

A revision of *Bromus* sect. *Triniusa* (*Poaceae*) in Khorassan (Iran)

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Abstract

Bromus sect. *Triniusa* is revised in Khorassan based on the new taxonomic concepts of *Bromus danthoniae* complex group and a remarkable herbarium material collected from Khorassan (Kopetdagh, northeastern Iran), as the main center of its diversity. *Bromus turcomanicus*, a narrow endemic species in central Kopetdagh hitherto known only from the type locality in southern Turkmenistan, is newly recorded for the flora of Iran. The presence of *Bromus pseudodanthoniae*, a neglected species in Flora Iranica, is confirmed. An identification key and additional note on taxonomy and biogeography of three-awned *Bromus* species is presented.

Keywords: Biogeography, brome grass, conservation, Khorassan, morphology, taxonomy

بازنگری بخش *Triniusa* از جنس *Bromus* (تیره گندمیان) در خراسان

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خلاصه

بخش *Triniusa* از جنس *Bromus* در خراسان براساس مفاهیم جدید آرایه‌شناختی کمپلکس *Bromus danthoniae* و جمع‌آوری نمونه‌های هرباریومی قابل توجه از حوزه خراسان-کپه داغ در شمال شرق ایران، به عنوان مرکز اصلی تنوع این بخش، مورد بازنگری قرار گرفته است. گونه اندمیک *Bromus turcomanicus* در کپه‌داغ مرکزی که تاکنون فقط از محل تیپ در جنوب ترکمنستان شناخته شده است، به عنوان گزارشی جدید برای فلور ایران معرفی می‌شود. حضور *Bromus pseudodanthoniae* در ایران، گونه‌ای فراموش شده در فلورا ایرانیکا، تایید می‌گردد. کلید شناسایی و یادداشت‌های تکمیلی درباره آرایه‌شناسی و جغرافیای زیستی گونه‌های سه سیخکی *Bromus* آرایه می‌شود.

واژه‌های کلیدی: جغرافیای زیستی، حفاظت، خراسان، رده‌بندی، ریخت‌شناسی، علف جارو

Introduction

Grasses make up one of the largest families of flowering plants and are rather uniformly distributed on all continents and in all climatic zones. Therefore, family *Poaceae* plays the most important role both in man's economic activity and in the composition of natural plant communities (Tzvelev 1989). *Bromus* L. (*Bromeae*: *Pooideae*) is a large genus of ca. 160 annual and perennial species and has been variously split into several groups as sections, subgenera, or generic segregates (Smith 1970, Tzvelev 1976, Stebbins 1981, Acedo & Llamas 2001). Acedo & Llamas (1999) comprehensively reviewed nomenclatural history of the infrageneric classification of the genus. There are many species complexes in this genus due to wide geographical range, high degree of morphological similarities, hybridization and polyploidy (Saarela *et al.* 2007, Fourtune *et al.* 2008).

Bromus danthoniae Trin. complex is an East Mediterranean-Southwest Asian group which comprises three species having three-awned lemmas. These species have been differently classified in several infrageneric taxa. Bor (1970) wrongly placed this group in sect. *Neobromus* (Shear) Hitchc. which is a quite distinct taxon with two annual hexaploid species in Pacific coasts of North and South America. Morphologically, three-awned *Bromus* species have been placed in sect. *Triniusa* (Steud.) Nevski (Tzvelev 1976, Scholz 1998) or subgen. *Triniusa* (Steud.) Pénzes (Stebbins 1981). Using isozyme data, Oja & Jaaska (1998) showed that *B. danthoniae* is distinct from diploid species of sect. *Bromus*, however, available molecular data on *B. danthoniae* and its relatives indicate that these species are nested within sect. *Bromus* (Ainouche & Bayer 1997, Saarela *et al.* 2007).

Originally, sect. *Triniusa* was circumscribed as a monotypic section that included *B. danthoniae*. Tzvelev (1976) placed *B. pseudodanthoniae* Drobow, a neglected species by Bor (1970) in Flora Iranica, in sect. *Sapheneuron* Nevski and speculated a hybrid origin for it as *B. danthoniae* × *B. scoparius*. Scholz (1998) retreated sect. *Triniusa* to include *B. danthoniae* and a newly described species, *B. turcomanicus* H.Scholz. He placed *B. pseudodanthoniae* as a subspecies of *B. danthoniae*, however, it has been accepted as a separate species by Tzvelev (1976), Czerepanov (1995), Quattrocchi (2006) and Clayton *et al.* (2006). In this paper, *Bromus* sect. *Triniusa* is taxonomically revised in Iran, mainly based on extensive collections from Khorassan-Kopetdagh as the main center of its diversity in the World.

Materials and Methods

Herbarium specimens of the genus *Bromus*, collected from NE Iran and S Turkmenistan in FUMH and W, were identified and examined using relevant literatures (Bor 1970, Tzvelev 1976, Scholz 1998). The distribution map of the species has been provided using geo-referenced distribution data in DIVA-GIS 7.3 software. IUCN Red List categories and criteria (IUCN 2010) have been consulted to determine the threat status of the species.

Results and Discussion

Bromus* sect. *Triniusa (Steud.) Nevski, in Trudy Sredne-Aziatsk. Gosud. Univ., Ser. 8c, 17: 23 (1934).

Annual grasses; Spikelets with three-awned lemmas, at least on the uppermost ones; Lemmas with two acute or blunt apical teeth, ovate to oblong-lanceolate, glabrous or hairy. Three species are accepted:

1. Lemma apex with 2 (or 4) sharply acute lobes; central awn inserted more than 2 mm below the apex 2
- Lemma apex with 2 short and blunt lobes; central awn inserted 1–1.5 mm below the apex 3. *B. turcomanicus*
2. Spikelets highly laterally compressed; middle and upper lemmas of mature spikelets three-awned; anthers 1.2–2 mm long 1. *B. danthoniae*
- Spikelets slightly laterally compressed and densely borne; only the uppermost lemmas of mature spikelets three-awned; anthers usually shorter than 1.2 mm 2. *B. pseudodanthoniae*

1. *Bromus danthoniae* Trin. in C.A. Mey., Verz. Pfl. Casp. Meer (C.A. von Meyer), 24 (1831)

Syn.: *Triniusia danthoniae* (Trin.) Steud., Syn. Pl. Gram. 328 (1855); *Boissiera danthoniae* (Trin.) A. Braun, Ind. Sem. Hort. Berol. 3 (1857); *Bromus macrostachys* Desf. var. *triaristatus* Hack., In: Flora 62: 155 (1879); *B. macrostachys* Desf. var. *danthoniae* (Trin.) Asch. & Graebn., Syn. Mitteleur. Fl. 2: 627 (1901); *B. danthoniae* Trin. var. *lanuginosus* Roshev., In: Fedtsch., Fl. Turkmen. 1: 166 (1932); *B. lanceolatus* Roth. var. *danthoniae* (Trin.) Dinsm., In: G.E. Post, Fl. Syria, ed. 2, 2: 775 (1933); *B. danthoniae* Trin. var. *uniaristatus* Melderis, In: Ark. Bot. ser. 2, 5: 63 (1959), nom. invalid.

Specimens examined: Iran, Khorassan, SW Dargaz, 25 km on the road towards Tandooreh, Chehelmir, 1000–1200 m, Ghoreshi 626G (FUMH); NW Taybad, Dahan-e Hemmat-Abad village, 1450 m, Ayatollahi & Mahvan 11083 (FUMH); SW Sarakhs, around Bazangan Lake, 1000 m, Ayatollahi & Mahvan 11129 (FUMH); SE Torbat-e Heydarieh, between Roshtkhar and Khaf, Pir-e Yahu, 2000 m, Ayatollahi & Zangooei 12409 (FUMH); SE Kalat-e Naderi, 5 km south of Zavin, 1620 m, Ayatollahi & Joharchi 13120 (FUMH); S Faruj, between Tabarian and Churak-Khaneh (Olang), 2200 m, Joharchi & Zangooei 14749 (FUMH); SE Tabas, Chyruk elevations, 1400 m, Ayatollahi & Zangooei 15273 (FUMH); SE Mashhad, on the road towards Saleh-Abad, Qichdar foothills, 700 m, Joharchi & Zangooei 20250 (FUMH); NW Gonabad, Bajestan, 5 km from Miandehi towards Marandiz, 800 m, Hojjat & Zangooei 28405 (FUMH); E Torbat-e Jam, on bifurcation road to Doabi, 675 m, Joharchi 34091 (FUMH); SW Chenaran, between Fereizi & Abghad, Doabi, 1600 m, Emadzade, Memariani & Zangooei 35994 (FUMH); W Mashhad, Kang mountains, 1500–1600 m, Joharchi & Zangooei 36518 (FUMH); E Bojnord, 3 km on the road towards Baba-Aman, 1020 m, Memariani & Zangooei 37505 (FUMH); SW Bojnord, Rein, eastern slopes of Shah-Neshin Mt., 1700 m, Memariani & Arjmandi 37643 (FUMH); W Bojnord, 3 km north of Dasht village, southern border of Golestan National Park, 980–1030 m, Memariani & Zangooei 39643 (FUMH); NW Bojnord, 3 km from Tange-Raz towards Raz, 1050 m, Memariani & Zangooei 40237 (FUMH); NE Shirvan, 5 km from Namanlu towards Bardar, in *Juniperus* woodland, 2040 m, Memariani & Zangooei 40733 (FUMH); N Faruj, 3 km from Kuran-Kordieh towards Sarcheshmeh, 1550 m, Memariani & Zangooei 42910 (FUMH); W Bojnord, Ghorkhod Protected Area, 10 km from Zard towards Kastan, 1625 m, Memariani & Arjmandi 43850 (FUMH).

- Biogeography and ecology

This species is widely distributed from Eastern Europe, East Mediterranean, Anatolia and Caucasia, through the Middle East to the Middle Asia, Tibet, W Himalaya and NW India. It also grows in a wide range of habitats such as steppes, sandy deserts, roadsides and fields, dry limestone slopes, up to middle mountain belt and is common and abundant in many plant communities in its distribution area, so it is evaluated as Least Concern (LC).

- Taxonomy

Morphologically, it is a highly polymorphic species. Spikelets are highly laterally compressed with lemmas which are sharply acute, bifid to quadrifid; middle and upper lemmas of the mature spikelets have three strongly bent or recurved awns; central awn inserted 3–6(–7) mm below the apex and the other two awns are shorter, erect and sub-terminal. Sometimes, the uppermost lemmas are five-awned with two outer very short and filiform awns. In several *Bromus* species, such as *B. danthoniae*, the absence or presence of indumentum in spikelets has been used to separate the varieties; *B. danthoniae* var. *lanuginosus* differs from the type variety by its short-pilose spikelets (Bor 1970, Tzvelev, 1976). Acedo & Llamas (1999) concluded that indumentum of spikelets is always a very variable character in the genus *Bromus*. Based on our observations in several specimens from the studied area, glabrous and hairy spikelets and also intermediate character states could be found not only in the same population but also in the same individual. In recent taxonomic concepts of family *Poaceae*, especially in genus *Bromus*, all morphological groups and infraspecific taxa described base on various indumentum characters of the spikelets, have been placed in synonymy of their type species (Clayton *et al.* 2006).

Bromus danthoniae var. *uniaristatus* is another infraspecific taxon characterized by glabrous lemmas which have only one awn except for the uppermost lemma or two uppermost ones (Bor 1970). According to Tzvelev (1976), it could be considered as only dwarf specimens of the type variety developed under extreme conditions (such as sand deserts). Hamzeh'ee *et al.* (2007) and Keshavarzi *et al.* (2007) simultaneously recorded this variety as a new record for the flora of Iran. All specimens in FUMH cited by Keshavarzi *et al.* (2007) were carefully examined. They are only very young collected or malformed specimens of *B. danthoniae*. Moreover, this variety is an invalid name because no type specimen was cited in the original description (Scholz 1998, Clayton *et al.* 2006). Therefore, it should be deleted from the list of Iranian flora.

2. *Bromus pseudodanthoniae* Drobow in M.G. Popov

(ed.), Key. Pl. Envir. Tashkent: 38 (1923)

Syn.: *B. macrostachys* Desf. var. *triaristatus* Boiss., Fl. Orient. 5: 652 (1854); *B. pseudodanthoniae* Drobow var. *pubiglumis* Tsvetlev in Spis. Rast. Gerb. Fl. SSSR, 103–106: 61 (1972); *B. danthoniae* Trin. subsp. *pseudodanthoniae* (Drobow) H. Scholz in Willdenowia 28: 147 (1998); *B. danthoniae* Trin. subsp. *rogersii* C.E. Hubb. ex H. Scholz in Willdenowia 28: 147 (1998).

Specimens examined: Iran, Khorassan, SW Bojnord, Rein, eastern slopes of Shah-Neshin mount, 1700 m, Memariani & Zangooei 37642 (FUMH); SW Bojnord, Rein, on the road towards Marjan rangelands, Barazanlu, 2220 m, Memariani, Zangooei & Arjmandi 37961 (FUMH); SW Bojnord, Rein, in Rein valley towards Garmak, in riverside 1600–1650 m, Joharchi, Zangooei & Arjmandi 38184 (FUMH); SW Bojnord, northern slopes of Aladagh Mnt., Bash-Rein, 2250–2380 m, Memariani & Zangooei 40739 (FUMH); NW Esfarayen, Salook National Park, Jowz valley, 1789 m, Joharchi & Zangooei 39772 (FUMH); SW Chenaran, Fereizi, Kandelan valley, 1808 m, Emadzadeh, Memariani & Zangooei 36130 (FUMH); SW Chenaran, Fereizi, northern slopes of Jaji Mnt., 1890–2060 m, Emadzadeh, Memariani & Zangooei 36362 (FUMH); SW Chenaran, 2 km from Fereizi towards Mohalleh-Sorkheh, 1730 m, Emadzadeh, Memariani & Zangooei 36409 (FUMH); SW Chenaran, Fereizi, Dermeh valley, in riverbank, 1973 m, Emadzadeh, Memariani & Zangooei 36698 (FUMH).

- Biogeography and ecology

This species is distributed from Caucasia, through Turkmenistan to Middle Asia (Syr-Darya, Amu-Darya, Hissar-Darvaz, Alai and Tien Shan regions) and grows on sands, stony mountain slopes, roadsides, fields and plantations (Tsvetlev 1976). Bor (1970) neglected this species in Flora Iranica and then Scholz (1998) recorded it as *B. danthoniae* subsp. *pseudodanthoniae* with only two specimens from central Alborz (Gach Sar) and Semnan province (Touran Protected Area). The specimen from Gach Sar (Tregubov 33) had been determined in Flora Iranica as *B. danthoniae* var. *danthoniae* (Bor 1970). Its populations in Khorassan are mainly growing in Aladagh, Salook and Binalood mountains on middle to high mountains slopes (1600–2400 m) specially as a ruderal plant in fields, orchards, roadsides and riverbanks (Figs 1 & 4). According to IUCN criteria and existing distribution data, this species is not regionally qualified as threatened but because of the number of

known and severely fragmented populations it is probable to be close to threatened (NT, Near Threatened).

- Taxonomy

This species is completely distinct from *B. danthoniae* by densely borne panicles and slightly laterally compressed and subterete spikelets and by having three awns only on the uppermost lemmas (Fig. 1) and also by shorter anthers. It is a morphologically variable species due to its habitats. Plants collected from dry mountain slopes are dwarf with only up to 15–20 cm long culms, looser panicles and recurved awns, for example specimens 39772 and 40739 (FUMH) collected from high mountain slopes of Salook and Aladagh. Specimens collected near the irrigated fields are higher with more densely borne spikelets in panicles and also with erect awns in younger plants; especially those growing on riverbanks are up to 65 cm high (38184 FUMH). Scholz (1998) described *B. danthoniae* subsp. *rogersii* based on erect central awns and its moist montane habitats and referred to its similarity to subsp. *pseudodanthoniae*. Clayton et al. (2006) in “GrassBase” placed this name in the synonyms of *B. danthoniae*. Based on the form of panicles, loosely compression of spikelets and variation in flexion of awns in different habitats, *B. danthoniae* subsp. *rogersii* is here placed in the synonymy of *B. pseudodanthoniae*.

It is highly probable that *B. pseudodanthoniae* to be confused with *B. lanceolatus* if the uppermost lemmas are not carefully examined in mature spikelets, because their panicle form and spikelets size are very similar whereas *B. lanceolatus* has only one awn on its all lemmas. Due to its weedy and ruderal life strategy and confusion with other species, more specimens and localities are expected to be found in future for *B. pseudodanthoniae*.

3. *Bromus turcomanicus* H. Scholz in Willdenowia 28: 148 (1998)

Specimens examined: Turkmenistan, Ashkabad province, Gaudan, D. Litwinow 2304 (W, holotypus); Iran, Khorassan, N Quchan, Dorbadam Protected Area, 14 km from Dorbadam towards Bajgiran, 1865 m, Memariani & Zangooei 40678 (FUMH); ibid, 40679 (FUMH); N Quchan, S of Bajgiran, on the road towards Bardar, 1700 m, J. Ghorashi 786G (FUMH); N Quchan, 10 km from Bajgiran towards Emam-Gholi, 1700–1800 m, J. Ghorashi 865G-A (FUMH); NW Daregaz, Kadeganlu, eastern hills, 1200 m, Joharchi & Zangooei 16348 (FUMH); SE Kalat, between Jalil-Abad & Qaleh-Now, 1200 m, Joharchi 42989 (FUMH).

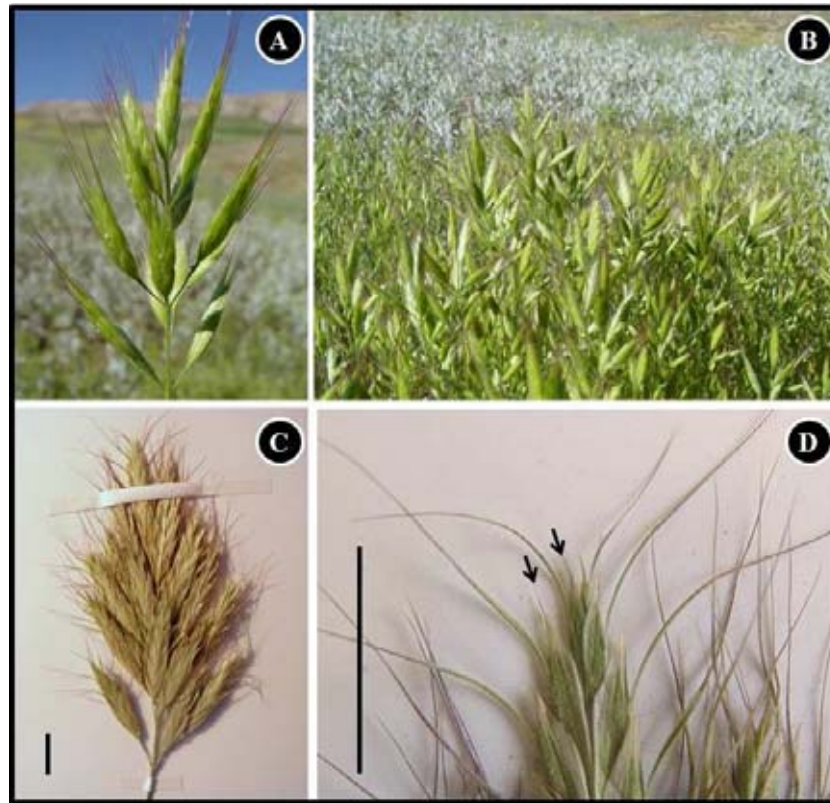


Fig. 1. *Bromus pseudodanthoniae*: A & B. Natural habitat (Aladagh Mts., 37961 FUMH) showing spikelets which are not highly laterally compressed, C & D. Herbarium specimen (Binalood Mts., 36362 FUMH) with densely born spikelets (C) and two uppermost lemmas (D) with three awns; arrows show two short outer awns (Bars = 1 cm).

- Biogeography and ecology

B. turcomanicus, formerly known from the type locality in southern Turkmenistan, is here recorded as a new species for the flora of Iran (Fig. 2). This Khorassan-Kopetdagh endemic species is distributed in central Kopetdagh and Hezar-Masjed mountains (Fig. 4) and grows in low and middle mountain slopes, and as a ruderal plant along the roadsides. Concerning to the extent of occurrence, area of occupancy and number of locations, it is here evaluated as an endangered species (EN B1+B2 ab (iii)).

- Taxonomy

This species is very similar to *B. danthoniae* in habit but remarkably differs by very blunt lemma lobes and a higher insertion point of the central awn (Fig. 3).

Morphologically, *B. turcomanicus* is more closely related to *B. danthoniae* than *B. pseudodanthoniae*.

As the result of this revision, the number of three-awned *Bromus* species in Iran is raised to three species and Khorassan-Kopetdagh Mountains is revealed as the main center of species diversity and morphological variation in sect. *Triniusia*. In biogeographical point of view, Khorassan-Kopetdagh floristic province seems to be the center of diversity and the connecting area between the Middle Asia and SW Asia for several plant taxa. More cytological and molecular studies are needed for delimitation of the species in sect. *Triniusia* and understanding of their relationship to the species in sect. *Bromus*.



Fig. 2. Herbarium specimens of *Bromus turcomanicus*: A. Holotypus (2304 W), B. 42989 FUMH.



Fig. 3. A & B. *Bromus turcomanicus* (40679 FUMH) spikelets (Bar: A = 10 mm) and their three-awned lemmas with short and blunt apex (Bar: B = 1 mm), C & D. Comparison of the lemma apex and insertion point of central awn in *B. danthoniae* (left) and *B. turcomanicus* (right) (Bars = 1 mm).

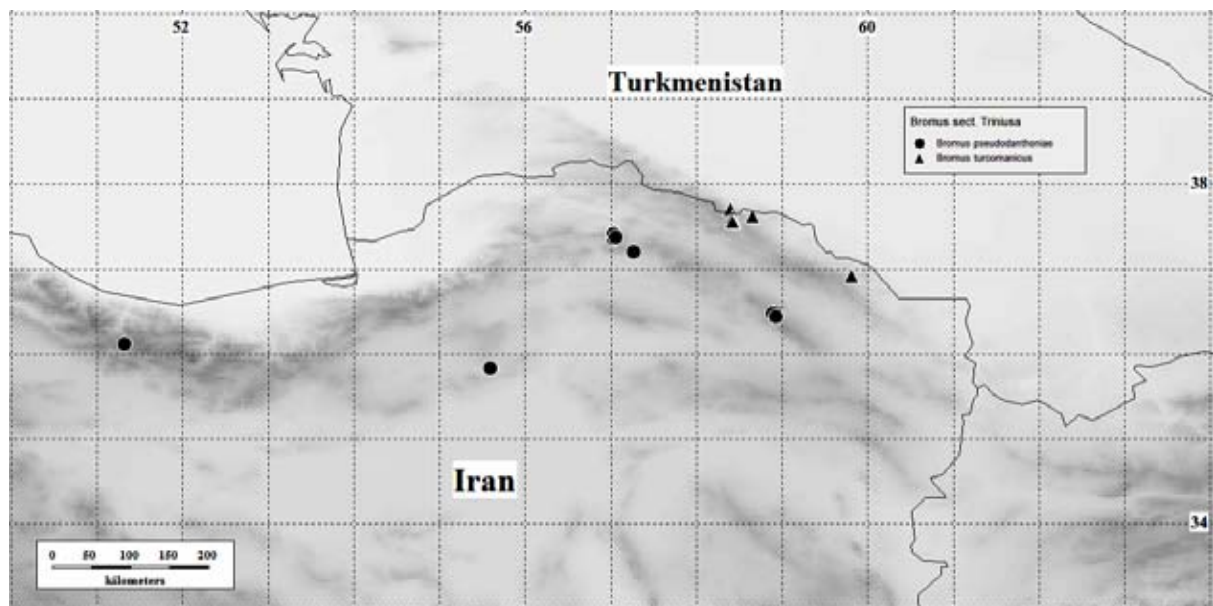


Fig. 4. Distribution map of *Bromus pseudodanthoniae* (circle) and *B. turcomanicus* (triangle) in Iran.

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