



## Some notes on the *Hordeum murinum* complex in Belgium

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**Illustrations** by the authors (Fig. 2-4 FV; Fig. 1 and 5-7 WV).

**ABSTRACT.** – *Hordeum murinum* subsp. *murinum* is a common archaeophyte in Belgium. A more southern subspecies, subsp. *leporinum*, is known since 1938 as a rare, ephemeral alien, mostly associated with the grain or wool industry. In the past decade, however, it has increasingly been recorded. In port areas in Antwerp and Ghent it has locally naturalized along railway tracks, on roadsides and rough ground. In addition, it is also found in similar habitats in urban areas. A third subspecies, subsp. *glaucum*, is also reported for the first time in Belgium, as a mere casual alien. The separation of these three taxa is not straightforward. Characters useful for their distinction are presented and all subspecies are illustrated as well.

**SAMENVATTING.** – **Enkele opmerkingen over het *Hordeum murinum*-complex in België.** *Hordeum murinum* subsp. *murinum* is een veel voorkomende archeofiet in België. Een meer zuidelijke ondersoort, subsp. *leporinum*, staat sinds 1938 bekend als een zeldzame en onstandvastige adventief, meestal aangevoerd met graan of wol. In het afgelopen decennium is ze echter steeds vaker waargenomen. In havengebieden in Antwerpen en Gent is ze lokaal ingeburgerd langs wegen en spoorwegen en in ruigten. Bovendien wordt ze ook aangetroffen in vergelijkbare habitats in stedelijke gebieden. Een derde ondersoort, subsp. *glaucum*, wordt hier ook voor het eerst gesignaleerd in België, wellicht als een efemere adventief. Het onderscheid tussen deze drie taxa is niet eenvoudig. Kenmerken die nuttig zijn voor hun onderscheid worden gepresenteerd en alle ondersoorten worden ook geïllustreerd.

**RÉSUMÉ.** – **Quelques observations sur le complexe *Hordeum murinum* en Belgique.** *Hordeum murinum* subsp. *murinum* est une archéophyte commune et très répandue en Belgique. Une sous-espèce plus méridionale, la subsp. *leporinum*, est connue depuis 1938 comme adventice occasionnelle, associée le plus souvent à l'industrie grainière ou lainière. Or, au cours de la dernière décennie, elle a été observée de plus en plus souvent. Dans les zones portuaires d'Anvers et de Gand, elle est naturalisée localement le long des voies ferrées et des routes et dans des friches. En outre, elle s'observe également dans des habitats similaires en milieu urbain. Une troisième sous-espèce, la subsp. *glaucum*, est également signalée pour la première fois en Belgique, probablement en tant que simple adventice occasionnelle. La séparation de ces trois taxons n'est pas simple. Les caractères utiles pour leur distinction sont présentés et toutes les sous-espèces sont également illustrées.

### Introduction: the genus *Hordeum* in Belgium

The genus *Hordeum* L. comprises about 32 species that are distributed in arid and temperate areas of the Northern Hemisphere, South America and South Africa (von Bothmer *et al.* 1995). Three species are considered part of the native Belgian flora (Lambinon & Verloove 2012). *Hordeum murinum* L. is a common, widespread weed and doubtlessly an archaeophyte rather than a genuinely native species (see also Morrison 1958). Two other species, *H. secalinum* Schreb. and *H. marinum* Huds., are confined

to more natural habitats and probably truly indigenous. The latter, however, is extinct for many decades (Van Landuyt 2006). The genus also includes some important cereal grains (barley), such as *H. vulgare* L. and *H. distichon* L. These are often encountered outside agricultural fields as well, for instance in port areas, railway sidings or road verges. In addition, several species of *Hordeum* have formerly been recorded as wool aliens in Belgium, as their awns easily adhere to sheep wool (Verloove 2006). Out of these neophytes, only a single species, the South Ameri-

can *H. jubatum* L., was able to naturalize. It now occurs in a number of mostly anthropogenic habitats, often on salty substrates (e.g. coal mine spoil heaps, coal terminals in port areas), often in abundance. It is also sometimes sown in new roadsides and – being a perennial – persists very well.

A second species, *H. leporinum* Link, was also observed occasionally in Belgium, more precisely between 1938 and 1959 and mostly associated with cereals and wool industry (Verloove 2006). This species is a member of the *H. murinum* complex, a well-defined, monophyletic and easily recognized group that accommodates ca. five taxa: the weedy species *H. murinum* s.str., *H. leporinum* and *H. glaucum* Steud. (the latter two with a more southern distribution that roughly encompasses the Mediterranean area) and two local endemics from Spain and Greece (Scholz & Raus 1997). The taxonomic position of some of these taxa, however, is debatable. They are now often subsumed (as subspecies) under *H. murinum* [subsp. *leporinum* (Link) Arcang. and subsp. *glaucum* (Steud.) Tsvelev; e.g. Tsvelev 1984, Gibbs Russell *et al.* 1990, von Bothmer *et al.* 1995, von Bothmer *et al.* 2007, Tison & de Foucault 2014, Fish *et al.* 2015, Jogan 2017, Stace 2019; this paper], although other authors adhere to the species rank for these taxa (e.g. Bor 1968, Bor 1970, Cocks *et al.* 1976, Henwood & Weiller 2009, Amer *et al.* 2013, Azer *et al.* 2016). Alternatively, the diploid *H. glaucum* is sometimes accepted as a distinct species with the other two (polyploids) as subspecies of *H. murinum* (e.g. León *et al.* 2014; see also Bieniek 2018). The uncertain taxonomic position, of course, relates to the difficulties encountered in separating these three taxa.

Since all three subspecies have been recorded in Belgium in recent times, and subsp. *leporinum* moreover showing clear signs of an incipient naturalization process, it appeared interesting to discuss and illustrate diagnostic features useful for their distinction and to give an overview of recent records and occupied habitats.

### Recognition and identification

*Hordeum murinum* and its close relatives form a monophyletic assemblage. They are easily separated from the other species of the genus. Plants are always annuals with all leaves with well-developed leaf sheath auricles and the glumes of the central floret distinctly flattened and with conspicuously ciliate margins. This combination of characters is not encountered in other members of the genus.

*Hordeum murinum* (s.str.) was described by Linnaeus (1753). Link (1834) later described *H. leporinum* as a more robust species with wider leaves and lateral florets that are generally staminate, not neuter. However, at present we know that none of these character states has any taxonomic value. *H. glaucum* was newly described by Steudel (1854). Although its description was rather detailed, not a single feature was really distinctive for the species (perhaps at most the glaucous appearance of the plant). In the course of time numerous other features have

been put forward to distinguish these three entities (e.g. Covas 1949, Jansen 1951, Morrison 1958, Cocks *et al.* 1976, Jacobsen & von Bothmer 1995, von Bothmer *et al.* 1995, Scholz & Raus 1997, von Bothmer *et al.* 2007, León *et al.* 2014, Tison & de Foucault 2014, Jogan 2017, Stace 2019), but only a few are considered helpful.

Based on these sources and on numerous herbarium specimens examined in the herbarium of Meise Botanic Garden (BR) it became apparent that the two non-native subspecies (*leporinum* and *glaucum*) are easily separated from the subsp. *murinum*. Both have central florets<sup>1</sup> that are distinctly stalked (stalk at least 1 mm long). Also, the awns of the central floret are usually shorter than those of the lateral florets and paleas of the lateral florets tend to be more densely pubescent. In contrast, in subsp. *murinum*, the central floret is sessile to shortly stalked (stalk, if present, up to 0.6(-0.8) mm long), awns of the central floret are normally at least as long as and often definitely longer than those of the lateral florets, and paleas of the lateral florets are nearly glabrous. The separation between subsp. *leporinum* and subsp. *glaucum* is less straightforward and the application of these names differs from one author to another (see also Tison & de Foucault 2014). As here understood, subsp. *glaucum* is a relatively slender plant (diploid!) with a narrow, densely flowered spike and an often more or less glaucous foliage. Floral details are more conclusive: the anthers of the central floret are very small (ca. 0.3-0.6 mm long), hardly longer than wide and not exerted at flowering; they are often dark or at least dark-mottled. The rachilla extension of the lateral florets is often yellow to orange and relatively short (León *et al.* 2014). Subsp. *leporinum*, in turn, is a coarser plant (polyploid!) often with a wider, more laxly flowered spike. Foliage is not markedly glaucous. The anthers of the central floret are larger (ca. 0.7-1.5 mm long), distinctly longer than wide, exerted at flowering and often uniformly pale. The rachilla extension of the lateral florets is usually paler (whitish to cream, sometimes orange) and linear.

The diagnostic features found to be most useful for the separation of the three subspecies are included in the following identification key. This key is best used in conjunction with Fig. 1.

- 1 Central (fertile) floret sessile or shortly stalked, stalk much shorter than that of the lateral florets, (nearly) always much less than 1 mm long. Awns of the lateral florets normally shorter than those of the the central floret. Palea of the lateral floret almost glabrous. Inflorescence normally green at flowering (rarely pinkish tinged), pale straw-colored in fruit ... subsp. **murinum**  
Central floret clearly stalked, stalk usually at least 1 mm long, about the same length as the stalk of the lateral florets. Awns of the lateral florets normally longer than those the central floret. Palea of the lateral floret distinctly pubescent. Inflorescence green to purplish at flowering, often brownish in fruit ..... 2

<sup>1</sup> Each node in the inflorescence bears a triplet of florets. The central one is bisexual and fertile whereas the lateral ones are staminate or neuter.

- 2 Anthers of central floret very small (0.3-0.6 mm long), hardly longer than wide, not exerted at flowering, often dark or at least dark-mottled. Rachis segment (i.e., the part of the inflorescence that bears the triplet of florets) relatively short, about twice as long as broad. Rachilla extension of the lateral florets sometimes yellow to orange and relatively short .... subsp. **glaucum**  
 Anthers of central floret longer (0.7-1.5 mm long), distinctly longer than wide, exerted at flowering, more often uniformly pale. Rachis segment about three times as long as broad. Rachilla extension of the lateral florets often paler (whitish, cream or orange), usually longer ..... subsp. **leporinum**

With some experience, subsp. *leporinum* is relatively easy to recognize, even without examining micromorphological details. Compared with subsp. *murinum* it usually has wider, more laxly flowered spikes with thicker florets, which renders the plant a slightly different habitus. Most striking, however, is that the spikelets often turn pinkish to reddish-purple during anthesis (Fig. 2, 4). This feature is more rarely observed in the other subspecies and possibly mostly as a result of exposure to extreme sunlight. For instance, in the unusually sunny spring of 2020 plants of subsp. *murinum* were sometimes observed to have pinkish-tinged inflorescences (Fig. 5). A plant formerly described from Mallorca as *H. rubens* Willk. (Willkomm 1875) doubtlessly is nothing else than *H. murinum* subsp. *leporinum* (see also Bor 1960). Based on this characteristic coloration, subsp. *leporinum* is often immediately distinguished, even from a distance. However, although strikingly pink- or purplish-colored inflorescences nearly always refer to subsp. *leporinum*, the reverse does not apply. Most plants naturalized in the Ghent port area clearly differ from subsp. *murinum* but have inflorescences that remain greenish-yellow, also at maturity (Fig. 3). These were first thought to belong to subsp. *glaucum* but eventually also were identified as

subsp. *leporinum*, based on micromorphological characters. Finally, in the fruiting stage, inflorescences of subsp. *leporinum* tend to be darker brown than the stramineous inflorescences of subsp. *murinum*.

Subsp. *glaucum* is much less easily separated and a thorough examination of florets is required (see key; Fig. 6, 7). The most reliable characters separating this subspecies from subsp. *leporinum* are the following. Anthers of the central floret are always smaller and hardly longer than wide (0.3-0.6 mm, vs. 0.7-1.5 mm long); they usually are mottled dark whereas in subsp. *leporinum* they more often are uniformly pale colored. The rachilla extension of the lateral floret tends to be darker and shorter in subsp. *glaucum*. We have observed a further character state (apparently not mentioned before in literature sources) that seems to reliably separate these two subspecies. The rachis segment that bears the three florets is markedly shorter in subsp. *glaucum* than in subsp. *leporinum*, about twice as long as wide vs. three times as long as wide (Fig. 1). This can also be seen in the illustrations of spikelets as presented by von Bothmer *et al.* (1995).

#### Distribution in Belgium

##### • *Hordeum murinum* subsp. *leporinum*

Subsp. *leporinum* was recorded a few times as a casual grain and wool alien between 1938 and 1959 (Verloove 2006). Since 2011 we have increasingly recorded this subspecies, especially in the port of Antwerp, subsequently also in the port of Ghent (see specimens examined). In many of these localities it has been repeatedly recorded since then. Although in the Ghent port area it was only recorded for the first time in 2019, it has obviously been present there since several years, given its current abundance, especially in the area comprised between the Siffer- and Grootdok (as indicated before, these



**Fig. 1.** Triplets of three subspecies of *Hordeum murinum*. Left to right: subsp. *glaucum*, subsp. *murinum* and subsp. *leporinum*. In subsp. *leporinum* and subsp. *glaucum* the central fertile floret is distinctly stalked (1). The rachis segment (2) of the latter is distinctly shorter than that of the former. The colored rachilla extension (3) of the lateral florets is also clearly visible in these two subspecies. In subsp. *leporinum* this extension is linear and long, whereas in subsp. *glaucum* it is shorter and usually darker as well.



**Fig. 2.** *Hordeum murinum* subsp. *leporinum* along railway tracks in the Antwerp port area, June 2015. In this area this subspecies is locally abundant since several years. Inflorescences often turn purplish-red in this subspecies.



**Fig. 3.** *Hordeum murinum* subsp. *leporinum* along railway tracks in the Ghent port area, May 2019. The inflorescences in this population remain greenish which makes the separation from subsp. *murinum* less easy.

plants do not turn reddish-purple which makes them much less apparent; Fig. 3). Elsewhere in the Ghent port area, purplish-colored plants have abundantly naturalized



**Fig. 4.** *Hordeum murinum* subsp. *leporinum* as a pavement weed in Wevelgem, May 2019. Inflorescences often turn purplish-red in this subspecies.



**Fig. 5.** *Hordeum murinum* subsp. *murinum* in Mariakerke (Ghent), June 2020. Although the inflorescence in this subspecies usually remains greenish, it can sometimes turn pinkish, possibly as a result of exposure to extreme sunlight.

lately, especially in the area between the John Kennedy-laan and Skaldenstraat. In addition, subsp. *leporinum* has been recorded in several other localities throughout the country. We noted its presence in several municipalities in the Brussels-Capital Region (Anderlecht and Schaerbeek) as well as in or near other suburban areas (Bredene, Ghent, Kortrijk, Namur, Roeselare, Wevelgem) and even in more rural areas (e.g. Oostnieuwkerke). According to the Waarnemingen.be website (<https://waarnemingen.be>) it has also been reliably observed by Dirk Derdeyn in Tournai in 2014.

While this taxon has been observed in Belgium since the 1930s, until recently it did not succeed in establishing itself. Based on a series of observations in the past ten years, however, it seems that subsp. *leporinum* is in the process of becoming a permanent member of our flora.

*Selection of specimens examined:*

- Harbour of Antwerp, Antwerpsebaan E of Delwaidedok (IFBL B4.45.23), foot of fence, abundant over +100 m, 29.05.2011, *F. Verloove* 8723 (BR);
- Harbour of Antwerp, SE side of Churchlldok (IFBL B4.56.33), railway track, 20.05.2013, *F. Verloove* 10093 (BR);
- Harbour of Antwerp, Treurenborg (S of Churchill-dok) (IFBL B4.56.33), railway track, several dozens, 02.06.2013, *F. Verloove* 10130 (BR);
- Bredene, corner Duindoornstraat (IFBL C1.15.24), dry open roadside, several dozens, looks +/- established, 13.06.2014, *F. Verloove* 10792 (BR);
- Brussel, tram station Teichmann (IFBL E4.16.33), bare gravelly soil by railway, frequent, 10.05.2015, *F. Verloove* 11348 (BR);
- Gent, Nieuw-Gent, Kikvorsstraat (IFBL D3.22.43), rough ground, at base of building, several dozens, 24.05.2015, *F. Verloove* 11418 (BR);
- Anderlecht (Brussels), Petit-Ile, B-Post (IFBL E4.35.13), dry roadside, several dozens, 21.06.2015, *F. Verloove* 11493 (BR);
- Harbour of Antwerp, SAMGA at Amerikadok (IFBL C4.16.34-43), rough ground near grain mill, 22.05.2016, *F. Verloove* 12339 (BR);
- Gent (Ledeberg), at Aldi (IFBL D3.22.24), rough ground (demolition site), 22.05.2016, *F. Verloove* 13713 (BR);
- Harbour of Ghent, Skaldenstraat (IFBL C3.53.23), sandy roadside, scattered individuals, 19.05.2019, *F. Verloove* 13498 (BR);
- Wevelgem, Egelantierstraat (IFBL E1.38.42), pavement weed, ± 150 individuals, 02.06.2019, *F. Verloove* 13527 (BR);
- Harbour of Ghent, Farmanstraat (IFBL D3.13.13), alongside railway tracks, very common (+1000 individuals), clearly established but probably long overlooked, 18.06.2019, *F. Verloove* 13729 (BR);
- Harbour of Ghent, Singel (IFBL C3.53.33), by railway tracks, foot of fences, rough ground, several dozens, 18.06.2019, *F. Verloove* 13730 (BR);
- Ghent, Nieuw Gent, Kikvorsstraat (IFBL D3.22.43), disturbed lawn, known from this locality since several years, 14.07.2019, *F. Verloove* 13579 (BR);
- Harbour of Ghent, W side of Sifferdok (IFBL C3.53.33), foot of silos, frequent, 14.07.2019, *F. Verloove* 13582 (BR);
- Gent, Port Arthurlaan (IFBL D3.12.24), roadside, alongside railway tracks, locally frequent, 03.05.2020, *F. Verloove* 13762 (BR);
- Harbour of Ghent, Daniel Kinetstraat N of Middendock (IFBL D3.12.22 and D3.13.11), by railway tracks, very common, 03.05.2020, *F. Verloove* 13765 (BR);
- Harbour of Ghent, Rodenhuizedock (IFBL C3.43.42), unloading quay for cereals, rather frequent, 17.05.2020, *F. Verloove* 13778 (BR);
- Roeselare (Rumbeke), Izegemsestraat (N357) (IFBL D1.58.24), roadside, foot of fences, gravel, etc., a few dozens, 31.05.2020, *F. Verloove* 13780 (BR);
- Oostnieuwkerke, Spanjestaart (IFBL D1.56.24), on gravel, roadside, several dozens, 07.06.2020, *F. Verloove* 13803 (BR);
- Wevelgem, Paridaanstraat (IFBL E1.38.24), sidewalk, roadside, on the verge of fallow field, etc., common, 12.06.2020, *F. Verloove* 13807 (BR);
- Kortrijk, Burgemeester Pyckestraat (IFBL E2.32.23), sidewalk, a single individual, 12.06.2020, *F. Verloove* 13808 (BR).



**Fig. 6 and 7.** *Hordeum murinum* subsp. *glaucum* in Sint-Denijs-Westrem, May 2020.

• *Hordeum murinum* subsp. *glaucum*

Subsp. *glaucum* is clearly a much rarer subspecies than *leporinum* and possibly ephemeral in Belgium. It was not mentioned by Verloove (2006). It has been collected four times so far in Belgium, for the first time as wool alien in 1970. In 2011 it was observed in plant containers with olive trees imported from southern Europe. In 2019 a single individual was observed by Luc Devos in Ghent, subsequently also by the first author who identified the subspecies. Finally, one of us (WV) observed a dozen of individuals of subsp. *glaucum* in Sint-Denijs-Westrem in 2020, on the verge of a major approach road.

*Specimens examined:*

- Cornesse-Pepinster, vallei van de Vesder, 07.1970, *H.G. Rabijns* 203 (BR; sub *H. murinum*);
- Tuincentrum May Flowers, weg Ruiselede-Aalter, in olijkuipe, diverse ex., 10.04.2011, *F. Verloove* 8581 (BR);
- Gent, Dampoort (IFBL D3.22.22), worked-up roadside, near railway station, a single individual, 09.06.2019, *F. Verloove* 13712 (BR).

**Habitat and ecology**

Subsp. *leporinum* and subsp. *glaucum* are thermophilous taxa that have their main distribution in the Mediterranean area. As a consequence they are only found in climatologically suitable habitats further north. In the two main areas where it has become established (Antwerp and Ghent), subsp. *leporinum* is mostly found in open, stony, sun-exposed habitats: the plants are often found on cinder ash in the narrow strip that lines the railway tracks, in cracks of concrete and pavement in road verges, on charcoal in coal storage areas, foot of walls, silos, fences and other infrastructures. In urban environments it has additionally been observed in tram beds, as a pavement and roadside weed, on rough ground or demolition sites. Plants are regularly treated with weed killer but either are herbicide resistant or manage to produce viable seeds prior to the first treatments. Several biotypes of subsp. *leporinum* are known to be resistant to selected herbicides (e.g. Tucker & Powles 1991, Matthews *et al.* 2000, Yu *et al.* 2007).

Subsp. *leporinum* is a reputed and very noxious weed of agricultural fields in some areas where it was formerly introduced, for instance in Australia and the southern parts of the United States (numerous references, e.g. Moore & Wheeler 2008). In Belgium it has not been observed so far in such habitats.

**Conclusion**

Two thermophilous subspecies of *Hordeum murinum* have increasingly been observed in Belgium in the past decade, subsp. *glaucum* and subsp. *leporinum*. Especially the latter is in the process of naturalization in various kinds of anthropogenically disturbed habitats (railway infrastructure, port areas, suburban environments). As a result of a changing climate, both will probably further expand in a near future. Given their bad reputation as nox-

ious agricultural weeds elsewhere in the world, their possible extension to arable fields is best closely monitored.

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