A revision of *Bromus* section *Ceratochloa* (Pooideae, Poaceae) in Belgium

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Illustrations – Scans of collections from BR and LG; photo by the author; line drawings by Sven Bellanger.

This paper is dedicated to the late Prof. Dr. Hildemar Scholz (1928-2012) who, for so many years, generously shared his knowledge on grasses in general and *Bromus* in particular.

Abstract. – A taxonomic revision of *Bromus* section *Ceratochloa* in Belgium. Two species groups within *Bromus* section *Ceratochloa* are easily identified: the *Bromus carinatus* and the *B. catharticus* group. Identification of (micro-) species within these groups, however, proves to be critical, especially in the former group. Five taxa have been identified: *Bromus carinatus* var. *marginatus* (syn.: *B. marginatus*), *B. catharticus* var. *catharticus*, *B. catharticus* var. *rupestris* (syn.: *B. brevis*), *B. polyanthus* and *B. sitchensis*. *Bromus carinatus* var. *marginatus*, *B. polyanthus* and *B. sitchensis* are reliably reported for the first time from Belgium (previous claims of the former proved to be erroneous), while the presence of genuine *B. carinatus* var. *carinatus* requires confirmation. The identity of the Belgian representatives of the *Bromus carinatus* complex is thoroughly discussed. The naturalization history, means of introduction, habitat preferences and ecology for all taxa are assessed and a selection of collections cited. For all taxa scans of a representative herbarium specimen and/or photographs are provided. At present only *Bromus sitchensis* is naturalized and obviously increasing, while *B. catharticus* var. *catharticus* appears to be a fairly frequent but mostly ephemeral introduction. The remaining taxa have not been recorded lately.

Samenvatting. – Een revisie van het Belgische materiaal van *Bromus* sectie *Ceratochloa*. Binnen *Bromus* sectie *Ceratochloa* worden gemakkelijk twee soortcomplexen onderscheiden, namelijk de *Bromus carinatus*- en *B. catharticus*-groep. Het herkennen van (micro-) soorten binnen deze complexen blijkt veel moeilijker, vooral binnen de eerste groep. Vijf taxa zijn uiteindelijk weerhouden: *Bromus carinatus* var. *marginatus* (syn.: *B. marginatus*), *B. catharticus* var. *catharticus*, *B. catharticus* var. *rupestris* (syn.: *B. brevis*), *B. polyanthus* en *B. sitchensis*. *Bromus carinatus* var. *marginatus*, *B. polyanthus* en *B. sitchensis* worden voor het eerst voor België gerapporteerd (eerdere opgaven voor de eerste berustten op foutieve determinaties), terwijl de aanwezigheid van *B. carinatus* var. *carinatus* nog dient bevestigd te worden. Vooral de exacte identiteit van de in België aangetroffen taxa uit de *Bromus carinatus*-groep wordt uitgebreid besproken. De inburgeringsgeschiedenis, wijze van introductie, habitatvoorkeur en ecologie van elk taxon wordt beschreven en een selectie van collecties wordt opgesomd. Van elk taxon is een herbariumscan en/of foto ingelast. Momenteel is blijkbaar enkel *Bromus sitchensis* een ingeburgerde en zich uitbreidende soort. *Bromus catharticus* var. *catharticus* komt weliswaar vrij frequent voor als adventiefplant maar blijft meestal strikt efemeer. De overige taxa werden recent niet meer waargenomen in België.

Résumé. – Une révision du matériel belge de *Bromus* section *Ceratochloa*. Au sein du genre *Bromus* section *Ceratochloa* deux groupes d'espèces se distinguent sans difficulté, le groupe de *Bromus carinatus* et le groupe de *B. catharticus*. Or, l'identification des (micro-) espèces s'est avérée beaucoup plus difficile, surtout dans le premier groupe. Finalement, cinq taxons ont été reconnus: *Bromus carinatus* var. *marginatus* (syn.: *B. marginatus*), *B. catharticus* var. *catharticus*, *B. catharticus* var. *rupestris* (syn.: *B. brevis*), *B. polyanthus* et *B. sitchensis*. *Bromus carinatus* var. *marginatus*, *B. polyanthus* et *B. sitchensis* sont mentionnés pour la première fois de Belgique (des récoltes antérieures du premier se sont

avérées erronées), alors que la présence réelle de *Bromus carinatus* var. *carinatus* n'a pas été démontrée. L'identité exacte des représentants du groupe de *Bromus carinatus* est longuement discutée. L'historique de la naturalisation, le mode d'introduction, l'habitat et l'écologie de tous les taxons sont décrits et une sélection du matériel d'herbier présentée. Chaque taxon est illustré (scan d'un échantillon d'herbier et/ou photo). A l'heure actuelle, seul *Bromus sitchensis* est bien naturalisé et visiblement en expansion. *Bromus catharticus* var. *catharticus* est une plante adventice assez fréquente mais le plus souvent fugace. Il n'y a pas de récoltes récentes pour les autres taxons.

Introduction: the genus *Bromus* s.l.

Bromus is a large festucoid grass genus with contested generic limits. As currently understood by most taxonomists (i.e. in a wide sense; see, however, below) it accommodates between 100 and 400 species, depending on species delimitation (Pavlick & Anderton 2007). Most occur in the temperate regions of both the Old and New World with some additional species in mountainous regions in the tropics.

The classification of *Bromus* s.l. is controversial. Pending additional research, *Bromus* is here accepted in a wide sense as to include four sections in Belgium. These can be distinguished as follows:

1 Lower glume 1-veined (sometimes with 2 faint and incomplete additional veins) 2

Lower glume with 3-5 distinct veins 3

2 Plants perennial. Awn (if present) always shorter than lemma, arising less than 1,5 mm below lemma apex .... Section *Bromopsis* Dumort. (syn.: *Bromopsis* (Dumort.) Fourr.)

Plants annual. Awn always longer than lemma, arising more than 1,5 mm below lemma apex ..... Section *Genea* Dumort. (syn.: *Anisantha* K. Koch)

3 Spikelets laterally compressed, lemma strongly keeled. Plants annual, biennial or perennial (sometimes short-lived) .... Section *Ceratochloa* (DC. et Beauv.) Griseb. (syn.: *Ceratochloa* DC. et Beauv.)

Spikelets terete, lemma rounded on the back. Plants always annual ..... Section *Bromus*

At least 11 species (and some extra subspecies) are native or at least archaeophytic in Belgium (Lambinon *et al.* 2004). Among these, *Bromus bromoideus* (now extinct in the wild) had a limited distribution and was confined to southeastern Belgium and northeastern France. At least 17 additional taxa were recorded as aliens since the 19th century, mostly as ephemerals (Verloove 2006). Table 1 gives an overview of those 28 species, with two additional names mentioned in alienplantsbelgium.be.

In the course of recent revisions in the Belgian herbaria it became clear that *Bromus* s.l. is still imperfectly known, especially with regard to the non-native taxa. In this contribution the Belgian representatives of section *Ceratochloa* are taxonomically revised. The native and

Table 1. Overview of Belgian representatives of *Bromus* s.l. with indication of their status (**Na/Ar**: native or archaeophyte; **Al**: alien; **Al<1950**: alien, not recorded after 1950). Based on Lambinon *et al.* (2004) and Verloove (2006), with additions published in alienplantsbelgium.be.

Section	Taxon
Bromopsis	*Bromus erectus* (Na/Ar)
	Bromus inermis (Al)
	Bromus ramosus (Na/Ar); incl. subsp. *benekenii* (Na/Ar)
Bromus	*Bromus alopecuros* (Al)
	Bromus arenarius (Al<1950)
	Bromus arvensis (Na/Ar)
	Bromus briziformis (Al<1950)
	Bromus bromoideus (Na/Ar)
	Bromus commutatus (Na/Ar)
	Bromus danthoniae (Al)
	Bromus grossus (Na/Ar)
	Bromus hordeaceus subsp. *hordeaceus* (Na/Ar), subsp. *longipedicellatus* (Al), subsp. *molliformis* (Al<1950), subsp. *pseudothominei* (Al) and subsp. *thominei* (Na/Ar)
	Bromus intermedius (Al)
	Bromus japonicus (Al)
	Bromus lanceolatus (Al)
	Bromus lepidus (Al)
	Bromus pectinatus (Al<1950)
	Bromus racemosus (Na/Ar)
	Bromus scoparius (Al)
	Bromus secalinus (Na/Ar)
	Bromus squarrosus (Al)
Ceratochloa	*Bromus carinatus* var. *marginatus* (Al<1950)
	Bromus catharticus var. catharticus (Al) and var. *rupestris* (Al<1950)
	Bromus polyanthus (Al<1950)
	Bromus sitchensis (Al)
Genea	*Bromus diandrus* (incl. subsp. *maximus*) (Al)
	Bromus madritensis (Al)
	Bromus rubens (Al)
	Bromus tectorum (Na/Ar)
	Bromus sterilis (Na/Ar)

non-native representatives of the other sections will be the subject of future contributions, always with the emphasis on the alien taxa.

Contested taxonomy

Infrageneric taxa have either been accepted as distinct genera, subgenera or sections. The latter classification, as proposed by Smith (1970), has been followed almost invariably by recent American authors (e.g. Matthei 1986, Pavlick 1995, Gutiérrez & Pensiero 1998, Planchuelo & Peterson 2000, Pavlick & Anderton 2007) and is applied here as well. In the Old World, on the contrary, there is little taxonomic agreement. Some authors raise all sections to generic rank (e.g. Tzvelev 1984, Spalton 2004, van der Meijden 2005, Valdés & Scholz 2006, Stace 2010), others still follow Smith l.c. (e.g. Veldkamp *et al.* 1991, Lambinon *et al.* 2004, Jäger & Werner 2005, Cope & Gray 2009). A minority applies subgeneric rank (e.g. Acedo & Llamas 1999). Recent molecular phylogenetic studies have not resolved the contested taxonomy (Saarela *et al.* 2007). It was shown that none of the current classification schemes reflect phylogenetic relationships in *Bromus*, although some of the infrageneric taxa proved to be monophyletic (including section *Ceratochloa*). The monophyly of *Bromus* s.l. itself was only moderately supported.

Materials and methods

The present account is primarily based on a revision of herbarium specimens collected in Belgium between 1869 and 2012. More than 150 collections from the main public herbaria [i.e. the herbaria of the National Botanic Garden of Belgium (BR), the University of Ghent (GENT) and the University of Liège (LG)] and the private herbarium of the author were revised. Additional field work was undertaken in order to check the degree of naturalization of selected populations and better understand the variability of the representatives of the *Bromus carinatus* complex.

A key to *Bromus* section *Ceratochloa* in Belgium

Bromus section *Ceratochloa* is originally confined to the New World. Barkworth *et al.* (2006) accepts about 25 species. However, species delimitation is very controversial, especially in the *Bromus carinatus* complex (see below).

Two species groups (the *Bromus carinatus* complex and the *B. catharticus* complex) are easily distinguished in Belgium but identification of (micro-?) species is much less straightforward. Several different taxa have been collected in Belgium but a reliable designation of every single herbarium collection to one of these taxa proved to be impossible, especially in the *Bromus carinatus* complex (see further under that complex). The complexity of the section is illustrated in figure 1, a herbarium collection that eventually turned out to belong with *Bromus carinatus* var. *marginatus* only after being

Figure 1. *The complexity of the section* Ceratochloa *is illustrated by this herbarium sheet from BR which, after being ascribed to several other species (and even genera), eventually turned out to belong with* Bromus carinatus *var.* marginatus.

ascribed to several other species (and even genera) during its identification history.

During this revision it became evident that many frequently used distinguishing features are of no or only limited taxonomic value. Most are related to species or species groups and discussed below. Some preliminary remarks should make the use of the identification key easier:

• The number of veins is best counted on the inner side of the lemma. This is a very useful character to separate both species groups. In the *Bromus catharticus* group veins usually are 11 in number but not all veins extend over the entire length of the lemma. In the *Bromus carinatus* group there are nearly always 7 veins.

• The lemma pubescence is a very variable character and of no taxonomic value, although it was given much weight by some authors, especially in the past (see, for instance, Shear 1900). Barkworth *et al.* (2006) already showed that lemma pubescence does not separate *Bromus*

carinatus and *B. marginatus* Nees. Keys that only rely on this feature are therefore unreliable (see for instance Cope & Gray 2009).

• Anther length is sometimes used to distinguish between related species. However, anther length is very different in chasmogamous and cleistogamous flowers and hence difficult to assess. Anther length for *Bromus stamineus* E. Desv. (syn.: *B. cebadilla* Steud., *B. catharticus* var. *elata* (E. Desv.) Planchuelo), as given by Planchuelo & Peterson (2000), only applies to chasmogamous flowers. In the *Bromus carinatus* complex flowers are nearly always cleistogamous (Barkworth *et al.* 2006).

For a reliable identification it is furthermore important to collect mature, normally developed plants (young or ill-grown plants may look very aberrant), to assess longevity (annual, biennial, perennial), and to make notes about or make photos of the inflorescence shape (the very typical long and drooping lowermost panicle branches of *Bromus sitchensis* are much less obvious when pressed).

1 Lemma 7(-9) veined (veins not raised), concolorous or weakly bicolored, always awned, awn 4-10 mm long (Fig. 2, left). Palea mostly ca. ¾ as long as lemma, rarely longer . Spikelets slightly flattened (***Bromus carinatus*** group) 2

Lemma 9-11 veined (veins often raised), distinctly bicolored (yellowish green in the lower part, darker in the upper), sometimes suffused with purple, unawned or with a short awn up to 3 mm long (Fig. 2, right). Palea ½ to ¾ as long as lemma. Spikelets very flat (***Bromus catharticus*** group) 5

2 Leaf sheath margin and throat perfectly glabrous. Palea nearly as long as lemma ..... ***B. polyanthus***

Leaf sheath margin and throat distinctly to sparsely hairy, never perfectly glabrous. Palea usually distinctly shorter than lemma (mostly ca. ¾ as long), rarely nearly as long as lemma 3

3 All lemma awns less than 7 mm long ..... ***B. carinatus*** var. ***marginatus***

At least longer lemma awns more than 7 mm long 4

4 Lowermost panicle branches long (>10 cm) and drooping with rather few, large spikelets confined to the tips of the branches (Fig. 3). Largest leaf width >10 mm. Usually (short-lived) perennial ..... ***B. sitchensis***

Lowermost panicle branches not exceeding 10 cm, erect to patent or reflexed, not drooping and with spikelets more evenly distributed. Leaves less than 10 mm wide. Usually annual or biennial ..... *B. carinatus* var. *carinatus*
[presence in Belgium requires confirmation]

5 Lemma unawned or with an awn up to 0.5 mm long. Spikelets 8-13 mm long. Young leaves predominantly folded ..... ***B. catharticus*** var. ***rupestris***

Lemma with awn ca. 1.5-2(-3) mm long. Spikelets usually longer, ca. 12-18 mm long. Young leaves predominantly rolled ..... ***B. catharticus*** var. ***catharticus***

At present only *Bromus sitchensis* is naturalized and obviously increasing, while *B. catharticus* var. *catharticus* appears to be a fairly frequent but mostly ephemeral introduction. The other taxa have not been recorded lately.

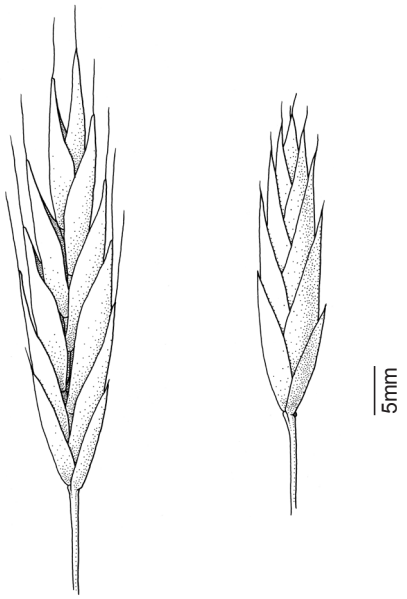

Figure 2. *Spikelets of* Bromus sitchensis *(left) and* B. catharticus *var.* catharticus *(right).*

Figure 3. *The typically drooping inflorescence branches of* Bromus sitchensis.

The taxa of *Bromus* section *Ceratochloa* recorded from Belgium

In the next pages the native area, the vector of introduction and degree of naturalization in Belgium, and some miscellaneous notes are given for each taxon recorded from Belgium. Only synonyms that have been used in Belgian

Figure 4. *A collection of two specimens of Bromus sitchensis by Norbert Cnops from Brussels (BR, LG). The younger specimen, shown on the right, is very reminiscent of B. carinatus var. carinatus.*

botanical literature are given (plus their corresponding names in *Ceratochloa*). For a more extensive synonymy, see Soreng *et al.* (2003). An overview of herbarium collections examined during the preparation of this paper is given in appendix 1.

Before describing the taxa for which well identified collections from Belgium exist, it may be worthwhile to draw attention to another possibly overlooked South American subspecies of *Bromus catharticus*, var. *elatus*. It is better known under its specific name *Bromus stamineus* (syn. *B. cebadilla*; see Planchuelo 2006, Pavlick & Anderton 2007). In general appearance it is more reminiscent of *B. carinatus* with which it shares the longer palea (contrary to Sigl 2008!) and awn length. In the above key it would therefore key out to the *B. carinatus* group on behalf of its lemmas with awns 4-10 (-12) mm long, longer palea and its less distinctly flattened and weakly bicolored spikelets. From the members of the *Bromus carinatus* group it is best distinguished by the combination of the following characters: its lemmas with 9(-11) veins, its perennial habit (unlike Pavlick 1995), more densely hairy leaf sheaths, palea subequalling lemma, narrow leaves (ca. 3-5 mm wide), etc. Phenetic analyses demonstrated that it is best considered as a variety of *Bromus catharticus* (Planchuelo 1991, Planchuelo 2006). Like *Bromus sitchensis* it is a perennial and increasingly cultivated as a valuable forage grass in the milder parts of Europe (as 'Grazing brome'), for instance in Switserland (Mosimann & Chalet 1996). It has been repeatedly recorded as an alien, in as well as outside of Europe (Forde & Edgar 1995, Ryves *et al.* 1996, Pavlick & Anderton 2007) and may be present in Belgium as well. In the British Isles it was once widely naturalized, but it has much declined in recent times (Cope & Gray 2009).

The *Bromus carinatus* complex

In the *Bromus carinatus* group species delimitation is very controversial. Shear (1900), followed by Pavlick (1995), distinguished numerous species and infraspecific taxa while Stebbins (1981) suggested that only one, very variable species should be accepted. Recent authors (mainly Barkworth *et al.* 2006, Pavlick & Anderton 2007) apply a more or less intermediate taxonomy. They

accept species like *Bromus polyanthus* Scribn. ex Shear and *B. sitchensis* Trin. but subsume *B. marginatus*, *B. subvelutinus*, etc. under *B. carinatus*.

The *Bromus carinatus* complex has an exceedingly confusing history in Belgium. Although collected since 1915[1], it was not mentioned in Belgian literature until Fasseaux (1948) reported – with some doubt as to its identity – about "*Bromus marginatus*" as an escape in and near the (former) "Jardin Botanique" in Brussels. This population proved to be very persistent and in the following decades the species was repeatedly confirmed. However, since the 3th edition of the *Nouvelle Flore de la Belgique* (De Langhe *et al.* 1983) it was renamed, without further comments, as *Bromus carinatus*. In the past years yet another binomial was proposed by Robert Portal (France) for exactly the same plants: *Bromus sitchensis*.

It is clear that more than one taxon of the *Bromus carinatus* group occurs or has occurred in Belgium. *Bromus carinatus* var. *marginatus* is here confirmed for a single, old collection from Brussels. However, this name does not apply for the well-known populations formerly found as an escape at the Botanic Garden, also in Brussels (see below). Another rather distinct and old collection, from Antwerp, is here identified as *Bromus polyanthus*. All other collections seen – including those from the surroundings of the former Botanic Garden in Brussels – probably belong with *Bromus sitchensis*.

Bromus sitchensis and *Bromus carinatus* var. *carinatus* are obviously closely related. They are, however, rather distinct in the field and usually easily told apart on such features like inflorescence shape and life form (longevity). However, in the herbarium these features are very hard to assess. A collection by Norbert Cnops from Brussels (*N. Cnops* 54.286, 02.09.1954) consists of two different sheets, one preserved in BR, the other in LG. The former matches *Bromus sitchensis* rather well while the latter more looks like genuine *B. carinatus* (Fig. 4). Theoretically, it may be that two different species were present in this locality but it seems more plausible that the latter represents a younger, not fully developed specimen of the former species. Extant Brussels populations exhibit the same diagnostic features as those from the vicinity of the former Botanic Garden. Moreover, at present it is obviously most common in this very area which, logically, suggests that current day populations still represent the same species. However, from other localities only a selection of reliably identified herbarium collections is enumerated for *Bromus sitchensis*. These mainly refer to recent collections and/or unambiguous older collections.

<u>*Bromus carinatus* var. *marginatus*</u> (Fig. 1)

Bromus carinatus Hook. & Arnott, Bot. Beechey. Voy. 403, 1840.
Ceratochloa carinata (Hook. & Arnott) Tutin, Fl. British Isles: 1458, 1952.
var. *marginatus* (Nees) Barkworth & Anderton, Madroño 53(3): 240, 2006.
Bromus marginatus Nees, Syn. Pl. Glumac. 1: 322, 1854.
B. carinatus var. *marginatus* C.H. Hitchc. ex Scoggan, Fl. Canada 2: 251, 1978. [comb. inval.]
Ceratochloa marginata (Nees) W.A. Weber, Brittonia 33(3): 325, 1981.

The native area of this taxon covers western North America (from British Columbia and Saskatchewan in Canada over the U.S.A. to northern Mexico). Outside its native range it has been reported from a few western European countries but many records require confirmation. See for instance Jansen (1951) for the Netherlands and Melderis (1968), Ryves *et al.* (1996) and Cope & Gray (2009) for the British Isles. However, according to Spalton (2003) most British records are erroneous. Also adventive in China (Liang *et al.* 2006).

This ephemeral alien was recorded only once near a railway station in Brussels (Schaarbeek), where it apparently was introduced with foreign goods.

Bromus carinatus var. *marginatus* is here reliably reported for the first time from Belgium. Previous claims (Fasseaux 1948) turned out to be in error for *Bromus sitchensis* (see further). *Bromus marginatus* was accepted as a species distinct from *B. carinatus* for many decades and its specific status was rarely questioned (Shear 1900, Hitchcock 1950, Pavlick 1995). It was usually distinguished from the latter on such features as longevity (perennial vs. annual or biennial), leaf sheath and lemma vestiture (usually more prominently pilose), leaf width (usually wider leaves) and awn length (usually shorter awns). Modern taxonomists emphasized on its longevity (Pavlick 1995) or vestiture and awn length (Stace 2010). However, a recent morphometric analysis by Barkworth *et al.* (2006) demonstrated that *Bromus carinatus* and *B. marginatus* are only reliably distinguishable on awn length: in the former most awns are 8-17 mm long while they are 4-7 mm long in the latter. For that reason, these authors reduced *Bromus marginatus* to a mere variety of *B. carinatus*.

<u>*Bromus polyanthus*</u> (Fig. 5)

Bromus polyanthus Scribn. ex Shear, Bull. Div. Agrostol., U.S.D.A. 23: 56, f. 34, 1900.
B. multiflorus Scribn., Bull. Div. Agrostol., U.S.D.A. 13: 46, 1898. [nom. illeg.]
B. paniculatus (Shear) Rydb., Fl. Rocky Mts. 90, 1917.
B. polyanthus var. *paniculatus* Shear, Bull. Div. Agrostol., U.S.D.A. 23: 57, f. 35, 1900.
Ceratochloa polyantha (Scribn. ex Shear) Tzvelev, Novosti Sist. Vyss. Rast. 7: 51, 1970 [1971].
C. polyantha (Scribn. ex Shear) W.A. Weber, Brittonia 33(3): 325, 1981.

[1] The two oldest collections (from 1915 and 1930) remained unnoticed up to present due to misidentifications. Both had been stored under several different names and eventually turned out to belong with *B. polyanthus* and *B. carinatus* var. *marginatus* respectively.

Figure 5. Bromus polyanthus. *(BR)*

Figure 6. Bromus sitchensis. *(BR)*

This taxon is native to the United States of America (from Montana to Washington, south to California and Texas). Outside its native range perhaps only known from the former USSR (Tzvelev 1984, Czerepanov 2007) and France (Chevalier 1934, Portal 1995). In Leningrad and Tashkent, it is apparently introduced (intentionally or unintentionally) via botanic gardens.

Recorded only once as an ephemeral alien in the port area of Antwerp, without obvious vector of introduction (possibly cereals; see Hennen 1924). Initially collected as '*Bromus schraderi*' (a synonym of *B. catharticus*), this specimen was subsequently identified as *B.* cf. *carinatus*. From *B. carinatus* it is separated at a glance by the slender, sinuous panicle branches. A closer examination reveals perfectly glabrous leaf sheaths, a feature never encountered in *Bromus carinatus*. On behalf of the open, more or less pendulous inflorescence this collection possibly belongs with var. *paniculatus*, although in this variety lemma awns are usually longer (up to 8 mm long). According to Pavlick & Anderton (2007) both characters vary and are of no taxonomic value.

The exact taxonomic status of *Bromus polyanthus* has been questioned. However, in a morphometric analysis Barkworth *et al.* (2006) demonstrated that it is more distinct from *Bromus carinatus* than *B. marginatus* and that specific rank is justified.

<u>*Bromus sitchensis*</u> (Fig. 2, 3, 4 and 6)

Bromus sitchensis Trin., Mem. Acad. Imp. Sci. St.-Petersbourg, Ser. 6, Sci. Math. 2(2): 173, 1832.

Bromus sitchensis is originally native in a rather narrow area on the West coast of North America, from Alaska to Washington, with rather disjunct populations further south to California; see Pavlick & Anderton 2007). Outside its native range poorly known as a result of confusion with *Bromus carinatus*. Confirmed from France (Portal 1995; apparently a recent introduction: Kerguélen 1975 only cited "*Bromus willdenowii*" from this section in France), Germany (Bayern; see Pallas 1994, Sigl 2008[2]; omitted, however, by Jäger 2011 and

[2] Also known from Rheinland-Pfalz (herb. BR: [Wissen], Siegtal, Wissener Hütte, Halde, 04.07.1961, *A. Schumacher* s.n.).

Scholz 2011), Sweden (Ekman 1989) and Switserland (see InfoFlora on http://www.crsf.ch). Claims of *Bromus carinatus* from northwestern and Central Europe might, at least in part, also refer to *B. sitchensis*. See for instance Clement (1981), Ryves *et al.* (1996) and Cope & Gray (2009) for the British Isles, Pallas (1994), Borkowsky & Hartwig (1997) and Sigl (2008) for Germany, Wilhalm (2000) for northern Italy, Jansen (1951) and Floristenclub Gelderse Vallei (1970) for the Netherlands, Mirek (1984) and Sutkowska & Pasierbinski (2009) for Poland, Ekman (1989) for Sweden, etc.

In Belgium *Bromus sitchensis* has been recorded in a wide range of anthropogenic habitats: rough ground, talus slopes and roadsides, canal banks, railway sidings, port areas (especially unloading quays, storage yards), foot of walls and fences (mostly in urban areas), dumps and borders of maize fields.

Bromus sitchensis thrives best in dry and sunny habitats but has also been recorded on (temporarily) wet soils as well as in (half-) shady places.

The first established populations of *Bromus sitchensis* in Belgium were found as garden escapes near the former Botanic Garden in Brussels where it was grown as a curiosity. Possible means of introduction elsewhere include timber and cereals. A few recent collections from maize fields are possibly also related with grain. Massive populations on canal banks (for instance in the port area of Ghent) might have been the result of deliberate sowing (revegetation, erosion control).

In parts of Europe, for instance in Switserland, *Bromus sitchensis* is grown as a forage crop (numerous references on the internet; see also Mosimann & Chalet 1996, Stewart 1996, Mosimann & Jeangros 2007, Boller *et al.* 2010). The first Dutch populations of "*Bromus carinatus*" (probably also *B. sitchensis*) were associated with American troops by Weeda *et al.* (1994) but this is rather unlikely: according to Jansen (1949, 1951) these were probably escapes from the Botanic Garden in Wageningen.

Bromus sitchensis is naturalized and obviously spreading. It doubtlessly is the most widespread species of the *Bromus carinatus* complex in Belgium (Fig. 7). At present it is best known from Brussels where it is widespread and locally very abundant (Fig. 8). Outside of Brussels it is much more rare and only known from some widely scattered localities, mainly in Flanders.

Fasseaux (1948) ascribed populations from the surroundings of the (former) Botanic Garden of Brussels to *Bromus marginatus*. This determination was confirmed by J.R. Swallen, at that time director of the Smithsonian Institute in Washington. Despite this confirmation, Fasseaux still had some doubt about this identity: plants from Brussels were less hairy than they should be with nearly glabrous leaves and spikelets that were at most scabrous, not pubescent. Moreover, panicles were less congested with longer lowermost branches that bear more spikelets. This led him to the conclusion that these plants

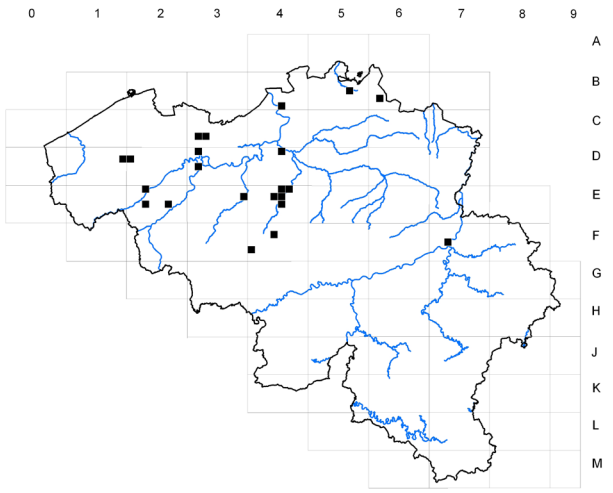

Figure 7. *Distribution of* Bromus sitchensis *in Belgium. Map solely based on specimens examined for this study.*

possibly belonged with var. *seminudus* Shear or var. *latior* Shear (erroneously as "*laxior*" in Fasseaux l.c.). About 50 collections of *Bromus carinatus* s.l. in the Belgian public herbaria (all collected between 1944 and 2012) are from Brussels (including its municipalities, viz. Evere, Schaarbeek, etc.). Most of these, and at least those from the immediate surroundings of the former Botanic Garden, most likely originated from the populations formerly described by Fasseaux (1948). A scrutinous examination of the main diagnostic features of all specimens seen from the original area of introduction (1942-1962;

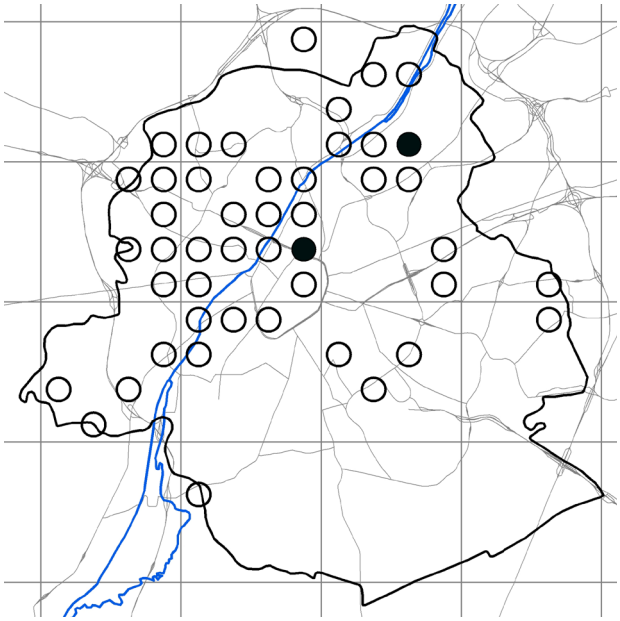

Figure 8. *Distribution of* Bromus sitchensis *in Brussels. Until 1962 it was recorded from two locations only (black dots). Since the 1970s the number of records has dramatically increased (circles). Source: The Flora of Brussels 2003-2005 (http://www.floraofbrussels.be/floraofbrussels/), with an update by the author.*

see below) demonstrates that these plants were fairly homogeneous: lower leaf sheaths are typically retrorsely pilose throughout, leaves are between 5 and 11 mm wide and lemmas are faintly scabrous to nearly glabrous. These are features that could point to *Bromus carinatus* as well as to *B. marginatus* and *B. sitchensis*. However, in all the collections that were examined the longer lemma awns are always more than 7 mm long (usually up to 9.5 mm long, never longer) which excludes *Bromus marginatus*.

Bromus sitchensis is much reminiscent of *B. carinatus* and both have been widely confused, especially in Europe. At present, the species status of the former is not questioned (Pavlick 1995, Pavlick & Anderton 2007) although Stebbins (1981) stated that the entire *Bromus carinatus* group should be accepted as a single, variable species. If so, or if *Bromus carinatus* and *B. sitchensis* would be given subspecies (or even varietal) rank, then *B. carinatus* should be subsumed under the latter for reasons of priority (see also Hitchcock *et al.* 1969). Indeed, distinguishing features for *Bromus sitchensis* appear to be mainly quantitative, rather than qualitative. According to major North American floras its most important characters are long, drooping lowermost panicle branches (at least 10 cm long) with at most 1 or 2 (rarely up to 3) large spikelets that are clustered near the tip of the branches, thick culms (ca. 4-7 mm wide), wide leaves (up to 12 mm wide), a perennial habit and palea considerably shorter than lemma (Shear 1900, Hitchcock 1950, Pavlick 1995, Pavlick & Anderton 2007). Portal (1995; soon afterwards followed by Conert 1998) furthermore added a longer rhachilla of the florets (> 3 mm long) with a more appressed indumentum and a longer ligule (often exceeding 4 mm). In practice, however, there seems to be a considerable overlap with forms of the exceedingly variable *Bromus carinatus*. Especially var. *hookerianus* (Thurb.) Shear of the latter – probably the usual introduction and escape from Botanical Gardens in Europe (Jansen 1949, 1951) – is very reminiscent of it in general habit. Shear (1900) describes it as a robust perennial plant, larger in all its parts than the species, with large panicles with spreading branches and larger spikelets. It is perhaps best distinguished from *Bromus sitchensis* by longer lemma awns (11-15 mm vs. 5-10 mm; see Pavlick 1995).

For sure, not all of these characters are taxonomically important. Palea length (compared with lemma length) obviously is a worthless feature and even differs within a single spikelet. Most recent authors no longer attribute any value to it (e.g. Pavlick & Anderton 2007). Similarly, rhachilla length and indumentum seem to be of no taxonomic use neither.

I have long contemplated the exact identity of the plant currently naturalized and expanding in Brussels and elsewhere in Belgium. It resembles *B. sitchensis* rather well but rarely combines all of its features: lowermost panicle branches are, indeed, long and drooping (at least with age) but often bear more than 2-3 spikelets, leaves are often slightly narrower and ligules shorter than they should be, etc. Chicouene (1996) expressed similar remarks about French populations of *Bromus sitchensis*: sheaths not glabrous, lowermost panicle branches with 3-5 spikelets (not 1-2), longer lemma awns, etc. However, Belgian plants obviously deviate from the usual circumscription of *Bromus carinatus* s.str. as well. The latter has much shorter, erect to patent (or even deflexed) lowermost panicle branches, much narrower leaves, longer awns and palea and rarely is perennial (see Fig. 9 for an authentic North American collection, reliably identified by the agrostologist A.S. Hitchcock). The possibility of a vigorous cultivar of the latter could be envisaged but according to A. Sutkowska (Poland; pers. comm. May 2012) such cultivars do not differ morphologically from wild plants. J. Saarela (Canada; pers. comm. May 2012) admits that species boundaries in the *Bromus carinatus* complex are weak and that there is a continuous gradation in key characters from small to large. However, if one of the existing names should be applied, then Belgian plants should be called *Bromus sitchensis*. On account of the obviously perennial habit, the very long, drooping lowermost panicle branches with relatively few, large spikelets born near the tips, the thick culms and wide leaves and the relatively short lemma awns (usually not exceeding 10 mm) the extant Belgian populations of the *Bromus carinatus* group are here ascribed to *B. sitchensis*.

The *Bromus catharticus* complex

Unlike the *Bromus carinatus* complex, this species group is much less complicated in Belgium in terms of taxonomy and identification. Two taxa have been recorded but only one is more or less frequent and still occurs at present.

<u>*Bromus catharticus* var. *catharticus*</u> (Fig. 2 and 10)

Bromus catharticus Vahl, Symb. Bot. 2: 22, 1791.
B. unioloides Kunth, Nov. Gen. Sp. 1: 151, 1815 [1816].

Figure 9. Bromus carinatus *var.* carinatus. *(BR, duplicate of a collection by A.S. Hitchcock)*

Figure 10. Bromus catharticus *var.* catharticus. *(BR)*

B. willdenowii Kunth, Revis. Gramin. 1: 134, 1829.
B. schraderi Kunth, Enum. Pl. 1: 416, 1833 (nom. illeg. superfl.).
Ceratochloa cathartica (Vahl) Herter, Revista Sudamer. Bot. 6(5-6): 144, 1940.
Ceratochloa cathartica (Vahl) Henrard, Blumea 4(3): 498, 1941.
Ceratochloa willdenowii (Kunth) W.A. Weber, Phytologia 51(6): 371, 1982.

Bromus catharticus var. *catharticus* is native from the southern United States of America to southern South America. It is a commonly naturalized introduction in the warm-temperate and (sub-) tropical regions of the world (Africa, Asia, Europe, Oceania).

In Belgium *Bromus catharticus* var. *catharticus* has been observed in a wide range of (mostly) artificial habitats, such as: rough ground, unloading quays in port areas, roadsides, river banks, gardens, dumps, urban areas (cracks in pavement, foot of walls), etc.

At least between 1887 and 1965 *Bromus catharticus* var. *catharticus* used to be very characteristic wool alien in the valley of river Vesdre (see also Visé 1942, 1958); wool-processing activities have ceased decades ago and it was not able to become established. *Bromus catharticus* var. *catharticus* also is a fairly typical grain alien. As early as 1876 it was already recorded near a grain mill in Wilsele and at present cereals still seem to be an important vector of introduction. It is quite often recorded by unloading quays for cereals, grain dumps, etc. It has also been recorded on several occasions from birdseed waste (see also Hanson & Mason 1985) and once as an introduction with palms in a garden center (pers. comm. I. Hoste, July 2012).

Despite having been introduced since ca. 150 years *Bromus catharticus* var. *catharticus* has not been able to naturalize so far in Belgium. Its actual presence is the result of repeated new introductions (Fig. 11). In rather few places it persists for at most some years. In Massenhoven, for instance, at the E313 motorway, a rather large population persists since at least 2009 (confirmed in 2012).

The name for this taxon has long been very controversial. The binomial *Bromus catharticus* – the first available name in this complex – was regarded for quite a long time as a *nomen confusum*. Raven (1960) argued that the correct name for 'Rescue grass' is *Bromus willdenowii*, while *B. unioloides* Kunth [non (Willd.) Raspail.!] should be accepted as a distinct species. Both are distinguished geographically and morphologically. Subsequently, however, this viewpoint was accepted by rather few taxonomists, mainly in Europe (for instance: Melderis 1968, Grossman 1973). Maw (1974), on the contrary, who performed a morphometric analysis of the British material, concluded that it was impossible to recognize two species. Finally, Pinto Escobar (1976) studied the type of *Bromus catharticus* and concluded that it is the one and only name to assign to 'Rescue grass'. Since then most taxonomists agreed that only one variable species should be accepted, *Bromus catharticus* (see for instance:

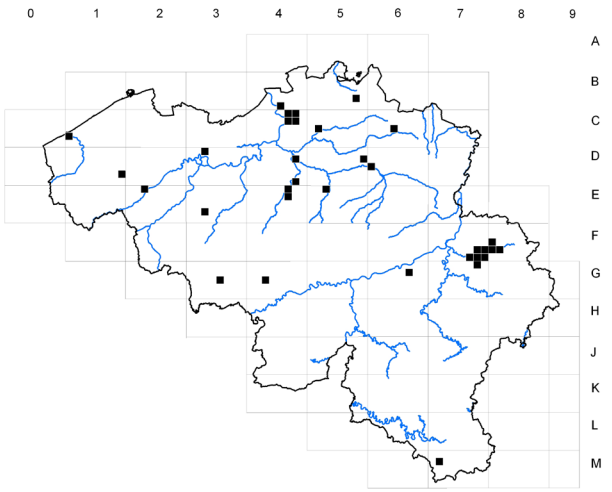

Figure 11. *Distribution of* Bromus catharticus *var.* catharticus *in Belgium. Map solely based on specimens examined for this study.*

Matthei 1986, Planchuelo 1991, Veldkamp *et al.* 1991, Pavlick 1995, Portal 1995, Gutiérrez & Pensiero 1998, Peterson & Planchuelo 1998, Pavlick & Anderton 2007, Cope & Gray 2009, etc.). However, a minority of present-day agrostologists still accepts (sometimes convincingly so!) two distinct species; see particularly Forde & Edgar (1995) for New Zealand and Ammann (2007) for Central-Europe (and to a lesser extent Tzvelev 1984 for the former Soviet Union).

A study of the Belgian collections reveals that *Bromus catharticus* is a very variable species and designating material to one of both "species" appears to be impossible. Moreover, the distinguishing features, as discussed by the aforementioned authors, are often contradictory or much less discriminatory than claimed. Ligules in *Bromus willdenowii*, for instance, are said to be glabrous by Forde & Edgar (1995) but hairy according to Ammann (2007; see also Chicouene 1996). Lemmas are said to be at least 17 mm long in *Bromus willdenowii* (Forde & Edgar l.c.) but even very vigorous plants of "*B. catharticus*" rarely have such long lemmas. Leaf width is also an important feature according to Forde & Edgar l.c. and Ammann l.c. (8-15 mm vs. 1,5-4 mm wide in *Bromus willdenowii* and *B. catharticus* respectively) but according to Tzvelev (1984) there is a considerable overlap (3-7 mm vs. 2,5-6 mm). The usual plant seen these days in Belgium is a coarse plant with large spikelets and broad leaves, with lemmas 9-11(-13) nerved, etc. If a segregate name should be applied for these plants, then, according to Forde & Edgar l.c., such plants correspond with the genuine 'Rescue grass' and thus with *Bromus willdenowii*.

Fedorov (1999) further complicates the issue and uses the (younger) binomial *Ceratochloa haenkiana* C. Presl (syn.: *Bromus haenkianus* (C. Presl) Kunth) to designate *B. unioloides* Kunth.

Compared with the *Bromus carinatus* group spikelets are usually more prominently flattened (and hence wider) and bicolored with lower part of lemmas distinctly paler than upper part. Moreover, lemma awns are always much shorter (rarely exceeding 3 mm) and the palea is much shorter than the lemma than in the *Bromus carinatus* group. Although superficially similar, confusion between these species groups is unlikely.

<u>*Bromus catharticus* var. *rupestris*</u> (Fig. 12)

var. *rupestris* (Speg.) Planchuelo & P.M. Peterson, Novon 8: 54, 1998.
Bromus brevis Nees, Syn. Pl. Glumac. 1: 326, 1854.
Ceratochloa brevis (Nees) B.D. Jacks., Index Kew. 1: 487, 1895.

Bromus catharticus var. *rupestris* is originally confined to central and southwestern Argentina (Peterson & Planchuelo 1998). It is a naturalized introduction in Australia (e.g. Harden 1993) and New Zealand (Forde & Edgar 1995). In the past it also was a fairly typical wool alien in parts of Europe (for instance in the British Isles, Ryves *et al.* 1996), but remained merely casual.

Figure 12. Bromus catharticus *var.* rupestris. *(LG)*

All Belgian records are from wool waste deposits or rough ground near wool-processing factories.

Bromus catharticus var. *rupestris* seems to have been recorded solely as a strictly ephemeral alien in Belgium (although it was not recognized prior to Verloove 2006).

This taxon is better known as *B. brevis*. It was reduced to varietal rank under *Bromus catharticus* by Peterson & Planchuelo (1998). Indeed, both taxa seem to be hardly distinguished. In its most typical form var. *rupestris* exhibits awnless lemmas with curved keels that are closely overlapping, producing a neat, very distinct spikelet that is narrowly ovate in outline (Stace 2010). However, awn length is a fairly variable character in section *Ceratochloa*. Plants with (nearly) muticous lemmas that otherwise do not differ from typical var. *catharticus* have also been encountered in Belgium. Only plants that correspond in every detail with var. *rupestris* have been accepted as such in this account. According to Stace l.c. it is a "rather characteristic" wool-alien in the British Isles[3]. Some

[3] Although it is omitted by Cope & Gray (2009), perhaps because it no longer occurs these days in the British Isles.

authors still accept its specific status (Stace l.c.) which is in accordance with biosystematic studies by Naranjo (1992). See also Forde & Edgar (1995).

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Appendix 1. Specimens examined. For each species the records are given in chronological order.

• *Bromus carinatus* var. *marginatus*

[Bruxelles], Parc Josaphat, derrière la gare de marchandises, 29.06.**1930**, *V. Lambert* s.n. (BR).

• *Bromus polyanthus*

Anvers, terrains maritimes du Sud, 17.07.**1915**, *J. Hennen* s.n. (BR).

• *Bromus sitchensis*

Evere, rudéral, 07.**1954**, *L. Delvosalle* s.n. (BR). – Evere, rudéral, 08.1954, *L. Delvosalle* s.n. (BR). – Evere (IFBL E4.16.43), stortterrein, 23.08.1957, *N. Cnops* 57.308 (BR).

Zevergem (IFBL D3.32.34), langs wegrand, 24.06.**1975**, *D. Duytschaever* 12 (BR, GENT). – Bruxelles, terrain vague près de la gare centrale, 07.1978, *P. Sotiaux* s.n. (BR).

Brussel-Stad, Ommegangstraat (IFBL E4.25.42), langs straatkant van een braakliggend terrein, zeer talrijk, ("deze populatie weet ik al jaren staan"), 13.06.**1980**, *D. Duytschaever* 97, 98 (GENT). – Braine-le-Château, bord de route, 13.08.1983, *G. Bruynseels* 1356 (BR). – Braine-le-Château, bord de route, 17.08.1983, *G. Bruynseels* 852 (BR). – Bruxelles, avant-port de Bruxelles, près de l'incinérateur, 06.10.1984, *J. Duvigneaud* 84/B/569 (BR). – Braine-le-Comte, Pont l'Incluse, 23.06.1985, *S. Depasse* 17/883 (BR). – Bruxelles, entre rue du Marais et gare du Congrès, 25.06.1985, *S. Depasse* 17/882 (BR). – Evere, terrain vague rudéralisé, 26.06.1987, *G. Bruynseels* 1218 (BR). – Evere, terrain rudéralisé, 27.06.1987, *G. Bruynseels* 1409 (BR). – Evere, terrain vague, 27.06.1987, *G. Bruynseels* s.n. (BR). – Arendonk, Veldweg De Heikant (IFBL B6.42.14), rand maïsakker, 1 eks., 27.05.1989, *A. Vermeijen* 89/4 (BR, GENT).

Bruxelles, près de la Place Rogier, terrain vague, 10.05.**1990**, *G. Bruynseels* 1626 (BR). – Denderleeuw (IFBL E3.28.21), op tredplek in nat, sterk verruigd hooiland, 05.08.1990, *H. Ruysseveldt* s.n. (BR). – Schaarbeek (IFBL E4.25.42), woeste grond aan Noordstation, 09.09.1990, *A. Van Den Bergh* s.n. (BR). – Kluizen (IFBL C3.42.23), langs waterspaarbekken, 03.09.1991, *J. Van Den Haute* 1703 (BR). – Brussel, Noordstation, 29.05.1992, *N. Wysmantel* s.n. (BR). – Denderleeuw (IFBL E3.28.21), natte ruigte, tussen Urtica dioica, 9 ex., 07.06.1992, *H. Ruysseveldt* s.n. (BR). – Brussel (IFBL E4.25.23), wegkant op braakliggend terrein, 26.06.1992, *A. Van Den Bergh* s.n. (BR). – Brussel, omgeving Rogierplein, wegkant braakliggend terrein, 26.06.1992, *A. Van Den Bergh* 1992/19 (BR). – Braine-le-Comte, talus du chemin de fer au Pont l'Incluse, abondant sur 100 m., 20.09.1993, *S. Depasse* 17/1016 (BR). – Ooigem, kanaal Roeselare-Leie, rand van de loskade bij een veevoederfabriek, talrijk, 17.07.1994, *F. Verloove* 1193 (priv. herb. F. Verloove, BR). – Willebroek, t.h.v. Zeekanaal, rand van het kanaal, reeds jaren ingeburgerd (ingezameld N. Wysmantel), 09.1994, *F. Verloove* 1304 (priv. herb. F. Verloove, BR). – Ooigem, kanaal Roeselare-Leie, braakgrond onder de graanlosinstallatie van een veevoederfabriek, ook reeds in 1994 en dus schijnbaar standhoudend, 05.06.1995, *F. Verloove* 1594 (priv. herb. F. Verloove). – Ooigem, kanaal Roeselare-Leie, rand van de loskade bij Voeders Braet, er reeds jaren standhoudend en uitbreidend, 06.07.1996, *F. Verloove* 2009 (priv. herb. F. Verloove). – Haven van Antwerpen, Kanaaldok (IFBL B4.55.12-14), ruderale grond en grasland naast graanoverslagbedrijf Manufert, grote, ingeburgerde populatie, 13.09.1997, *F. Verloove* 2677 (BR). – Antwerpen, Kanaaldok (IFBL B4.55.12-14), aan Manufert, 13.09.1997, *D. De Beer* 448 (priv. herb. D. De Beer). – Bruxelles, près de la Place Rogier, terrain vague, abondant, vitalité optimale, 28.06.1998, *C. Vanden Berghen* s.n. (BR). – Bressoux (Liège), trottoir rue Paul Janson, 23.07.1999, *J.-M. Dieu* s.n. (LG).

Zwevezele (IFBL D2.21.23), braakliggend stuk akker, langs oever gracht, 10.07.**2001**, *H. Ruysseveldt* 2895, 2896 (BR). – Gentse kanaalzone (IFBL C3.43.41), kanaalberm t.h.v. veer van Terdonk (kant Doornzele), grote populatie, 10.2001, *W. Van Landuyt* s.n. (BR). – Tiegem (IFBL E2.36.34), recent verstoorde plek langs wegkant, 26.06.2003, *H. Ruysseveldt* 3463 (BR). – Brussel (IFBL E4.25.11), 20.08.2003, *L. Allemeersch* s.n. (BR). – Brussel (IFBL E4.16.31), 21.08.2003, *L. Allemeersch* s.n. (BR). – Merksplas, Lochtenberg (IFBL B5.36.12), weg ten Z van Mark, 07.09.2003, *D. De Beer* 1000 (priv. herb. D. De Beer). – Zwevegem (IFBL E2.33), grazige vegetatie langs veldweg, 12.10.2003, *H. Ruysseveldt* 3668 (GENT). – Lichtervelde (IFBL D1.28), grazige vegetatie wegkant, 19.07.2007, *H. Ruysseveldt* 4341 (GENT).

Brussel, kanaalzone (Groendreef × Rederskaai) (IFBL E4.25.23), ruigte, algemeen, 19.06.**2011**, *F. Verloove* 8794 (BR, LG). – Lichtervelde, Duifhoek (Duifhoekstraat) (IFBL D1.28.33), rand maïsakker, talrijk, 03.09.2011, *F. Verloove* 8966 (BR). – Gent (Muide), Port Arthurlaan (IFBL D3.12.24), foot of wall and fence, pavement weed, commonly naturalized, 28.05.2012, *F. Verloove* 9456 (BR, LG). – Brussel, Koninginnelaan (IFBL E4.25.24), rough ground and lawn near railway siding, abundant, 28.05.2012, *F. Verloove* 9451 (BR). – Anderlecht, rue P. Marchant × canal (IFBL E4.35.13), roadside, canal bank, etc., very common, 28.05.2012, *F. Verloove* 9452 (BR). – Vilvoorde, Strombeeksesteenweg × Sint-Annalaan (IFBL E4.15.22), pavement weed, 28.05.2012, *F. Verloove* 9453 (BR). – Boom, terrein voormalige brandweerkazerne (IFBL D4.15.22), langs voetpad en braakliggend terrein, tweetal forse pollen, 02.06.2012, *N. Wysmantel* s.n. (BR). – Zwevegem, former railway track (IFBL E2.33.42), rough ground, very common (abundant), 06.06.2012, *F. Verloove* 9450 (priv. herb. FV, BR). – Willebroek, Vaartstraat (IFBL D4.15.42), op braakliggende terreinen,

sinds lang gekende populatie op twee locaties (meerdere m²), 27.06.2012, *N. Wysmantel* s.n. (BR). – Harbour of Gent, canal Gent-Terneuzen (W-bank), at Terdonk (IFBL C3.43.41), canal bank, very dense, nearly monospecific stand over several 100's of meters, known since 2001, 01.07.2012, *F. Verloove* 9498 (BR). – Brussel, Glibertstraat, close to Noordstation (IFBL E4.25.24), foot of fence, lawns, rough ground, etc., exceedingly common in this area, 06.07.2012, *F. Verloove* 9508 (BR). – Brussel (Ganshoren), Maria van Hongarijelaan (IFBL E4.24.22), worked-up roadside, scattered individuals, 06.07.2012, *F. Verloove* 9509 (BR). – Gent (Brugse Poort), Kettingstraat (IFBL D3.12.34), foot of tree, 29.07.2012, *F. Verloove* 9572 (BR).

The following collections, all from the immediate surroundings of the former Botanic Garden, most likely also belong with *Bromus sitchensis* (see before):

[Bruxelles], chantier de la Jonction Nord-Midi, dans le bas du Jardin botanique, 07.**1944**, *E. Michel* s.n. (BR). – Bruxelles, travaux de la Jonction Nord-Midi, 26.06.1945, *A. Lawalrée* 1301 (BR). – [Bruxelles], décombres derrière les serres à multiplication du Jardin botanique de l'Etat, 02.08.1946, *E. Michel* s.n. (BR). – Bruxelles], chantier de la jonction N-M, 10.08.1946, *E. Michel* s.n. (BR). – Brussel, ruigte, 1947, *W. Fasseaux* s.n. (BR). – Bruxelles, décombres Jonction Nord-Midi, 08.1947, *E. Michel* s.n. (BR). – Bruxelles, Jonction Nord-Midi, 09.1947, *A. Lawalrée* s.n. (LG).

[Bruxelles], terrain de la Jonction dans la traversée du Jardin botanique, 16.06.**1950**, *G. André* s.n. (BR). – Brussel, N-Z-verbinding langs den Plantentuin, 26.10.1950, *E. Michiels* s.n. (BR). – Bruxelles, sur la Jonction, terrains incultes, 02.09.1951, *N. Cnops* s.n. (LG). – Bruxelles, chantier Jonction, 19.08.1952, *M. Coûteaux* 748 (BR). – Brussel (IFBL E4.25.42), bouwwerf N-Z verbinding, Bot. tuin, 30.08.1952, *A. Jans* 99/52 (BR). – Brussel (IFBL E4.25.42), vaag terrein N-Z verbinding, Kruidtuin, 30.08.1952, *A. Jans* s.n. (BR). – Brussel (IFBL E4.25.42), bouwwerf N-Z verbinding, Rijksplantentuin, 01.09.1952, *A. Jans* 99/52 (BR). – Brussel, woest terrein van de N-Z-verbinding bij den Plantentuin, 23.08.1954, *E. Michiels* s.n. (BR). – Bruxelles (IFBL E4.25.42), lieux incultes sur la Jonction, 02.09.1954, *N. Cnops* 54.286 (BR, LG). – Bruxelles, chantier de la Jonction Nord-Midi, rudéral, (…) naturalisée abondamment en cet endroit et formant de véritables prairies, 04.08.1956, *A. Lawalrée* 7776 (BR; also distributed by Soc. Fr. Ech. Pl. Vasc. as number 2822). – Bruxelles, au pied d'une palissade, le long du chemin allant de la rue Neuve (entre Priba et le Bon Marché) à la halte du Congrès, trottoir de droite près de la halte du Congrès, 20.08.1956, *J. Duvigneaud* s.n. (BR). – Brussel, Noord-Zuid Verbinding, 11.06.1957, *L. De Ruyver* s.n. (BR). – Bruxelles, abondant dans des terrains vagues en face de la gare du Nord, 09.1957, *J. Lambinon* s.n. (BR, LG). – Brussel, bouwplaats langs nieuwe laan N-Z verbinding, 01.10.1957, *J.E. De Langhe* 512/57 (BR).

Bruxelles, au Congrès (gare), terrains vagues, 17.08.**1960**, *S. Depasse* 17/349 (BR). – Bruxelles, terrains vagues le long de la Jonction, 29.06.1962, *J. Duvigneaud* 62/B/690 (BR).

• *Bromus catharticus* var. *catharticus*

Bruxelles, exposition, 09.**1869**, *Muller* s.n. (BR).

Wilsele, près de l'usine Bodart, **1876**, *C. Baguet* s.n. (BR). – Wilsele, environs de l'usine Bodart (laine exotique), 1876, *C. Baguet* s.n. (GENT).

Merxem, lieux incultes, 12.08.**1884**, *J. Hennen* s.n. (BR). – Merxem, 09.1884, *J. Hennen* s.n. (GENT). – Averbode, graminée subspontanée, 1887, *Ghysebreght* s.n. (BR). – Gérard-Champs, Verviers, Goe, Dison, graviers de la Vesdre, 04.09.1887, *M. Halin* s.n. (BR).

Ensival, Pepinster, etc., décombres et graviers, 07.**1895**, *Halin* s.n. (BR).

Près Theux, bord chemin, 27.07.**1902**, *H. & F. Schwers* s.n. (LG). – Verviers (Haute Crotte), décombres, 09.1902, *P. Halin* s.n. (LG) [mixed collection with var. *rupestris*]. – Petit Rechain, 1903, *P. Doubleman* s.n. (LG). – Austruweel, bord de l'Escaut, 07.09.1903, *A. Charlet* s.n. (LG). – Merxem, terrain à décombres au nord et près du Canal à l'est de la chaussée Deurne-Merxem et non loin de cette chaussée, 17.06.1904, *J. Hennen* s.n. (LG). – Ensival, graviers de la Vesdre, 25.09.1904, *M. Halin* s.n. (BR). – Vierset-Barse, champ de betteraves, 23.09.1905, *A. Charlet* s.n. (LG). – Schaerbeek, terrains incultes près de la gare (troisième habitation dans cette commune), 23.09.1907, *Isaacson* s.n. (BR). – Berchiwé, décombres, 16.06.1908, *P. Errard* s.n. (BR). – Virton, décombres, 07.1908 et 08.1909, *A. Verhulst* s.n. (BR). – Schaerbeek, lieux incultes, 10.07.1908, *Isaacson* s.n. (BR). – Virton, décombres, 12.07.1909, *A. Maréchal* s.n. (LG).

Anvers-Sud, terrains incultes, 23.08.**1915**, *J. Hennen* s.n. (BR). – Nieuport, dans les ruines près de l'entrée d'un abri, 20.09.1919, *L. Magnel* s.n. (BR).

Ensival, graviers de la Vesdre, 22.08.**1921**, *A. Visé* s.n. (BR).

Dison, terres incultes, 06.**1932**, *P. Doubleman* s.n. (LG). – Pepinster, graviers de la Vesdre, 25.08.1936 (cultivé 09.1939), *H. Henin* s.n. (LG).

Graviers de la Vesdre, adventief, 09.**1947**, *C. Pelgrims* s.n. (BR). – Dolhain, graviers de la Vesdre, 10.1947, *C. Pelgrims* s.n. (BR). – La Louvière, terrain de décombres, 1948, *J. Duvigneaud* s.n. (BR). – Haine-Saint-Pierre, terrain de décombres, 09.1948, *J. Duvigneaud* s.n. (BR). – Goffontaine, graviers de la Vesdre, 15.11.1948, *J.-M. Warlet* 107 (BR). – Graviers de la Vesdre, 27.08.1949, *J. Dodelet* s.n. (BR).

Graviers de la Vesdre, 09.**1950**, *C. Pelgrims* s.n. (BR). – Mechelen, stortterrein Galgenberg, 01.10.1950, *N. Cnops* 50.150 (BR). – Béthane, Vesdre, woladventief, 17.09.1951, *J.E. De Langhe* s.n. (BR). – Goé, Vesdre, lieu inculte, 14.09.1952, *N. Cnops* 52.577 (BR). – Goé, wolstort aan de Vesdre, 28.09.1952, *A. Jans* 147/52 (BR). – Béthane, Vesdre, op een wolstort, 28.09.1952, *J.E. De*

Langhe s.n. (BR). – Entre Goë et Béthane, petit terrain vague, 08.09.1953, *J. Lambinon* s.n. (LG). – Béthane, vallée de la Vesdre, décombres, 10.1954, *J.-L. De Sloover* 299 (BR). – Pepinster, graviers de la Vesdre vers Goffontaine, 09.1955, *J. Lambinon* s.n. (LG). – Béthane, décombres, 09.1955, *J. Lebeau* s.n. (BR). – Surdent, graviers Vesdre, 09.1958, *L. Renard* s.n. (LG). – Béthane, petit terrain vague dans la cour du lavoir (adventice lainier), 10.10.1959, *J. Lambinon* 59/B/536 (LG). – Pré-Javais, graviers de la Vesdre, 15.10.1959, *E. Dodelet* 107/404bis (BR). – Verviers, graviers de la Vesdre, 16.10.1959, *J. Damblon* s.n. (LG).

Entre Jemappes et Ghlin, décombres, 28.06.**1961**, *Fr. Macédone* s.n. (BR). – Molenstede (IFBL D6.31), ruigte, 09.1962, *H. Vannerom* s.n. (BR). – Goffontaine, graviers de la Vesdre, 10.1965, *J.-M. Warlet* s.n. (BR).

Turnhout, kanaal, meelfabriek Joosen-Luyckx, kom Oude Kaai, zandgrond, 20.07.**1972**, *J. Aerts* s.n. (GENT). – Vilvoorde (IFBL D4.57.14), tuin van het H.R.T. Tuinbouw, 17.09.1976, *A. Jans* 53/76 (BR).

Nederbrakel, privé-terrein, tussen tuin en bosje, 21.06.**1988**, *J. de Ruyver* 16943 (BR).

Antwerpen, Albertkanaal te Merksem (Vaartkaai) (IFBL C4.27.11), omgewoelde wegberm bij de meelfabriek Vamo Mills, 22.08.**1993**, *F. Verloove* 1002 (priv. herb. FV, BR). – Antwerpen, Albertkanaal te Merksem (IFBL C4.27.11), recent omgewerkte wegberm (loskade) bij de meelfabriek Vamo Mills, vrij talrijk, 17.10.1993, *F. Verloove* 1061 (priv. herb. FV). – Hooglede (IFBL D1.47.21), in de tuin, gekweekt uit vogelzaadmengsel, 22.08.1994, *F. Verloove* 1340 (priv. herb. FV). – Antwerpen, harbour of Antwerpen, Graandok (Zesde Haven- × Churchilldok) (IFBL B4.55.44), graindump at the Sobelgra grain mill, several specimens, 22.05.1998, *F. Verloove* 3346 (priv. herb. FV). – Antwerpen, harbour of Antwerpen, small dock near Albertkanaal at Merksem (IFBL C4.17.34), unloading quay for the local grain mills, several specimens, 27.06.1998, *F. Verloove* 3347 (priv. herb. FV, BR). – Antwerpen, Ekeren (IFBL B4.55.44), Sobelgra, ruderaal, adventief, 19.09.1998, *K. Symons* s.n. (BR). – Antwerpen, haven (IFBL B4.55.44), Sobelgra, 10.10.1998, *N. Wysmantel* s.n. (BR). – Beveren (IFBL D1.48.11), opgehoogd terrein bij fabriek, 13.08.1999, *H. Ruysseveldt* 2328 (BR). – Gent, Henri Farmanlaan (IFBL D3.13.13), vrij talrijk tussen kasseien langs goederenspoorlijn, 17.10.1999, *W. Van Landuyt* 90-30 (GENT).

Nederbrakel, onder naaldhout, 18.01.**2000**, *E. Jacques* 19036 (BR). – Brussel, Vilvoordsebaan (IFBL E4.16.34), ruderal road verge, scattered specimens, 11.11.2001, *F. Verloove* 4999 (LG).

Balen, Ongelberg (IFBL C6.34.34), ruig randje aan ingang bedrijf, 07.11.**2011**, *R. Barendse* s.n. (BR). – Ooigem, canal Roeselare-Leie (IFBL E2.13.21), unloading quay for cereals, several tens, 24.05.2012, *F. Verloove* 9419 (BR) – Massenhoven, carpoolparking tussen Albertkanaal en afrit E313 (IFBL C5.32.22), 28.07.2012, *D. De Beer* s.n. (priv. herb. D. De Beer).

• ***Bromus catharticus* var. *rupestris***

Verviers (Haute Crotte), décombres, 09.**1902**, *P. Halin* s.n. (LG) [mixed collection with var. *catharticus*].

Verviers, chantier, 28.07.**1938**, *F. Sternon* s.n. (LG). – Verviers, chantier, 28.07.1938, *J. Goffart* s.n. (LG). – Verviers, en face de la Chantoire, terrain vague, 24.08.1938, *F. Sternon* 251 (LG).

Selection of other relevant specimens:

• ***Bromus carinatus***

U.S.A., California, Santa Barbara, Dry hillside, 04.07.1913, *A.S. Hitchcock* (Amer. Gr. Nat. Herb. n° 853) (BR);

U.S.A., California, Fort Bragg, Mendocino County, Moist slope of sandy cliff near the sea, 16.07.1915, *A.S. Hitchcock* (Amer. Gr. Nat. Herb. n° 852) (BR).

• ***Bromus stamineus***

U.S.A., California, west of San Mateo, Skyline Blvd., open hills, 27.04.1963, *L.S. Rose* 63002 (BR).

• ***Bromus marginatus***

U.S.A., California, Truckee, Woods near moist meadow, Downer Creek, 14.07.1913, *A.S. Hitchcock* (Amer. Gr. Nat. Herb. n° 858) (BR);

U.S.A., California, Truckee, Rocky slope, 16.07.1913, *A.S. Hitchcock* (Amer. Gr. Nat. Herb. n° 859) (BR);

U.S.A., Nevada, Reno, Rocky slope, Hunter Creek Canyon, 18.07.1913, *A.S. Hitchcock* (Amer. Gr. Nat. Herb. n° 857) (BR).

• ***Bromus polyanthus***

U.S.A., Montana, Glacier National Park, Opening in woods, McDonald Creek and Little Kootenai River, 08.07.1914, *A.S. Hitchcock* (Amer. Gr. Nat. Herb. n° 854) (BR);

U.S.A., Arizona, Fort Valley, near Flagstaff, Meadow land, 10.08.1915, *A.S. Hitchcock* (Amer. Gr. Nat. Herb. n° 856) (BR);

U.S.A., New Mexico, Ute Park, Colfax County, In a low meadow about willow thickets with Agropyron tenerum, 09.09.1916, *P.C. Standley* (Amer. Gr. Nat. Herb. n° 855) (BR).