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Juncus dichotomus (Juncaceae) in northwestern Italy, a xenophyte new to Europe

Abstract

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Juncus dichotomus, a native of the Americas, is reported for the first time from Europe. It is more or less widely naturalised in northwestern Italy (provinces of Biella, Novara, Torino and Vercelli) and probably largely overlooked elsewhere as a result of confusion with *J. tenuis*. Diagnostic features of both species (and other members of the *J. tenuis* group currently found in Europe, viz. *J. anthelatus* and *J. dudleyi*) are critically assessed and an identification key is presented. Taxonomy and nomenclature of *J. dichotomus* are discussed, especially with regard to the status of *J. platyphyllus*, and notes on its present distribution in Italy and its ecology are provided. Like *J. tenuis*, it often grows in valuable natural and seminatural habitats and locally seems to behave like an invasive environmental weed.

Additional key words: *Juncus tenuis* group, taxonomy, naturalisation, plant invasions

Introduction

Juncus L. is a nearly cosmopolitan genus and counts, as currently understood, about 300–315 species (Brooks & Clemants 2000; Kirschner 2002a, b; Mabberley 2008). *J.* sect. *Steirochloa* Griseb., to which *J. dichotomus* Elliott belongs, is readily distinguished by its perennial life form, singly borne flowers, presence of floral bracteoles, terminal inflorescences and non-septate leaves. It accommodates 35 species that are widely distributed throughout the temperate regions of the world (except South Africa). Its centres of diversity are in North America, temperate South America and Central Asia (Kirschner 2002b). *J. compressus* Jacq., *J. gerardii* Loisel. and *J. squarrosus* L. are more or less widespread native species in Europe. An additional species, *J. tenuis* Willd., originally native to North America, has become a widely naturalised xenophyte in large parts of Europe. According to DAISIE (2008), it is among the most widespread non-native plant species in Europe.

In the past years, *Juncus dichotomus*, which is closely related to *J. tenuis* and native to the eastern and south-eastern United States, has been increasingly recorded in northwestern Italy (regions of Lombardia and Piemonte). Since both species are easily confused with one another,

J. dichotomus could actually be more widespread. It usually occupies similar, often natural or seminatural habitats (including nature reserves or otherwise protected areas) and locally behaves like an environmental weed. Therefore, it seems essential to draw the attention to the presence of *J. dichotomus* in Europe.

In the present paper, the diagnostic features of *Juncus dichotomus* are presented and compared with those of related species from the *J. tenuis* group; furthermore, its taxonomy is discussed. Finally, some ecological and chorological notes are added and an identification key for the currently recorded members of the group in Europe is presented.

Taxonomy

The *Juncus tenuis* group is a taxonomically difficult species complex. It may be treated in two ways: either as one or two exceedingly variable species or as a complex of several closely related but specifically distinct taxa. Since Wiegand (1900), the latter taxonomic viewpoint has widely prevailed, with only a few exceptions such

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as Cronquist & al. (1977), who still accepted *J. tenuis* as a very broadly circumscribed species. The most recently published taxonomic revisions of the group (Brooks & Clemants 2000; Kirschner 2002b) unequivocally treat *J. tenuis* in a narrow sense and accept 12 additional species, including *J. dichotomus*. Brooks & Whittemore (1999) showed that *J. anthelatus*, another member of the group, is not only morphologically but also genetically distinct from *J. tenuis*. Only few taxonomists, especially from Central and South America (see for instance Balslev 1996), adopt a more or less intermediate taxonomy and treat (some of) these species at varietal rank (e.g. *J. tenuis* var. *dichotomus*).

Length, form, colour and texture of leaf sheath auricles provide by far the best identification feature in the *Juncus tenuis* group, as stated by Catling & Spicer (1987): “once the different kinds of auricles are seen, their evaluation in fresh or dried specimens is usually a simple matter”. Further characters are often more difficult to assess and appear to be rather variable: form, length and colour of capsules, position of tepals after anthesis (spreading or not), inflorescence form (congested or lax), robustness, etc. Other characters are only useful to separate certain species from each other (e.g. presence of seed tails).

Juncus dichotomus itself is a rather variable species (see below). The following description is solely based on the populations currently found in Europe (NW Italy).

- Juncus dichotomus*** Elliott, Sketch Bot. S. Carol. 1: 406. 1817 ≡ *Juncus tenuis* var. *dichotomus* (Elliott) A. W. Wood, Class-Book Bot.: 726. 1861
 = *Juncus platyphyllus* (Wiegand) Fernald in Rhodora 47: 124. 1945 ≡ *Juncus dichotomus* var. *platyphyllus* Wiegand in Bull. Torrey Bot. Club 30: 448. 1903 ≡ *Juncus tenuis* var. *platyphyllus* (Wiegand) Cory in Rhodora 38: 405. 1936 [this combination is often erroneously attributed to F. J. Hermann, see e.g. Jones & al. 1997 and Shetler & al. 2006]
 = *Juncus tenuis* var. *unicornis* E. Mey. in Linnaea 3: 371. 1828
 = *Juncus cognatus* Kunth, Enum. Pl. 3: 349. 1841
 = *Juncus albicans* Fernald in Proc. Amer. Acad. Arts 45: 415. 1910

Densely caespitose perennial. *Rhizomes* densely branched to short-creeping. *Cataphylls* 1–3. *Stems* erect, usually reddish at base, (10–)15–40 cm tall. *Leaves* basal to sub-basal, usually 2–3, flat (but readily becoming involute), up to c. 18 cm long and c. 0.7 mm wide; *leaf sheath auricles* very short (hardly projected beyond point of insertion), 0.1–0.5 mm long, scarious, whitish (sometimes tinged purplish), rounded at apex. *Lowest bract* leaflike, up to 15 cm long, exceeding the inflorescence. *Inflorescence* terminal, many-flowered, slightly congested (more rarely somewhat loose), 2.5–4 cm long. *Flowers* solitary, unilaterally arranged on up to 3 primary branches. *Bracteoles* 2, broadly ovate, rounded to acute at apex,

c. 1.5 mm long. *Tepals* subequal, lanceolate, acute at apex, c. 3.5 mm long. *Stamens* 6, anthers 0.4–0.8 mm long. *Capsule* unilocular, ellipsoid, rounded at apex, usually slightly shorter than to nearly equalling tepals, light brown, c. 3 mm long. *Seeds* 0.3–0.4 mm long, without or with indistinct appendages.

The initial circumscription of *Juncus dichotomus* was rather narrow. Wiegand (1900), for instance, describes it as having leaves nearly terete and auricles being almost cartilaginous, not scarious. This narrow species concept is still adopted (but at a lower, varietal rank), especially by Central and South American taxonomists, e.g. Balslev (1996), who describes the features of *J. dichotomus* as follows: “leaf blade terete or channelled, when channelled the central part of the x.s. is thicker than the edges, adaxial side with or without a narrow band of hyaline cells occupying less than 1/3 of the width” and furthermore: “auricles firm and cartilaginous”. The plants currently found naturalised in Italy hardly match this description, but rather that of *J. tenuis* s.str., according to Balslev’s (1986) circumscription of that species.

However, shortly after his study of the *Juncus tenuis* group in North America (see above), Wiegand (1903) acknowledged that *J. dichotomus* might also display flat leaves, naming this variety var. *platyphyllus*. Wiegand’s assertion was later corroborated by Fernald (1945), who found that *J. platyphyllus* warranted specific rank, not only on morphological but also on chorological grounds. Diagnostic features included flat blades (inrolled upon drying) and round-tipped leaf sheath auricles of firm, membranaceous texture. This description corresponds highly to the Italian collections. The taxonomic justification of *J. platyphyllus* is debated. The most relevant and recent taxonomic revisions of the *J. tenuis* group (Brooks & Clemants 2000; Kirschner 2002b) merely place it in the synonymy of *J. dichotomus*. However, several relatively recent regional floras and catalogues still accept *J. platyphyllus* as a good species (e.g. Radford & al. 1968; Seymour 1969; Strausbaugh & Core 1978; Matthews & Mellichamp 1989; Cooperrider & al. 2001). A combination at varietal rank, perhaps most appropriate, seems to have become outdated. Surprisingly, var. *platyphyllus* was also combined under *J. tenuis* by Cory (1936).

Likewise, the justification of some other taxa currently included in *Juncus dichotomus* is uncertain and additional research is required. Especially the South American *J. cognatus*, which has become naturalised in Australia and New Zealand (see below), is rather distinct in having terete (filiform) leaves and nearly coriaceous leaf sheath auricles.

In general habit, *Juncus dichotomus* is much reminiscent of *J. tenuis*. As a rule, the latter is slightly larger in all its floral parts (tepals, capsules, seeds; see Brooks & Clemants 2000) but there often is a considerable overlap. *J. dichotomus* usually has a distinct reddish stem base, a feature normally absent in *J. tenuis*. However, both species

are most reliably separated by leaf sheath auricle characters. In *J. tenuis*, these auricles are very thin and hyaline, often pointed towards the apex (more rarely rounded) and up to 6 mm long (much longer than wide) (Fig. 1A). In *J. dichotomus*, in contrast, the leaf sheath auricles are scarious and opaque, rounded at the apex and hardly projected beyond the point of insertion (0.1–0.5 mm long and much wider than long) (Fig. 1B). The leaf sheath auricles are preferably to be assessed on the lowermost fertile shoots and enable one to identify both species without difficulty. However, it has to be noted that the leaf sheath auricles of the upper (younger) leaves and of non-flowering stems of *J. tenuis*

are often very short and therefore much reminiscent of those of *J. dichotomus*. Moreover, with age (and often in herbaria as well), the long and pliable auricles of *J. tenuis* are readily damaged. In some populations of the latter, even well developed leaf sheath auricles are relatively short (c. 1 mm long) but still distinctly projected beyond the point of insertion and longer than wide. Such plants might be the result of introgression and genetically lean further towards *J. dichotomus*. If this is the case, the specific status of *J. dichotomus* and the other members of the *J. tenuis* complex might come into question. A revised taxonomy, preferably at subspecific level, might turn out to be more appropriate, but this will require additional research.

Another close relative of *Juncus dichotomus* seems to be *Juncus interior* Wiegand. Both do not differ in leaf sheath auricle characters. Wiegand (1900) separated the latter from *J. dichotomus* on the basis of its flat leaves but, as described above, this distinction is no longer valid since *J. dichotomus* might also display flat leaves (var. *platyphyllus*; see above). In modern floras both are mainly divided on geographical grounds (*J. interior* is a more inland species, both are largely allopatric in their native distribution range; see Brooks & Clemants 2000). *J. interior* also has slightly darker and larger capsules and the lowest bract is often shorter (hardly exceeding the inflorescence). Moreover, it is possibly less weedy (a few adventive records outside North America have not been confirmed so far; Kirschner 2002b).

Additional, instructive illustrations of *Juncus dichotomus* and/or *J. platyphyllus* are provided by Fernald (1945) and Barros (1953). Particularly useful are the draw-

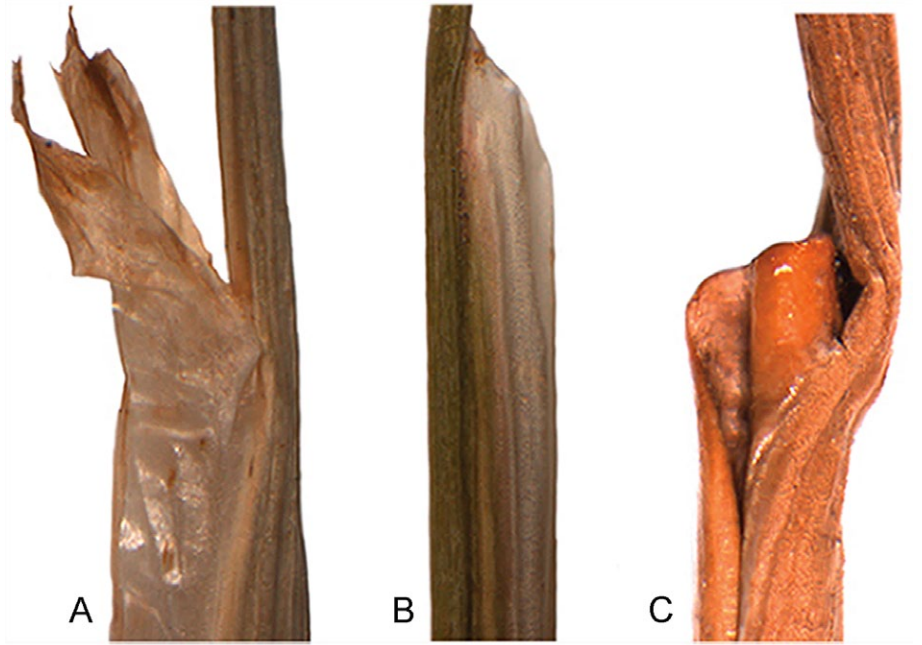


Fig. 1. Leaf sheath auricles in the *Juncus tenuis* group – A: *J. tenuis* (Ameno, Lago d’Orta, Italy, 21.7.1992, G. Galasso, MSNM 30955); B: *J. dichotomus* (Lombardore, Italy, 7.9.2009, F. Verloove 7907, PRA); C: *J. dudleyi* (Koksijde, Belgium, 30.07.2009, F. Verloove 7710, herb. Verloove).

ings in Godfrey & Wooten (1979), where *J. dichotomus* and *J. tenuis* are compared opposite each other. Detailed illustrations of the characteristic leaf sheath auricles of *J. tenuis* and its relatives can be found also in Catling & Spicer (1987).

Juncus dichotomus is not the only member of the *J. tenuis* group that recently managed to become naturalised in Europe. In order to facilitate the identification of critical plants and to improve the general knowledge on the group in Europe, an identification key is provided for their distinction. In addition to *J. dichotomus* and *J. tenuis*, the following two species are also increasingly recorded: *J. anhelatus* (Wiegand) R. E. Brooks & Whitem. (e.g. in Belgium and Great Britain; see Verloove 2006; Wilcox & Tregale 2008) and *J. dudleyi* Wiegand (e.g. in Austria, Belgium, Germany, Great Britain and Slovakia; see Kirschner 2002b).

Key to the species of the *Juncus tenuis* group in Europe

1. Leaf sheath auricles scarious to coriaceous (leathery), hardly projected beyond the point of insertion, much wider than long, 0.1–0.5 mm long, rounded at apex 2
- Leaf sheath auricles hyaline (translucent), longer than wide, c. (1–)2–6 mm long, usually acute towards apex (more rarely rounded) (Fig. 1A) 3
2. Auricles scarious, whitish, opaque (neither rigid nor shiny) (Fig. 1B); tepals not or hardly spreading in fruit *J. dichotomus*
- Auricles leathery and very rigid, yellowish to orange-brownish, shiny (Fig. 1C); tepals spreading in fruit *J. dudleyi*



Fig. 2. Currently known localities of *Juncus dichotomus* in northwestern Italy.

- 3. Inflorescence tall, very diffusely branched and with widely spaced flowers (internodes at least partially much longer than tepals); plant usually more than 70 cm; capsules c. 2–2.5(–3) mm long, nearly spherical, mostly less than $\frac{3}{4}$ of tepal length; longest ultimate branches of the cymes 30–50 mm long *J. anthelatus*
- Inflorescence smaller, not diffusely branched and with congested flowers (internodes rarely longer than tepals); plant usually much smaller than 70 cm; capsules mostly more than 3 mm long, ellipsoid, only slightly shorter than tepals; longest ultimate branches of the cymes 10–20 mm long *J. tenuis*

Chorology

Juncus dichotomus is mainly native in the eastern and southeastern United States, in latitudes south of Massachusetts. It occurs rather disjunctly in Colorado (Brooks & Clemants 2000). Further south, it is found in Mexico (see, e.g. McVaugh 1993), Central America and parts of South America (Barros 1953; Balslev 1996). However, occurrences in South America are probably secondary, although of old origin (Kirschner 2002b).

Outside the New World, *Juncus dichotomus* has been recorded from New Zealand (Healy & Edgar 1980) and Australia (New South Wales and Queensland, see, e.g. Beadle & al. 1982, Hnatiuk 1990, Wilson & al. 1993, usually as *J. cognatus*). It has potentially been widely overlooked elsewhere.

Here, *Juncus dichotomus* is reported for the first time from Europe. In northwestern Italy it was initially discovered by Jean-Marc Tison in 2006 and subsequently confirmed in several, widely scattered localities in the regions of Lombardia (province of Novara) and Piemonte (provinces of Biella, Torino and Vercelli). A thorough

herbarium revision of collections of *J. tenuis* would possibly yield additional records. A random revision of about 45 Italian collections of *J. tenuis* from MSNM (Herbarium of the Museo Civico de Storia Naturale di Milano) and the private herbarium of Adriano Soldano, both relevant because they essentially house collections from the area in which *J. dichotomus* is known to occur at present, i.e. the regions of Lombardia (provinces of Como, Milano and Varese), Piemonte (provinces of Biella, Novara, Verbanco-Cusio-Ossola and Vercelli) and Toscana (province of Massa Carrara), yielded two additional records of

J. dichotomus (Fig. 2 and Specimens seen). Additional research in the Belgian herbaria BR, GENT and LG (containing several collections from the provinces of Como and Torino) did not yield records. Thus it seems that *J. dichotomus* is a relatively recent but fast spreading xenophyte.

The invasion history of *Juncus dichotomus* in Italy is unknown. An unintentional anthropogenic introduction is most likely. The earliest records are both from the banks of the river Sesia north of Vercelli (1976 and 1983). This area might be the initial point of introduction but this requires confirmation (e.g. from additional herbarium revisions). Molecular research might show whether multiple introductions took place or whether it has spread out from a single colony.

Specimens seen. — ITALY: LOMBARDIA: Prov. Novara, Novara, aire d’autoroute de Novara Norte, sentier inondable dans les rizières, 8.8.2006, *J.-M. Tison s.n.* (LG, herb. J.-M. Tison, herb. Verloove). — PIEMONTE: Prov. Biella, Cerrione, Parco Riserva Naturale La Bessa, roadverges, common, along with *Digitaria violascens* and *Panicum dichotomiflorum*, 8.9.2009, *F. Verloove 7942* (BR); Candello, baraggia, heath (shallow depressions, gravelly paths, etc.), locally common, 11.9.2009, *F. Verloove 7950* (BR); Prov. Torino, Lombardore, torrente Malone (close to SP 267), sandy river bank, 7.9.2009, *F. Verloove 7907* (PRA, herb Verloove); Chivasso, river Orco (close to its junction with river Po), gravelly and sandy soil, temporarily damp, locally abundant, 14.9.2009, *F. Verloove 7935* (TO); Prov. Vercelli, Arborio, Sesia, 11.8.1976, *A. Soldano 757* (herb. A. Soldano); Albano, greto della Sesia, 31.8.1983, *Badino 11290* (herb. A. Soldano); Carisio, river Elvo between SP 1 and railway track Milano–Torino, gravelly river bank (also by adjacent paths and rice

fields), very common all around, 9.9.2009, *F. Verloove* 7939 (BR, MSNM).

Habitat preference and ecology

In its area of origin, *Juncus dichotomus* usually grows in sandy, well drained but frequently wet soils (Brooks & Clemants 2000). Moist to even wet conditions as a prerequisite for its settlement are invariably stressed by most authors. McVaugh's (1993) observations, for instance, show that *J. dichotomus* can predominantly be found in "moist places, ditches ..., seasonally wet depressions in grasslands ... along rivulets ...". According to Correll & Correll (1975), *J. dichotomus* has also been recorded "in seepage areas, edge of water about lakes, ponds and streams ...". This seems to correspond highly with its habitat preferences in its secondary distribution area in Italy. There, *J. dichotomus* always grows in at least temporarily damp conditions: sandy or gravelly riverbanks, shallow depressions in heaths, wet paths by rice fields or ditches.

In its area of origin as well as in Europe, *Juncus tenuis* is much less demanding and grows in exposed or shaded sites, in soils ranging from sand to clay, under moist or drier conditions (Brooks & Clemants 2000). In Europe, it is often confined to dry, sandy and rather acidic soils (tracks or clearings in woodland, disturbed heaths etc.) but also occurs on river banks (e.g. along the river Ticino in Italy) and other wet habitats. In recent times, it has been increasingly seen in urban habitats as well (e.g. in cracks of the pavement).

In Italy, *Juncus dichotomus* mostly grows in natural to seminatural, vulnerable habitats (often nature reserves or other protected areas). However, these are often highly invaded by xenophytes. Accompanying species are, among others, *Cyperus esculentus*, *C. glomeratus*, *C. microiria*, *C. strigosus*, *Digitaria violascens*, *Eleocharis obtusa*, *Lindernia dubia*, *Panicum dichotomiflorum* and *Schoenoplectus mucronatus*.

Although hardly known outside the Americas, *Juncus dichotomus* seems to be fairly invasive and weedy in its secondary distribution range in the Old World, especially in New Zealand (Randall 2007+). In general, it is probably widely overlooked and confused with *J. tenuis*. A better recognition of the species will probably yield new records, not only in Italy but possibly also elsewhere in Europe. *J. dichotomus*, much like *Digitaria violascens* in the same area, proves to be a typical "invader in disguise": long before its discovery, it has already been able to spread widely and to become naturalised (Verloove 2010).

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