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Some potentially weedy *Cyperaceae* new to Spain

Abstract

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Six subtropical weeds of the *Cyperaceae* family (*Bulbostylis thouarsii, Cyperus compressus, C. distans, C. iria, C. pumilus* and *Fimbristylis dichotoma*) are reliably reported for the first time from Spain (and probably from Europe as well). All were found in a municipal nursery near Valencia, destined for the restoration of natural habitats, and have probably been introduced, inadvertently, with coconut fiber from tropical Asia (possibly Sri Lanka). These species are briefly characterized and their weed status in the world is assessed. To prevent a future naturalization eradication of these weeds is recommended.

Key words: *Bulbostylis, Cyperus, Fimbristylis,* alien flora, sedges.

Introduction

The *Cyperaceae* family includes about 92 genera and 4450 species and has a nearly cosmopolitan distribution (Mabberley 2008). A number of species in this family are of importance economically, ethnobotanically, horticulturally or are significant weeds (Bryson & Carter 2008, Simpson & Inglis 2001). Many of the latter are rapidly spreading beyond their native ranges and have invaded the warm-temperate and (sub-) tropical regions of the world, including parts of southern Europe. Four of the world's worst weeds are in the genus *Cyperus* (Carter & Bryson 1996) and it is expected that many weedy species of the Cyperaceae family will benefit from climate change. Especially taxa with C_4 photosynthetic pathways, such as *Cyperus rotundus* ('the world's worst weed') are potential winners that could considerably extend their distributions, also in Europe (Simpson & al. 2011).

Many genera of the *Cyperaceae* are notoriously complex in terms of identification, taxonomy and/or nomenclature. Recent investigations by the first author (in the field and in the herbarium) revealed several interesting new data about non-native *Cyperaceae* in southern Europe (see for instance Verloove 2010, 2012, 2014; Verloove & Mesterházy 2013; Verloove & Sánchez Gullón 2010; Verloove & Soldano 2011) but a lot of work still needs to be done: assessing the frequency and distribution of the introduced species, their genuine degree of naturalization, appreciation of habitats occupied, etc. will require further study.

The nursery trade is known to be an important vector for the inadvertent introduction and dispersal of weed species. Yet, very few publications emphasize on this issue (for instance: Hoste & Verloove 2010). The species of *Cyperaceae* commented upon in this paper all have been found inside the municipal nurseries of El Saler in the Natural Park of La Albufera de Valencia (Spain). In this and other Valencian plant nurseries threatened autochthonous species are cultivated in view of their re-introduction into the wild (Ferrer-Gallego & al. 2013). In the past years dozens of subtropical weeds have been detected in these nurseries and some of these were already the subject of previous publications: *Cleome viscosa* L., *Cyperus odoratus* L., *Dactyloctenium aegyptium* (L.) Willd., *Epilobium ciliatum* Raf., *Ludwigia hyssopifolia* (G. Don) Exell, *Muntingia calabura* L., *Murdannia spirata* (L.) Brückn. and *Spermacoce latifolia* Aubl. (Ferrer & Laguna 2009, 2010, 2013; Ferrer & al. 2009, 2012; Laguna & al. 2009, 2013; Mansanet Salvador & al. 2014). All these weeds occurred since the application of coconut fiber as a complementary substratum for plant culture. These coconut fibers are therefore believed to be the main vector of introduction for these weed species. In fact most of the subtropical weeds detected so far are originating in India and neighboring territories in southeastern Asia, or are indicated there as widely established invaders. The main Spanish supplier of coconut fiber has a processing plant for this product in Sri Lanka and this country may well be the exact origin of the weeds currently found in the nurseries.

Especially in the nurseries destined to grow native forest plants circumstances are ideal for the development of introduced weeds. In contrast with the nurseries where herbaceous species are cultivated and where weeds are regularly removed, shrubs and trees remain for quite a long time (2-3 or more years) in the same containers. In these sites the herbaceous weeds are not very competitive and constitute no direct threat for shrubs and trees; moreover, their control is very expensive. They are therefore tolerated and in no time germinate and proliferate. In addition, reforestation managers use to think that these weeds are not competitive in the plantation sites (mainly forests or shrub land ecosystems) where they must grow under harsh conditions where only the native tree species are supposed to survive. However, the weeds are quite often able to migrate to other, nearby suitable natural habitats that are more receptive to exotic herbs, such as wetlands or coastal dunes. In fact, some traditional nursery weeds in Valencia, such as *Cardamine flexuosa* With., restricted to nurseries only a few years ago, can now be found as outdoor weeds in nitrophilous vegetation surrounding wetlands and irrigated crops (E. Laguna & P.P. Ferrer, pers. obs.)

We noticed that the particular procedure applied to grow plants in these forest nurseries (i.e. on grille tables, instead of plane-bottom tables) is ideal to ensure that the tree roots cannot overpass the pot length (enhancing very good and concentrated root systems). However, this procedure apparently also facilitates the germination of weed seeds; the substratum is continuously washed, progressively reducing the concentration of allelopathic substances which could delay or prevent the germination of herbaceous weeds (Dr. E. Dana, pers. com.).

Results

The six alien species of *Cyperaceae*, recently observed in a nursery in El Saler near Valencia, are presented in alphabetical order beneath. For each entry the following infor-

mation is provided: accepted name, synonyms (if relevant), data from herbarium label, references to useful iconography, currently known distribution, diagnostic features (compared with related taxa, known to occur in the Iberian Peninsula or elsewhere in Europe) and useful information with regard to weed status in general and in Sri Lanka and neighboring areas (for instance India) in particular. Voucher specimens of all species are preserved in the herbarium of the Botanic Garden of Meise, Belgium (BR).

Bulbostylis thouarsii (Roem. & Schult.) Lye ex Veldk. & Verloove, Blumea 59: 10 (2014)
≡ *Scirpus thouarsii* Roem. & Schult., Syst. Veg. 2: 134 (1817)
≡ *Isolepis thouarsii* (Roem. & Schult.) Nees, Linnaea 9: 291 (1834) non *I. thuarsii* A. Dietr. (1833), nom. illegit.
– *Scirpus puberulus* Poir., Encycl. 6(2): 767 (1805), non Michx. (1803)
= *Isolepis puberula* Kunth, Enum. 2: 205, 213 (1837)
= *Bulbostylis puberula* (Kunth) C.B.Clarke in Hook. f., Fl. Brit. India 6: 652 (1893), nom. illegit.
= *Stenophyllus puberulus* Killip, J. Siam Soc. Nat. Hist., Suppl. 7: 57 (1927), nom. illegit.

Spain, prov. Valencia: El Saler (UTM 30SYJ3060), viveros municipales de El Saler, 2 m, 25.11.2009, *E. Laguna & P.P. Ferrer* 9 (BR).

Iconography: Kern (1974).

B. thouarsii is originally native to tropical Africa and Asia and inhabits sandy localities at low elevations, often near the sea. It is much reminiscent of *B. cioniana* (Savi) Lye, the only species of this genus known to occur in the Iberian Peninsula (Luceño & Escudero 2007b). Both are delicate, hairy annuals with densely pubescent glumes with an excurved mucro and transversely wrinkled nutlets. Compared with Spanish specimens of *B. cioniana* (originating in Moguer, prov. Huelva; BR!), *B. thouarsii* is distinguished by its closely packed spikelets (vs. a more or less lax, compound inflorescence), glabrous stems (vs. hirsute), smaller glumes (ca. 1.75-2.25 mm long, vs. 2.5-4.5 mm long) and smaller nutlets (ca. 0.75-1 mm long vs. 1-1.3 mm long). Most of these characters are variable and it is obvious that these species (as well as others related to *B. hispidula* (Vahl) R.W. Haines) are all closely related and possibly in need of taxonomic revision.

B. thouarsii is a major weed in Sri Lanka (Holm & al. 1979). It is particularly common in paddy fields (Prasad & Singh 2002; see also Soerjani & al. 1987 and Moody 1989). It is, however, better known as *B. puberula*, a superfluous name (see Veldkamp & Verloove 2014).

Cyperus compressus L., Sp. Pl.: 46 (1753).

Spain, prov. Valencia: El Saler (UTM 30SYJ3060), viveros municipales de El Saler, 2 m, 25.11.2009, *E. Laguna & P.P. Ferrer* 4 (BR).

Iconography: Häfliger (1982).

C. compressus is widely distributed in tropical, subtropical and warm temperate regions around the world and is usually found in a variety of habitats disturbed and altered by humans, e.g., waste places, grasslands, lawns, crops, roadsides, fallow rice fields, etc. It is a low annual with spikelets usually in digitate clusters (or on a very short axis), distinctly cuspidate glumes and obovate nutlets. It is unlikely to be confused with any of the other European species, native as well as introduced.

C. compressus is a very widespread and locally dangerous or major weed (e.g. Bryson & Carter 2008; Häfliger 1982; Holm & al. 1979; Simpson & Inglis 2001). In Sri Lanka it is a weed of cultivated land and waste places (Koyama 1985) and in Karnataka (India) it is common as a weed in rice fields and numerous other disturbed habitats, dry as well as marshy, and from sea level up to hilly areas (Prasad & Singh 2002).

Cyperus distans L. f., Suppl. Pl.: 103 (1782).

Spain, prov. Valencia: El Saler (UTM 30SYJ3060), viveros municipales de El Saler, 2 m, 25.11.2009, *E. Laguna & P.P. Ferrer* 6 (BR).

Iconography: Häfliger (1982).

C. distans is a pantropical weed inhabiting marshes, canal banks, ditches, agricultural crops (including rice) and other damp habitats. It is easily distinguished from all other species in Europe, native as well as introduced, by its very narrow spikelets (ca. 0.5 mm wide at the beginning of flowering) with remote glumes (apex of glume barely reaching next glume).

C. distans was recently reported for the first time from Spain (Castroviejo 2005, 2007a). The species was identified by K.A. Lye on the basis of a herbarium scan. On the occasion of a thorough revision of *Cyperus* in the Flora Europaea area (Verloove, in prep.) recently collected herbarium specimens of this population were kindly offered by J. Amigo [A Coruña: Negreira, a orillas del Tambre, junto a la desembocadura del rio Barcala. En herbazal de *Cypero-Bidentetum frondosae* sobre los depósitos limosos que se forman en el anillo de inundación por efecto del embalse Barrié de la Maza (UTM 0521428/4749806), 145 m, 02.09.2013, J. Amigo (SANT 68614, dupl. BR)]. These plants somehow look like *C. distans*, especially with regard to inflorescence shape and spikelet color, but have much broader spikelets. Moreover, the plants from Negreira have elongate stolons bearing tubers and are ascribable to *C. esculentus*. Hence, the record from El Saler represents the first genuine occurrence of this species in Spain (and probably in Europe).

C. distans is a widespread and locally dangerous or major weed (e.g. Bryson & Carter 2008; , Häfliger 1982; Holm & al. 1979; Simpson & Inglis 2001). In the southeastern U.S.A. (despite being a recent introduction; see Carter & al. 1996) "(…) field botanists and weed scientists should seek and report additional populations, and appropriate state and federal agencies should undertake eradication measures to ensure early control of this potentially invasive pest (…)" (Bryson & Carter 2008).

Cyperus iria L., Sp. Pl. 1: 45 (1753).

Spain, prov. Valencia: El Saler (UTM 30SYJ3060), viveros municipales de El Saler, 2 m, 25.11.2009, *E. Laguna & P.P. Ferrer* 10 (BR).

Iconography: Häfliger (1982).

C. iria is probably originally native in (sub-) tropical Asia but it has become established in tropical and temperate areas of the world. In the southeastern U.S.A. *C. iria* primarily is a weed of drainage ditches, rice fields and poorly drained sites in other agricultural fields or disturbed areas (Bryson & Carter 2008). With its small, nearly orbicular glumes (ca. 1.3-1.8 mm long and wide) that are subequal to the nutlets it cannot be confused with any of the known species of the genus in the Iberian Peninsula (Castroviejo 2007a). Claims of this species in Italy in the Euro+Med Plantbase (Jiménez-Mejías & Luceño 2011) are erroneous and referable to *C. microiria* Steudel, another major Asian rice field weed (Raynal 1977). The latter has glumes that are more widely spaced (successive glumes 1.1-1.5 mm apart vs. 0.7-0.9 mm) and that bear a more prominent mucro (0.2-0.25 mm vs. 0.05-0.12 mm). Moreover, its spikelets are spreading, not ascending (Tucker & al. 2002).

C. iria is among the most important cyperaceous weeds in terms of its adverse effect on agriculture. It is ranked the 33th world's worst weed and it is a major agricultural pest, particularly of rice (Holm & al. 1977). A single plant of *C. iria* may produce more than 5000 viable seeds (Jacometti 1912). *C. iria* is a widespread, dangerous and/or major weed in many areas (e.g. Bryson & Carter 2008; Häfliger 1982; Holm & al. 1979; Simpson & Inglis 2001). In Sri Lanka it is a declared dangerous weed in cultivated grounds and rice fields (Holm & al. 1979, Koyama 1985).

Cyperus pumilus L., Cent. Pl. II: 6 (1756).
≡ *Pycreus pumilus* (L.) Nees, Linnaea 9: 283 (1834).

Spain, prov. Valencia: El Saler (UTM 30SYJ3060), viveros municipales de El Saler, 2 m, 25.11.2009, *E. Laguna & P.P. Ferrer* 1 (BR).

Iconography: Kern (1974).

C. pumilus is widespread in the Old World (sub-) tropics. In the New World, it is an introduction in the West Indies and the U.S.A. where it is spreading lately (Bryson & Carter 2008). It is a minor weed of disturbed sandy soils of rice and fallow fields. With its bifid styles and biconvex nutlets *C. pumilus* belongs to (sub-) genus *Pycreus*. From the three species currently known in the Iberian Peninsula (*C. flavescens* L., *C. flavidus* Retz. and *C. mundtii* (Nees) Kunth; Castroviejo 2007b) *C. pumilus* is easily told apart in being a tiny annual with glumes with conspicuously excurved awns.

C. pumilus seems to be less weedy and is less widely dispersed than the other species in this account. However, it is a dangerous weed in India (Holm & al. 1979). See also Bryson & Carter (2008).

Fimbristylis dichotoma (L.) Vahl, Enum. Pl. Obs. 2: 287 (1805).
= *Scirpus puberulus* Michx., Fl. Bor. Amer. 1: 31 (1803).

Spain, prov. Valencia: El Saler (UTM 30SYJ3060), viveros municipales de El Saler, 2 m, 25.11.2009, *E. Laguna & P.P. Ferrer* 5 and 7 (BR).

Iconography: Häfliger (1982).

F. dichotoma is found throughout the tropical and semitropical regions of the world including Africa, Asia, the Pacific Islands and North and South America. It has been reported as a weed of paddy crops, old rice fields, ditches, lawns, open wetland pastures and meadows, roadsides, cultivated lands and along forest margins (Holm & al. 1977). *F. dichotoma* is cited as a weed in pineapple, rice, roselle, teak, taro and other upland row crops (Holm & al., 1977). It is much reminiscent and often poorly distinguished from *F. bisumbellata* (Forssk.) Bubani, a species that is widely distributed in the southern half of the Iberian Peninsula (Luceño & Escudero 2007a). The latter is smaller in all its parts: it is a delicate annual barely reaching 15 cm, with spikelets ca. 1.5 mm wide, glumes ca. 1.5 mm long and nutlets ca. 0.7-0.8 mm long. *F. dichotoma*, in contrast, is an annual or (more often) perennial with stems up to 75 cm or more long, with spikelets 2.5-3 mm wide, glumes ca. 2-3 mm long and nutlets ca. 1-1.25 mm long.

In the two collections referred to above, nutlets are brownish. In *Fimbristylis dichotoma* they usually are whitish to stramineous but they may be, although less frequently so, brown as well (Kern 1974).

F. dichotoma is included among the most important cyperaceous weeds in terms of their adverse effect on agriculture (Bryson & Carter 2008) and is ranked 40th among the world's worst weeds (Holm & al. 1977). It is a very widespread and locally dangerous or major weed (e.g. Häfliger 1982; Holm & al. 1979; Simpson & Inglis 2001). It is very common in South and East Asia (Prasad & Singh 2002).

Discussion

Although at least some of the species of *Cyperaceae* here presented have shown to be difficult to eradicate, their occurrence in a Valencian plant nursery is in the first place merely anecdotal. Nonetheless, the authors considered it appropriate, for various reasons, to bring it to the attention of botanists and ecologists.

Coconut fibers – most likely the main vector of introduction for these subtropical weeds – are not widely known as a mechanism for the inadvertent dispersal of diaspores. Their increased and uncontrolled application in the nursery trade may be called into question. As demonstrated above all the species here concerned are reputed weeds, especially in the warm-temperate and subtropical regions of the world (some even ranked among the world's worst weeds!). In the surroundings of Valencia most of them will find favorable climatological circumstances. Most annoying, however, is that the threatened autochthonous species that are cultivated in the municipal or other public nurseries are re-introduced in vulnerable natural ecosystems (e.g. Marjal del Moro de Puzol and Sagunto). The likeli-

hood of weed diaspores being introduced along with the cultivated plants is very high. Moreover, in these coastal wetlands and dunes circumstances for many of these weeds are ideal, not only for their survival but probably also for a future naturalization.

The managers of the Valencian municipal nurseries therefore are envisaging to refrain from using coconut fiber as a complementary substratum and its usage is advised against in similar plant nurseries, especially if autochthonous species are involved. In case of maintaining the use of coconut fiber, because of economic and/or for technical reasons, the plant containers should be severely controlled and weeds removed. Especially the sites where autochthonous species are grown should be monitored for at least 2-3 years, removing emerging weeds whenever needed.

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