Juncus section *Iridifolii* (Juncaceae) in Belgium

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Abstract. – Two non-native representatives of *Juncus* section *Iridifolii* are recognized in Belgium, *J. ensifolius* (with all verified collections belonging to var. *ensifolius*) and *J. xiphioides*, the latter probably recorded for the first time outside of its native distribution range in America. Both species are described and illustrated and their distribution, status and ecology briefly discussed.

Samenvatting. – ***Juncus* sectie *Iridifolii* (Juncaceae) in België.** Twee niet-inheemse soorten van *Juncus* sectie *Iridifolii* werden waargenomen in België: *J. ensifolius* (waarvan alle geverifieerde collecties blijken te behoren tot var. *ensifolius*) en *J. xiphioides*, deze laatste wellicht voor het eerst buiten het natuurlijke areaal in Amerika. Beide soorten worden beschreven en afgebeeld en hun verspreiding, status en ecologie worden kort besproken.

Résumé. – ***Juncus* section *Iridifolii* (Juncaceae) en Belgique.** Deux membres de *Juncus* section *Iridifolii* ont été répertoriés en Belgique, *J. ensifolius* (dans les collections vérifiées il s'agit toujours de la var. *ensifolius*) et *J. xiphioides*, ce dernier probablement signalé pour la première fois en dehors de son aire d'indigénat en Amérique. Ces deux espèces sont décrites et illustrées et leurs distribution, statut et écologie sont brièvement discutés.

Introduction

Juncus L. is a large, cosmopolitan genus and counts more than 300 species (Brooks & Clemants 2000, Kirschner 2002a,b, Mabberley 2008). It is particularly well represented in North America (with 95 species) while it is rare in the tropics. At least twenty species are considered native in Belgium (Lambinon & Verloove 2012). Residence status of some of these, however, is debatable. The recently discovered *J. balticus* Willd. may either have been imported fortuitously or originated from the seedbank of a historical phase of dune development (Leten & Fasseaux 2008). Similarly, *J. foliosus* Desf., known since 1984 (Vannerom 1984), was first recognized by ponds where fish from southern and eastern Europe had been introduced, along with several other neophytes like *Lindernia dubia* (L.) Pennell. It may either be a long neglected native species or a recent introduction. Three predominantly or exclusively North American species, *J. canadensis* J. Gay ex Laharpe, *J. ensifolius* Wikstr. and *J. tenuis* Willd., the latter represented by four distinct subspecies (Lambinon & Verloove 2012, Hoste & Verloove 2016), are evidently non-native.

One of these introduced species, *Juncus ensifolius*, belongs to a peculiar group of species with swordlike, laterally compressed leaves, section *Iridifolii* Snogerup & Kirschner. This section was previously known as section *Ensifolii* Snogerup, an illegitimate name (Kirschner *et al.* 1999). In May 2016 a relatively large population of another species that obviously belonged to this section was discovered in Blankenberge (province of West-Flanders, Belgium). Compared with *Juncus ensifolius*, this species was more robust and had much wider leaves. Also, on closer examination, flowers turned out to have six stamens. In this, it differs from *J. ensifolius* var. *ensifolius*, which has three stamens; all specimens from Belgium we examined belong to var. *ensifolius*. The plants in Blankenberge were identified as *J. xiphioides* E. Mey., another North American species that, apparently, has not been recorded so far in Europe.

Since both *Juncus ensifolius* and *J. xiphioides* seem to thrive very well and are genuinely or potentially invasive species (e.g., ranked 'critical' and 'urgent' respectively by Thomas 2010), they are described and depicted in this paper and their ecology and current distribution and status in Belgium are discussed.

Identification, distribution and ecology

Juncus section *Iridifolii* accommodates perennial species with flowers clustered or in tight heads and with flo-

ral bracteoles absent. Most distinctive, however, are the leaves that are laterally compressed (i.e., flattened with one edge facing the culm), a unique feature in this genus. Depending on species delimitation it counts seven or up to ten species (Brooks & Clemants 2000, Kirschner 2002a, b) in western North America, Mexico and easternmost Asia. Its center of diversity obviously lies in western North America. At least one species, *J. ensifolius*, is known outside its native distribution range, primarily as an ornamental, also in Europe (e.g. Jäger *et al.* 2008). A second species, *J. xiphioides*, was recently discovered in Belgium, possibly for the first time outside of the New World. Both species are closely related and fairly similar; they are separated in the following couplet:

1 Widest leaves more than 10 mm wide. Plant robust, usually more than 60 cm tall. Stamens six ..... ***Juncus xiphioides***

Leaves at most 6 mm wide. Plant slender and much smaller, not exceeding 60 cm. Stamens three ..... ***J. ensifolius*** var. ***ensifolius***

Juncus ensifolius Wikstr., Kongl. Vetensk. Acad. Handl. 2: 274. 1823. var. ***ensifolius***

Herbs, perennial, rhizomatous, 2-4(-6) dm. Culms erect, 2-4(-6) mm diam. Leaves: basal 1-3, cauline 2-6, straw-colored; auricles absent; blade 2-16(-25) cm × 1.5-4(-6) mm. Inflorescences: heads solitary, more rarely in panicles or racemes of 2-50 heads, 2-14 cm, erect or ascending branches; primary bract erect; heads 3-70-flowered, obovoid to globose, 7-13 mm diam., congested. Flowers: tepals usually dark brown, lanceolate; outer tepals 2.7-3.6(-4) mm, apex acuminate; inner tepals 2.2-3(-3.5) mm, nearly equal, apex acuminate; stamens 3; anthers ½ to equal filament length. Capsules included to slightly exserted, chestnut to dark brown, 1-locular, oblong, 2.4-4.3 mm, apex obtuse proximal to beak. Seeds elliptic to obovate, 0.4-1 mm, occasionally tailed. 2n = 40. (Description modified from Brooks & Clemants 2000.) (Figure 1 and 2.)

Distribution and residence status: widely distributed in western North America, reaching Mexico in the south (Kirschner 2002a); also known from Japan (Kuril Islands) and other parts of Far Eastern Asia where it may be native as well. It is introduced in Europe and Oceania (Australia and New Zealand). In Europe *J. ensifolius* is mostly known from northern and Central-Europe. It was probably first recorded from the British Isles (Kent 1958; see also Poland 2005), subsequently also from Finland (Pohjakallio & Hamet Ahti 1974), Norway (Grøstad 2003), Sweden (Christofferson 1984), Germany (e.g. Kiffe 1988, Koch 1991, Walter 1998), Austria (Hohla 2001), the Netherlands (Adema & Mennema 1976), France (Tison & de Foucault 2014) and Luxembourg (Foyer 1987). More recently, it was also found in southern Europe, for instance in Italy (Bertolli & Prosser 2014).



Figure 1. Juncus ensifolius. *The flower heads are few in number, densely congested and very dark colored. (Bocholt, June 2015)*



Figure 2. Juncus ensifolius. *Herbarium specimen from Kehlen, Grand Duchy of Luxembourg, 1986 (BR).*

In Belgium *J. ensifolius* is a recent introduction. It was probably first found in the wild in 2006 by Pascal Hauteclair in Hergenrath in the valley of river Gueulle (a single individual in a clearing in woodland; Verloove & Lambinon 2014). Subsequently it was discovered after infrastructural works in nature reserve Gulke Putten in Ruiselede in 2009 by Ivan Hoste (also a single specimen; in 2010 it had disappeared). A large population with ca. 100 plants was observed in 2012 in a cattle pool in nature reserve Maskobos near Jabbeke (observation Jacques De Groote) and in the same year it was also found on the exposed margins of a retention basin in Lier (Bogerse Plassen; observation Kristine Wuyts *et al.*). Since then it was also seen in Turnhout (2013), Bocholt (2015) and Wondelgem (2015) (observations Kathleen Verstraete, Ward Vercruysse and Tim Adriaens respectively; see: http://waarnemingen.be/soort/view/6921). Being a recent introduction, invasion status of *J. ensifolius* in Belgium is hard to assess. It probably disappeared from the two oldest localities (each with a single individual) but has been confirmed for several years now in most of the others. In Jabbeke it recently much decreased after removal of *Crassula helmsii* (Kirk) Berger (comm. H. De Blauwe) while in Lier it has suffered from the rapid colonization of the area by native *Phragmites australis* (Cav.) Steud. (comm. W. Van Spaendonk).

Habitats: Wet meadows, marshy areas, wet granite areas, shores, banks and ditches, often montane (Brooks & Clemants 2000). In Belgium *Juncus ensifolius* has been recorded on exposed pond margins (often recently constructed retention basins), in ditches and similar, at least temporarily damp habitats.

Recognition: *Juncus ensifolius* var. *ensifolius* differs from *J. xiphioides* in being less robust (culms normally not exceeding 50 cm and leaves less than 6 mm wide) and in having flowers with three stamens, although in one collection from Belgium (Doomkerke) most flowers have 4 stamens. Also, *J. ensifolius* usually has relatively few, densely congested, multi-flowered and very dark brown flower heads, a trait not seen in *J. xiphioides*, at least not in the population recently detected in Belgium (see below).

Juncus ensifolius var. *montanus* (Engelmann) C. L. Hitchcock is a critical taxon. It is sometimes considered a variety of *J. xiphioides* or even a distinct species, *J. saximontanus* A. Nelson (compare Brooks & Clemants 2000 with Kirschner 2002a). However, it only seems to differ from var. *ensifolius* in stamen number (6 versus 3).

Specimens examined (Belgium and adjacent territories):
• Belgium: Doomkerke (Ruiselede, prov. W.-Vl.), reservaat De Gulke Putten, IFBL D2.14.13, zacht glooiende oeverzone na recente graafwerken (creatie venmilieu), 26.07.2009, *I. Hoste* 2009-112 (priv. herb. I. Hoste); Lier, Bogerse Plassen (retentiebekken Duwijkloop), noordwestzijde, aan ingang Ondernemersstraat (IFBL C5.41.32), vochtige oever, zandleem, 16.07.2014, *D. De Beer* 1596 (priv. herb. D. De Beer); Gent (Wondelgem), Lange Velden, droogvallende vijveroever, recent aangelegd, 12.07.2015, *T. Adriaens* s.n. (BR 14451959).
• Grand Duchy of Luxembourg: Kehlen, Brameschhof, au bord de la mare dans jardin Henri Foyer (Mr. Foyer en ignore l'identité et la provenance), 31.07.1986, *H. Foyer* s.n. (BR 1059619).

Juncus xiphioides E. Mey., Syn. Junc. 50. 1822.

Herbs, perennial, rhizomatous, 5-9(-12) dm. Culms erect, 2-6 mm diam. Leaves: basal 1-3, cauline 2-6, straw-colored; auricles absent; blade 10-40 cm × (3-)7-12(-16) mm. Inflorescences panicles or racemes of 20-50 heads, 2-14(-20) cm, erect or ascending branches; primary bract erect; heads 15-70-flowered, obovoid to globose, 7-11 mm diameter, at first relatively lax, more congested at maturity. Flowers: tepals green to brown or reddish brown, lanceolate, 2.4-3.7 mm, nearly equal, apex acuminate; stamens 6; anthers ½ to equal filament length. Capsules slightly exserted, chestnut to dark brown, 1-locular, ellipsoid, 2.4-3.8 mm, apex acuminate. Seeds elliptic to obovate, 0.4-0.6 mm, not tailed. 2n = 40. (Description modified from Brooks & Clemants 2000.) (Figure 3 and 4.)

This species and *Juncus ensifolius* are morphologically and genetically closely similar (e.g. Drábková *et al.* 2003) and have been treated as members of a single species. Engelmann (1866-1868) reduced the latter to varietal rank under *J. xiphioides*, var. *triandrus* Engelmann. Recent



Figure 3. Juncus xiphioides. *The inflorescence is paniculate with rather numerous, fairly lax, paler colored flower heads. (Blankenberge, July 2016)*



Figure 4. Juncus xiphioides*. Herbarium specimen (Blankenberge, 2016,* Filip Verloove *12519).*

authors, however, accept both entities as distinct species (Brooks & Clemants 2000, Kirschner 2002a). Moreover, these authors now consider var. *triandrus* as a synonym of *J. saximontanus*.

Distribution and residence status: confined to the southwestern United States and northwestern Mexico (Kirschner 2002a). To our knowledge it has never been reported outside of its native distribution range so far. In May 2016 a seemingly well-established population was discovered in Blankenberge (province of West-Flanders; IFBL B1.48.42) on the abandoned grounds of the former sand sculpture festival. The origin of these plants is unknown. The sand usually applied for these purposes originates from river Maas, not from North America. Species of *Juncus* are increasingly grown as ornamentals but *J. xiphioides* seems to be absent or at least quite exceptional in European gardens (e.g. Huxley 1999, Jäger *et al.* 2008). There are apparently no suppliers in Belgium and the Netherlands (www.plantago.nl/; accessed 22 July 2016). There were no other garden ornamentals seen in this locality, except for a single, young and obviously self-sown individual of *Cortaderia selloana* (Schult. & Schult. f.) Asch. & Graebn. The species was accompanied by other aliens like *Conyza bilbaoana* J. Rémy, *Dysphania ambrosioides* (L.) Mosyakin & Clemants and *Oenothera* L. div. spec. In its single locality *J. xiphioides* grows in relative abundance (several tens) in a small area of less than 500 m². The locality was in use until the end of 2013 and it is tempting to believe that the species was introduced after the site was abandoned. If so, it is obviously able to colonize in a fast way. It is clearly naturalized in this unique locality, with numerous old as well as young, self-sown individuals all over the place. Its persistence, however, depends on the final destination of the area.



Figure 5. *Habitat of* Juncus xiphioides *in Blankenberge, July 2016.*

Habitats: Salt marshes, moist areas, ditches, springs, lake and stream shores (Brooks & Clemants 2000). In Blankenberge *J. xiphioides* grows in shallow, temporarily damp depressions on sandy substrate (Fig. 5). It is found in several subpopulations and locally forms nearly monospecific stands.

Recognition: plants are in all parts more robust than *J. ensifolius*. Its leaves are wider (up to 16 mm wide in Blankenberge) and its culms taller (usually more than 60 cm tall, in Blankenberge up to 120 cm tall). Its flowers have six stamens, not three like in *J. ensifolius* var. *ensifolius*. Compared with the latter its flower heads are relatively few-flowered and fairly lax (12-20 flowers per head, much less frequently congested and with up to 70 flowers) and much paler in color, usually reddish brown. Moreover, inflorescences are paniculate with more numerous flower heads that are very widely spaced.

Specimens examined:
• Belgium: Blankenberge, Emiel Moysonpad (IFBL B1.48.42), shallow depression on sand, former sand sculpturing festival area, several tens, 05.06.2016, *F. Verloove* 12499 (BR); Idem, 27.07.2016, *F. Verloove* 12519 (private herbarium F. Verloove, dupl. BR).

Discussion and conclusion

With their very tiny seeds rushes are very easily dispersed by wind, water or other agencies. No wonder that they are well-represented in checklists of alien plants or weed lists. Clement & Foster (1994) listed 25 species that have been reliably recorded in the British Isles while 27 species are considered 'weeds' in at least some part of the world (Holm *et al.* 1979). Most of these introductions are found in natural habitats, contrary to many other aliens. For instance, the non-native species that were known so far from Belgium (*Juncus canadensis*, *J. ensifolius* and *J. tenuis* s.l.) all grow, at least in part, in heathlands, clearings in woodlands, exposed ponds or fens, etc. and occupy niches where vulnerable native species are found in close proximity. They can be classified as 'invasive' according to some classification systems, e.g. Richardson *et al.* (2000).

The species here reported as a probable new introduction for the European flora, *Juncus xiphioides*, has a similar ecology and thus the potential to also become an invasive species. Since it is closely related to and reminiscent of a species already present, *J. ensifolius*, it seems worthwhile drawing the attention to this new alien species. It is a well-known fact that taxonomic resources are essential for the effective management of invasive plants and that incorrect identifications can impede ecological studies (Pyšek *et al.* 2013).

Acknowledgements. – Dirk De Beer, Ivan Hoste, Walter Van Spaendonk and Hans De Blauwe are acknowledged for providing useful information about known Belgian localities of *Juncus ensifolius*.

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