 1129 [University of Isfahan]; – Mazandaran: Sari, Vavsar, S slopes of Shahdezh mountain, 2500–2750 m, Naderi

& Jafari 1062 [University of Isfahan]; – N of Kandavan neck, 2450 m, Runemark & Mozaffarian 25765 [TARI]; – Elburz, Pole Zangule, 2000 m, Gauba 1830 [B]; – Azerbaijan: Arasbaran Protected Area, Kalana mountain, W of guard station, 2470–2550 m, Jamzad et al. 70223 [TARI]; – Kiyamaki Protected Region, Kiamaki Dagh ad boreo-orientem a pago Miab, secus rivulum, 2100 m, 16.6.1977, Rechinger 56833 [W 1982-0007031]; – SW margin of Ghori Goli lake, 2050 m, Zehzad et al. 70315 [TARI]; – Orumieh University, Ansari 4442 [TARI]; – Orumieh, Soluk, 2300 m, Sabeti 5061 [TARI]; – Mahabad, Boana, 1700 m, Fattahi & Bolouki 62 [TARI]; – 50 km to Sardasht from Mahabad, 1580 m, Runemark & Mozaffarian 29130 [TARI]; – 18 km Sardasht to Piranshahr [Khaneh], 1000 m, Runemark & Forughi 19901 [TARI]; – Kurdistan: 25 km Baneh to Sanandaj, route of Nekerouz mountain, 1560 m, Hamzeh'ee et al. 95177 [TARI pro parte]; – 75 km W.N.W of Sanandaj towards Marivan, 1890 m, 18.5.1966, Archibald 2053 [W 1968-0017043]; – 2 km Marivan, 1330 m, Fattahi & Khaledian 1192 [TARI]; – Sanandaj, Zaleh station, 1540 m, Fattahi & Khaledian 1192 [TARI]; – Hamedan: Ganj-nameh, 1100–1400 m, Ariavand s.n. [University of Isfahan]; – 8 km SW of Hamedan, 2100 m, Pabot 27526 [TARI]; – Kermanshah: Kamyaran to Songhor, Kori-zagheh, 1900 m, Hamzeh'ee & Asri 87983 [TARI]; – 95 km Kermanshah to Kerend-e Gharb, 1420 m, Hamzeh'ee 807 [TARI]; – Lorestan: Chaman-soltan, 1430 m, Nekouei & Sahebi 15698 [University of Isfahan]; – 50 km Aligodarz, Shoul-abad, 1700 m, Runemark & Lazari 26353 [TARI]; – Kohkiluyeh va Boyer-Ahmad: iter Yasouj et Eqlid, Cheshmeh-Chenar, 2170 m, 5.5.2011, Naderi s.n. [University of Isfahan]; – Sisakht, 2209 m, 30°51.615' N, 51°28.470' E, 20.4.2010 Naderi 1063 [University of Isfahan]; – Bakhtiari: Brojen, Protected Area, 1700 m, Nowroozi 2496 [TARI]; – Fars: Sepidan, gas station, 2150 m, Naderi 1064 [University of Isfahan]; – Khorasan: Darrud to Jaghargh, mts. Binalud, 2100–2600 m, 3.6.2010, Naderi & Hosseini 1065 [University of Isfahan]; – Esfarayen, N slopes of Shah-e Jahan mountain from Darparchin-e bala, 1700–2500 m, Mozaffarian 48507 [TARI]; – 40 km Ghayen to Haji-Abad, 1213 m, 33°42.102' N, 59°38.281' E, 21.5.2011, Naderi s.n. [University of Isfahan]; – Semnan: Shahrud, Abr mountain, 1400 m, Riazi 5171 [TARI]; – Tehran: Pulur, 1350 m, Dini & Arazm 10438 [TARI]; – Lar to Pulur, road of Haraz, 2550 m, 19.7.1972, Dini & Arazm 10502 [TARI]; – Lar valley, 2420 m, Wendelbo & Assadi 13315 [TARI, W 1975-0006556]; – Lar, Kharsang, 2500 m, Amin 10630 [TARI]; – Haraz [Ordugah-e Haraz rood], 1930 m, Forughi 2555 [TARI]; – Elburz, S of Kandevan tunnel, 2150 m, 36°08' N, 51°18' E, 24.6.1959, Wendelbo 2151 [W 1960-0022606]; – 24' NNE Tehran, 6500 ft., 11.7.1962, Furse 3142 [W 1964-0013806]; – Elburz, Gachsar, 18.6.1962, Furse 2620 [W 1964-0013825 pro parte]; – Taleghan, Jovestan, 1850 m, Babakhanlou & Amin 19591 [TARI]; – Amir-abad, road of Ghazvin to Rasht, 2000 m, Foroughian & Hariri 10473 [TARI]; – Arak, Khan-e miran, Sefid-khani mountain, 2100–2300 m, Mozaffarian & Massoumi 47758 [TARI].

Afghanistan: Farah rud, inter Shindand et Dilaram, 1150 m, 24.4.1967, Rechinger Iter Orientale 33413 [W 1970-0008915]; – Kabul, in valle Paghman prope Kabul, 2300–2800 m, 21.6.1962, Rechinger 17171 [W 1963-0001304]; – 15 km N of Salang Pass, 2450 m, 2.7.1976, Veldkamp 7226 [W 2007-0016022].

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