Carduus acanthoides (Asteraceae), a locally invasive alien species in Belgium

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Illustrations: F. Verloove (photos) and H. Engledow (distribution map)

Samenvatting. – *Carduus acanthoides*, een in België plaatselijk invasieve soort. *Carduus acanthoides*, een soort met een erg onduidelijke status in België (inheems vs. niet-inheems, ingeburgerd vs. efemeer) werd in 2012 gevonden in havengebieden in Antwerpen en Gent. Uit herbariumonderzoek bleek dat de soort in de haven van Antwerpen reeds minstens sinds de jaren 1970 werd ingezameld maar nooit eenduidig werd benoemd. Ondertussen is ze in grote delen van het havengebied algemeen en plaatselijk zelfs erg invasief. Het onderscheid tussen *C. acanthoides* en *C. crispus* wordt in dit artikel uitgebreid besproken en beide soorten worden afgebeeld. De habitatpreferenties van *C. acanthoides* worden kort geschetst en een verspreidingskaart voor de ruime omgeving van Antwerpen wordt gepresenteerd.

Résumé. – *Carduus acanthoides*, localement invasif en Belgique. En Belgique, *Carduus acanthoides* doit être considéré comme une espèce assez énigmatique (indigène ou non-indigène, naturalisée ou éphémère). En 2012, l'espèce était observée dans les ports d'Anvers et de Gand. Des recherches dans les herbiers prouvent qu'elle a été introduite dans le port d'Anvers dans les années 1970, mais son identité restait longtemps incertaine. Aujourd'hui elle est largement répandue dans la région portuaire, et localement elle peut être considérée comme une espèce invasive. Les différences entre *Carduus acanthoides* et *C. crispus* sont discutées en détail, accompagnées d'illustrations. L'écologie de *C. acanthoides* est brièvement décrite et une carte montre sa distribution dans la région d'Anvers.

Introduction

Carduus, as traditionally circumscribed, is a genus of ca. 90 Old World species, mainly distributed in Eurasia and Africa (Kazmi 1964, Keil 2006, Mabberley 2008). Several species are reputed agricultural and/or environmental weeds and occur widely beyond their native distribution range (see for instance Desrochers *et al.* 1988). Only a few species are native (or at least archaeophytic) in Belgium: *Carduus crispus* L., *C. nutans* L. and *C. tenuiflorus* L. (Lambinon & Verloove 2012). Several others have been recorded as ephemeral aliens in Belgium: *Carduus hamulosus* Ehrh., *C. pycnocephalus* L., *C. thoermeri* Weinm. [syn.: *C. nutans* subsp. *leiophyllus* (Petrovič) Arènes] and *C. vivariensis* Jord. (Verloove 2006). An additional species, *Carduus acanthoides* L., has always been, in many respects, an enigmatic species in Belgium (see for instance van Rompaey & Delvosalle 1978, Lambinon & Verloove 2012): it was uncertain whether or not it occured in Belgium and, if so, what status should be assigned to it (native or non-native and, in the latter case, naturalized or merely ephemeral).

In May 2012 I found some plants of an unusual species of *Carduus* in the port area of Ghent. Similar plants were known to me, for many years, from the port area of Antwerp (fig. 1). These plants looked very much like *Carduus crispus* but finally turned out to belong with *Carduus acanthoides*. In Ghent this species probably occurs as a casual (grain) alien but in Antwerp it is widely and commonly naturalized and clearly present for quite a long time. This was subsequently confirmed by a partial revision of the herbarium of the Botanic Garden Meise, Belgium (BR).

In this paper the distinguishing features for *Carduus acanthoides* and *C. crispus* are thoroughly discussed and illustrated. The residence status (native vs. non-native), ecology and habitat preferences for the former in Belgium are also reviewed and an up-to-date distribution map for the surroundings of Antwerp is presented.

Taxonomy and morphology of *Carduus acanthoides*

Carduus acanthoides and *C. crispus* (as well as *C. nutans*) were initially described by Linnaeus (1753). To distinguish between both species Linnaeus emphasized the characters of the inflorescence: *C. acanthoides* was described as having pedunculate, solitary and villous flower heads ("calycibus pedunculatis solitariis erectis



Figure 1. Carduus acanthoides, *Antwerp, port area (Scheldelaan), Fort St.-Filips, grassland, August 2012. In this area C. acanthoides was probably introduced in the late 1970s but its presence long remained unnoticed. At present it has become locally very common and behaves like an invasive species.*

villosis"), while *C. crispus* was separated on behalf of its clustered flower heads ("flosculis aggregates"). Linneaus' original description was apparently too imprecise and in the course of time as many different concepts of *C. acanthoides* seem to have arisen as there have been workers on the genus. As a result a lot of diacritic features have been proposed to distinguish between both species that proved to be unreliable: they were not unique for one of both species, too variable to have any taxonomic value or simply erroneous. In this paper I firstly focus on characters from Linneaus' original description, completed with additional features observed on Belgian specimens that further seem to separate *C. acanthoides* and *C. crispus*. Digital images of the type specimens of both species, respectively LINN 966/6 in LINN (not 966/5 as erroneously stated by Kazmi 1964) and BM, were also examined.

Flower heads. The species' solitary flower heads were given much weight by Linnaeus (1753). Indeed, as seen in the types, eventually, flower heads are always solitary in *Carduus acanthoides* but they are sometimes aggregated in small clusters before or at the beginning of flowering. Moreover, flower heads of *Carduus acanthoides* are mostly clearly pedunculate, often with the peduncle devoid of a spiny wing just below the head (contrary to the opinion of most authors; see for instance Tamamschyan 1998). In normally developed plants capitula are also obviously larger than they are in *Carduus crispus*. This is correctly assessed by, for instance, Keil (2006) or Stace (2010) but largely neglected by many other authors. Shi & Greuter (2011) give identical measurements for both species. In fact, flower heads of *Carduus acanthoides* are somehow reminiscent of those of *Cirsium vulgare* (and thus markedly larger than those of *C. crispus*). The shape of the involucre is also different: this is more or less spherical or even wider than long in *Carduus acanthoides* but rather longer than wide in *C. crispus* (as correctly assessed by Arènes 1954). Finally, one or more flower heads in *Carduus crispus* tend to be pendent (or at least obliquely inserted, doubtlessly as a result of being closely clustered) by the end of flowering, while in *C. acanthoides* flower heads remain erect. Finally, it should be noted that the involucre of the latter is not more villous than it is in *Carduus crispus*; in fact, involucres are most of the time sparsely hairy to subglabrous in both species.

Leaves. Linnaeus (1753) did not emphasize the leaf characters to distinguish between both species. Kazmi (1964), while examining the type material, found out that leaf indumentum is a useful feature but the distinction is less straightforward than claimed by him. In *Carduus acanthoides* the lower leaf surface is subglabrous and more or less shiny. In fact, on closer examination, leaf veins bear some sparse, multicellular hairs. In *Carduus crispus*, contrary to Kazmi l.c., such hairs are not absent but accompanied by a conspicuous cobwebby indumen-

tum and/or simple hairs. Both such hairs are always lacking in *Carduus acanthoides*. This feature was correctly assessed by Lambinon & Verloove (2012) and Keil (2006) but also, for instance, by Amaral Franco (1976). Other authors largely neglected this important feature (e.g. Arènes 1954). Leaf incision also seems to be a reliable character to separate both species: in *Carduus acanthoides* leaves tend to be more deeply divided (pinnatipartite versus sinuate-pinnatilobate to pinnatifid in *C. crispus*) (see Arènes 1954, Jäger & Werner 2005).

Degree of spininess. The degree of spininess and the dimensions of spines on stem wings and leaf lobe apices are given much taxonomic value by many others. Authors such as Jäger & Werner (2005), van der Meijden (2005) and Lambinon & Verloove (2012) give most weight to this character in their keys and vernacular names also often refer to it (e.g. "Langstekelige distel" in Dutch). However, although spines tend to be often longer in *Carduus acanthoides*, robust plants of *C. crispus* may have longer spines than usually claimed for the former. Moreover, Keil (2006) came to the conclusion that the degree of spininess is subjective and of little value.

Additional features. Two additional features, perhaps of a lesser taxonomic value and difficult to assess in the herbarium, were observed in the field. First, the colour of the corolla is slightly different: usually purple in *Carduus crispus* versus pink or dark-pink in *C. acanthoides*; see also Tamamschyan (1998). Second, although contrary to Shi & Greuter (2011) and Tamamschyan (1998), I have observed that, at least in western Europe, *Carduus acanthoides* is usually much taller.

While studying the Belgian material of *Carduus acanthoides* and *C. crispus* it became evident that several standard floras fail to distinguish between both species.



Figure 2. *Flower head of* Carduus acanthoides*, Ghent, port area (Singel), roadside, July 2012.*

The ongoing confusion between them (as recently referred to by Stace 2010) doubtlessly is a result of this. With the key provided in *Flora Europaea* (Amaral Franco 1976), for instance, it is impossible to reliably identify *Carduus acanthoides*. In couplet 30 *Carduus acanthoides* and *C. crispus* are distinguished on stem indumentum (respectively "stem arachnoid-hairy to tomentose" and "stem glabrous to subglabrous", while in the text both are characterized as having stems that are "sparsely arachnoid-hairy"). Moreover, for *Carduus acanthoides* flower heads are said to be sessile while they nearly always are shortly but distinctly pedunculate.

Kazmi (1964) also exaggerates stem wing characters and the degree in which they extend below the flower heads. In lead 37 he writes (for both *Carduus acanthoides* and *C. crispus*): "Rami usque ad capitulum alati, (…)" while in the text he admits that flower heads may well be shortly pedunculate and wingless (with peduncle up to 2 cm long) in *Carduus acanthoides*. Many plants seen from Antwerp and Ghent exhibit this feature and hence fail to key out with Kazmi's key.

Some authors (for instance Arènes 1954, Tamamschyan 1998, Shi & Greuter 2011) claim that *Carduus acanthoides* more or less has glaucous foliage but this could not be confirmed on Belgian plants.

Both species are opposed in the following couplet. Major characters are in bold face. Other representatives of the genus *Carduus*, occurring in Belgium and neighbouring territories, can be identified with Lambinon & Verloove (2012).

Flower heads (fig. 2) nearly hemispherical or slightly wider than long, (at maturity) **solitary**, erect, **often clearly pedunculate** and devoid of a spiny stem wing just below inflorescence. **Lower leaf surface subglabrous to slightly hairy with multicellular hairs** confined to the veins; unicellular and cobwebby hairs absent. Leaves mostly pinnatipartite. Corolla usually bright pink. Plant often very tall (frequently up to 200 cm or taller) and longer spines (stem wings, leaflobe apices) frequently more than 5 mm long .... *Carduus acanthoides*

Flower heads (fig. 3) more or less ovoid (longer than wide), **clustered** and with often one or more heads oblique, sessile with spiny stem wings extending to base of inflorescence. **Lower leaf surface sparsely or densely hairy with a mixture of multicellular, unicellular and cobwebby hairs** (fig. 4). Leaves less deeply divided, usually sinuate-pinnatilobate to pinnatifid. Corolla darker, usually purple (rarely white). Plant usually smaller with longer spines less than 5 mm long (but tall plants with longer spines may also occur) ..... *C. crispus*

Review of *Carduus acanthoides* in Belgium

There seems to have always been much uncertainty about *Carduus acanthoides* and *C. crispus* in Belgium. The issue was already discussed at length by Crépin (1866). He even suggested that the usual Belgian representative of



Figure 3. *Inflorescence of* Carduus crispus*, Kortrijk, rough ground near river Leie, August 2012.*



Figure 4. *Lower leaf surface of* Carduus crispus*, Kortrijk, rough ground near river Leie, August 2012.*

this group was *Carduus acanthoides*, not *C. crispus*! By the end of the 19th century little had changed although only *Carduus crispus* (incl. *C. acanthoides* auct.) was accepted by Durand (1899). Arènes (1954) and Kazmi (1964) revised part of the Belgian collections and confirmed, probably for the first time, both *Carduus acanthoides* and *C. crispus* from Belgium (although their determinations proved to be sometimes contradictory). Since then both species are included in the standard Belgian floras (see De Langhe *et al.* 1967 up to Lambinon & Verloove 2012).

However, in the past decades uncertainty about the genuine presence of *Carduus acanthoides* in Belgium lingered on. Van Rompaey & Delvosalle (1978) wrote: "Déterminations suspectes: la présence de l'espèce dans nos régions est douteuse" and, under *Carduus crispus*, "Pris parfois erronément pour *C. acanthoides*". Lambinon & Verloove (2012) wrote: "RR ; distribution à étudier : surtout (ou exclusivement, sauf à l'état adventice ?) dans l'E du territoire de la Flore."

The residence status of *Carduus acanthoides* in Belgium is also much debated. According to Amaral Franco (1976) it is not native in Belgium although it is unclear on which data this statement is based. Wagenitz (1987) confirms that it is an eastern or southeastern European element and even occurrences in Central Europe are probably mostly archaeophytic. *Carduus acanthoides* was not included in a recent checklist of Belgian non-native vascular plants (Verloove 2006), nor was it in the recent distribution atlas of vascular plants in Flanders (Van Landuyt *et al.* 2006). In Euro+Med Plantbase (http://www.emplantbase.org/home.html) it is given for Belgium as "introduced".

The following (old) herbarium collections were approved by Arènes and Kazmi (listed chronologically):

- Bouillon, Cordemoy (ferme), il est assez abondant à Bouillon, s.d., F. Crépin s.n. (BR);
- Auby, bords des chemins, 06.07.1866, Delogne s.n. (BR);
- Bouillon, 19.06.1867, C.-H. Delogne s.n. (BR);
- Ixelles, lieux incultes, 08.1873, L. Piré s.n. (BR);
- Maeseyck, bords des chemins, 28.06.1874, H. Verheggen s.n. (BR);
- Héverlé, prairie, 16.07.1885, A. Busschodts s.n. (BR);
- Haeren, 12.07.1912, M. Guns s.n. (BR);
- Bois d'Héverlé, 07.08.1912, L. Crevecoeur s.n. (BR);
- Merxem (Anvers), décombres dans le poldre, 13.09.1916, H. Vandenbroeck s.n. (BR);
- Deurne (Anvers), lieux incultes, 20.09.1916, H. Vandenbroeck s.n. (BR);
- Falaën, Montaigle, vallée du Flavion, 17.07.1923, J.F. de Witte s.n. (BR);
- Berchem, 09.07.1934, L. Deleruelz s.n. (BR);
- Wervicq, bords de la Lys, 1939, Desplanques s.n. (BR);
- Belvaux, bords chemins, 06.1946, O. Gras s.n. (BR);
- Haccourt, à Hallembaye, bord de la route, 11.06.1951, A. Lawalrée 3533 (BR).

Below follows an enumeration of collections seen by me from the wide surroundings of Antwerp (starting in 1978). Records from the 1970s were initially identified as *Carduus acanthoides* by J.E. De Langhe but eventually, erroneously, ascribed to *C. crispus* by J. Duvigneaud. See also the distribution map (fig. 5).

- Anvers, à la limite de Ekeren [= Oude Landen], 26.11.1978, J. Duvigneaud 78 B 708, R. D'hose & J.E. De Langhe (BR);
- Anvers, sur le port, en bordure des voies ferrées, 26.11.1978, J. Duvigneaud 78 B 711, R. D'hose & J.E. De Langhe (BR);
- Antwerpen, brug langs de Noorderlaan over Albertkanaal (IFBL C4.16.44), zandige berm, 15.09.1979, R. D'hose 79.9.15/1 (BR);
- Antwerpen, Noorderlaan, 15.09.1979, J.E. De Langhe & R. D'hose s.n. (BR);
- Schoten, ten N van Botermelkbrug (IFBL B4.58.44), vaartdijk, 23.07.1986, E. Jacques 15863 (BR);
- Antwerpen, Houtdok (IFBL C4.16.44), op een zandige helling, sporadisch, 13.06.2005, E. Molenaar 050613a (BR);

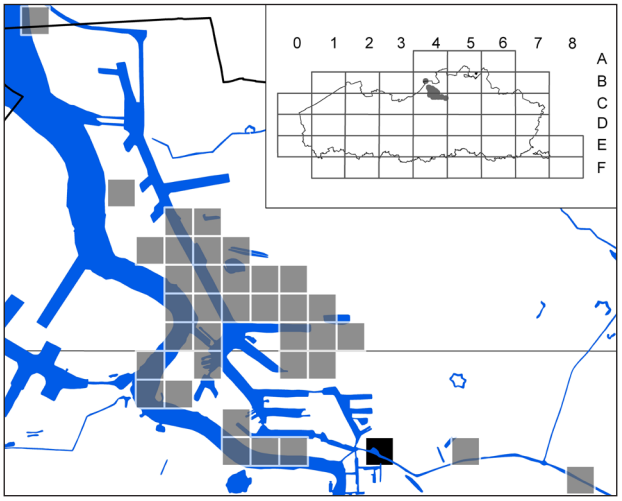


Figure 5. *Distribution map of* Carduus acanthoides *around Antwerp, based on herbarium collections and field notes by the author. Black 1 × 1 km square: original area of introduction.*

• Antwerpen, haven (IFBL C4.16.12), 22.06.2012, R. Barendse s.n. (BR);
• Harbour of Ghent, Singel (IFBL D3.13.11), roadside, 3x, 01.07.2012, F. Verloove 9607 (BR, LG);
• Harbour of Antwerp, Luithagen (Transcontinentaalweg) (IFBL C4.16.12), railway track, roadside, common, 15.07.2012, F. Verloove 9566 (BR);
• Harbour of Antwerp, Noorderlaan near former General Motors-plant (IFBL B4.56.31), roadside, rough ground, etc., very common, 15.07.2012, F. Verloove 9567 (BR);
• Harbour of Antwerp, Albertkanaal (N-side) at Merksem (IFBL C4.16.44), roadside, 15.07.2012, F. Verloove 9568 (BR);
• Harbour of Antwerp, N101 (Scheldelaan), km 27 (IFBL C4.16.33), roadside, ruderal, 05.08.2012, F. Verloove 9603 (BR);
• Harbour of Antwerp, Oud Fort St.-Filips (IFBL C4.14.24), sand raised site, grassland, etc., frequent, 05.08.2012, F. Verloove 9604 (BR);
• Wijnegem, nature reserve Het Wijtschot (by Albertkanaal) (IFBL C4.28.21), grassland, +/- ruderal, frequent, 19.08.2012, F. Verloove 9632 (BR);
• Merksem, Metropoolstraat (by Albertkanaal) (IFBL C4.17.43), roadside, by canal, several tens, 19.08.2012, F. Verloove 9633 (BR).

Ecology and habitat preference

In the Antwerp port area *Carduus acanthoides* has been recorded in a wide range of habitats. It is most frequent (and often co-dominant) in sandy roadsides on shell-lime (especially alongside the Noorderlaan). These locations are regularly disturbed (e.g. mowing, worked-up) but it also occurs in adjacent, more or less undisturbed dry grasslands, also on shell-lime (formerly sand raised). *Carduus acanthoides* also commonly grows on dikes of the river Scheldt (i.e. between Scheldelaan and the right bank of river Scheldt) but exclusively on the grassy outer side that is not affected by the tide. In these habitats *Carduus acanthoides* often forms nearly monospecific stands. It has also been recorded on rough ground, by railway tracks, on talus slopes, ground heaps and other highly disturbed habitats in the port. In Wijnegem it occurs in dry grassland in a nature reserve (Het Wijtschot), close to the Albertkanaal.

It is difficult to assess with certainty the rate of spread of *Carduus acanthoides* in the Antwerp port area. In the late 1970s it was discovered by De Langhe & D'hose in two or three localities, all in close proximity. These recorders were familiar with the area and do not refer to other localities, nor did they comment on its (wider) distribution. One may assume that these localities were, at that time, the only known which may suggest an initial introduction during the 1970s. Now, about 40 years later, *Carduus acanthoides* has become an exceedingly common xenophyte in large parts of the port area (see distribution map). Now it frequently occurs in huge numbers in an area that covers approximately 150 km². In the sense of Richardson *et al.* (2000) it is not only a naturalized but even an invasive species (although it is mostly confined to disturbed, often man-made habitats). *Carduus acanthoides* is a wind-dispersed species and seemingly has spread in a fast way to suitable habitats. It seems to have primarily spread in a linear way, i.e. by colonizing habitats alongside two main roads in the port area (Noorderlaan and Scheldelaan). A future, wider naturalization is very likely, the number of potential migration routes being numerous (Albertkanaal, motorway E19, etc.).

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