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# New contributions to allochthonous *Ludwigia* species (Onagraceae) on Catalonia

# Noves contribucions a les espècies al·lòctones de *Ludwigia* (Onagraceae) a Catalunya

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***Ludwigia grandiflora*** (Michaux) Greuter & Burdet subsp. ***hexapetala*** (Hook. & Arn.) Nesom & Kartesz

Montsià: Amposta, al riu Ebre, CF0109, 0 m, 22-VII-2018, J. Bou (HGI 23947).

Allochthonous species from the genus *Ludwigia* on the Iberian Peninsula have often generated taxonomic confusion, since although the various plant catalogues mention only *Ludwigia grandiflora* in this region (Nieto Feliner, 2000; Bolòs *et al.*, 1993), Verloove & Sánchez (2008) reported *L. peploides* from the Llobregat River. In addition, in 2016, one of us (J.B.) published a study on the allochthonous taxa of *Ludwigia* in Catalonia, in which it was concluded that all the samples analysed corresponded to *L. peploides* subsp. *montevidensis* (Bou Manobens & Font Garcia, 2016), a hydrophyte from the Americas that has invaded both rivers and still waters throughout a large part of Europe (CABI, 2019).

In order to increase our knowledge of the dynamics and situation of *L. peploides* in Catalonia, in 2018 a campaign was launched to collect samples from the populations of several Catalan basins. In the Ebre River, there was a population (Fig. 1a), not recognised in our previous study, found in the main course of the river, in an area bordering the Ebre Delta Natural Park. An analysis of the morphology of various specimens determined that it was *Ludwigia grandiflora* subsp. *hexapetala* (HGI 23947). This taxon naturalised in the Lez River in Montpellier (France) in 1826 (Dandelot, 2004), from where it has expanded its range substantially, becoming one of the invasive aquatic plants with the greatest impact (Ruaux *et al.*, 2009), with similar biology and dynamics to *L. peploides* subsp. *montevidensis*. The presence of *L. grandiflora* subsp. *hexapetala* in Catalonia, and specifically in the area of the Ebre Delta, which is geographically more remote from the populations found in France than other basins, raises several doubts about its introduction in Catalonia, the transport vector, and the population it originated from, as it could have come from either European populations or have originated from a native American population.


Figure 1. Herbaceous *Ludwigia* spp. plants in summer 2018: a) *L. grandiflora* subsp. *hexapetala*, in the Ebre River, at Amposta; and b) *L. peploides* subsp. *montevidensis*, in the Ter River, near Colomers.

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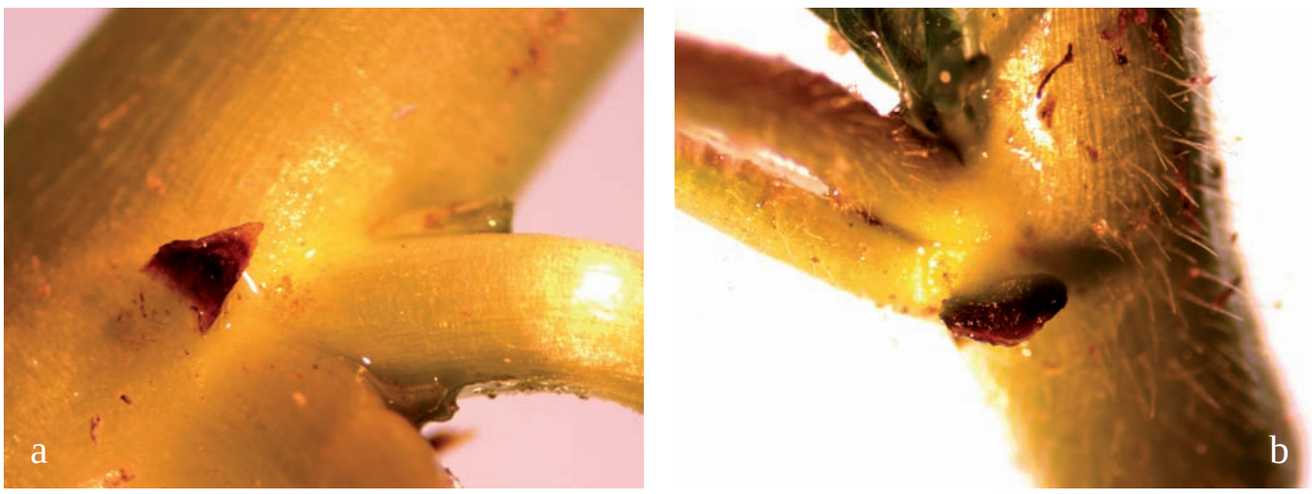


Figure 2. Detailed photograph of the stipules of a) *L. grandiflora* subsp. *hexapetala* in the Ebre River from Amposta, and b) *L. peploides* subsp. *montevidensis* from Girona. The presence of stipules and trichomes on the stem is a distinguishing character for this subspecies of *L. peploides*.


Figure 3. Flowers of a) *L. grandiflora* subsp. *hexapetala* from Amposta, and b) *L. peploides* subsp. *montevidensis* from Girona.

***Ludwigia peploides*** (Kunth) P.H. Raven subsp. ***montevidensis*** (Spreng.) P.H. Raven

Baix Empordà: Torroella de Montgrí, al Ter, entre la resclosa i el pont, EG0954, 4 m, 15-VII-2016, J. Bou (HGI 23251). Alt Empordà: Palau-Saverdera, a la Bassa del Camí Ral, EG1181, 7 m, 23-VII-2018, J. Bou (HGI 23944); Palau-Saverdera, basses de les Garrigues, EG1181, 10 m, 23-VII-2018, J. Bou (HGI 23945). Baix Llobregat: El Prat de Llobregat, riba esquerra del Llobregat, DF2377, 3 m, 22-VII-2018, J. Bou (HGI 23946). Baix Ebre: Deltebre, Secanella, bassa de la Barraca d'en Salvador, CF0911, 0 m, 22-VII-2018, J. Bou (HGI 23948).

According to Bou Manobens & Font Garcia (2016) *L. peploides* subsp. *montevidensis* is naturalised and expanding its range in Catalan rivers, which is very worrying due to the high risk of invasion of river ecosystems (Rodríguez-Merino *et al.*, 2017). This taxon is known to have an enormous capacity for vegetative multiplication through small propagules (Ruaux *et al.*, 2009), something that has been demonstrated by how easily it recovered after several attempts to mechanically control its presence in two specific populations. In Alt Empordà, in an endeavour to recover a pond in poor ecological condition, the mechanical eradication of the population was attempted (ACN, 2016), but new populations have appeared (HGI 23944 and HGI 23945), probably due to propagules or viable seeds that were not removed. The second case involved a pond in Baix Ebre, linked to a house, where heavy machinery was used to eliminate the population and prevent its propagation. However, in this case, even though part of the soil where it had rooted was removed (personal observation), this was not sufficient and the population has regrown (HGI 23948). Its enormous capacity for dispersion is thus guaranteed both in terms of sexual reproduction and the creation of propagules (Dandelot, 2004), as observed in the Ter basin. Although our previous research (Bou Manobens & Font Garcia, 2016) dealt with more or less fragmented population centres throughout the basin, in the summer of 2018 it was observed that the populations had increased their

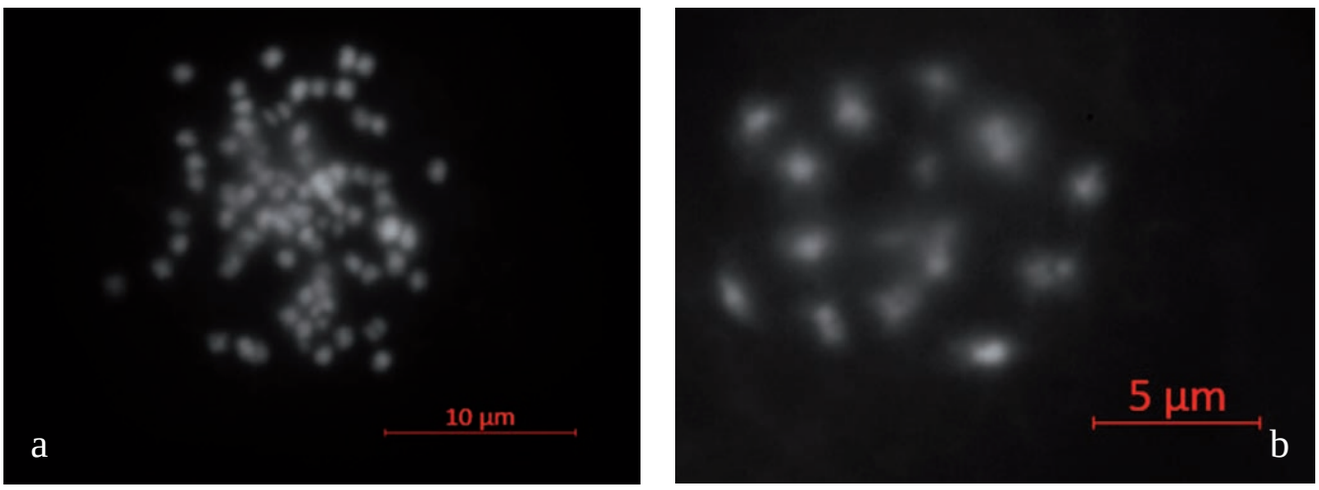


Figure 4. Somatic metafase chromosomes of a) *L. grandiflora* subsp. *hexapetala* from Amposta, and b) *L. peploides* subsp. *montevidensis* from Girona.

continuity (Fig. 1b), from the lower part of the Onyar River, around Quart, to the mouth of the Ter River, at Torroella de Montgrí. The rapid expansion of this taxon in Catalonia, particularly in the Ter basin, and the various impacts evident in other European countries (Dandelot, 2004; Dandelot *et al*., 2005, 2008; Robert *et al*., 2013), highlight the need to classify this species as a major threat to Catalonia's aquatic ecosystems.

To identify the samples collected in this study, not only have we studied morphological characters, which have sometimes led to confusion in our area (Bou Manobens & Font Garcia, 2016), but we have also counted the number of chromosomes to remove any doubt, as the two taxa are different in this respect (Dandelot, 2004). *L. grandiflora* subsp. *hexapetala* is decaploid, whereas *L. peploides* subsp. *montevidensis* is diploid (Zardini *et al*., 1991a,b). All the studied populations were analysed using the "Plateforme de Cytogénétique Moléculaire Végétale" (PCMV; Molecular Cytogenics Platform) at the INRA, in Le Rheu (France). All the plants attributed to *L. peploides* subsp. *montevidensis* have 16 chromosomes, while *L. grandiflora* subsp. *hexapetala* from the Ebre River has 80 chromosomes. In order to clarify the differences, the following identification key is proposed:

1 Elongated stipules (Fig. 2a). Sepals persistent on the fruit, more than 18 mm long. Flowering stems and pedicels with patent hairs 1-2 mm long. Leaves of the flowering stems lanceolate to almost obovate-lanceolate, dull, 4-12 cm long. Petals (12)15-23 mm long (Fig. 3a). Small stomata 28±3 µm. Chromosomes 2*n*=80 (Fig. 4a) ..... .....*L. grandiflora* subsp. *hexapetala*

– Reniform stipules (Fig. 2b). Sepals persistent on the fruit, more than 10 mm long. Flowering stems and pedicels with patent hairs 0.5-1 mm long. Leaves of the flowering stems obovate-oblong to almost elliptical-oblong, shiny, 3-6 cm long. Petals 10-18 mm long (Fig. 3b). Stomata 19±2 µm. Chromosomes 2*n*=16 (Fig. 4b) ..... .....*L. peploides* subsp. *montevidensis*

Over recent years, the dynamics of both species have been representing a serious threat to the biodiversity of aquatic ecosystems, demonstrating the need for new studies on these invasive hydrophytes. In order to efficiently manage and control them, we need to more precisely understand the population dynamics and impacts of these invasive species, while also focusing on their origins and population genetics.

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