

Short Communication

The invasive water primrose *Ludwigia grandiflora* (Michaux) Greuter & Burdet (Spermatophyta: Onagraceae) in Germany: First record and ecological risk assessment

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Abstract

A population of *Ludwigia grandiflora*, an aquatic weed from South America, has been recorded in the North West of Germany near Leer, Lower Saxony in an old branch of the River Leda, a tributary of the River Ems. This species is new to the German flora. After an initial observation of only a few individuals in 2004, a dense growth of *L. grandiflora* has been observed from 2009 onwards. An ecological risk assessment, mainly based on knowledge about invasion histories in neighbouring countries, showed that this species is a threat to German biodiversity; thus, it is considered to be invasive and has been assigned to the German Black List. In accordance with nature conservation efforts, management policies are being developed by the appropriate authority to eliminate the population.

Key words: *Ludwigia grandiflora*, Spermatophyta, alien species, freshwater, Germany, risk assessment, Black List

Introduction

The water primrose *Ludwigia grandiflora* (Michaux) Greuter & Burdet, native to South America, was intentionally released in 1830 in southern France but remained restricted to the area from the Camargue to Aquitaine during a long period until the middle of the twentieth century (Dandelot 2004). However, the spread of *L. grandiflora* has been substantial during the past four decades in France, where the species is now already present in half of the country (Dandelot 2004), and in other European countries (records of free-living individuals in Belgium (Bauchau et al. 1984), Ireland (F. Lucy, personal communication), Italy (EPP0 2004), The Netherlands (Kleuver and Holverda 1995), Spain (EPP0 2004a), Switzerland (Vauthy et al. 2003), and the United Kingdom (Palmer 2008)). Dandelot et al. (2005) suggested that during the 20th century, the increased use of *L. grandiflora* as an ornamental aquatic plant has accelerated its expansion in Europe. Brunel (2009) predicted that *L. grandiflora* would soon occur elsewhere

in the wild if countries do not take action to prevent its entry and spread.

First record in Germany

Here in this record, we are the first to document the presence of *Ludwigia grandiflora* in German waters (Figure 1). On 4 August 2009, a visit to an old branch of the River Leda (53°11.01'N and 7°38.77'E), a tributary of the River Ems located in the North West of Germany near Leer, Lower Saxony, revealed a dense growth of water primrose, a new alien species to the German flora.

This stagnant old branch is isolated from the River Leda by a dike and filled with surface and ground water. The branch is 510 m long and on average 30 m wide, with a maximum depth of about 1.0 m.

On 19 August 2010 and 11 September 2010, the site was surveyed to estimate the extent of the invasion. These surveys revealed a very dense population of *L. grandiflora*. The population's density was not quantified, but several stands of different sizes were found



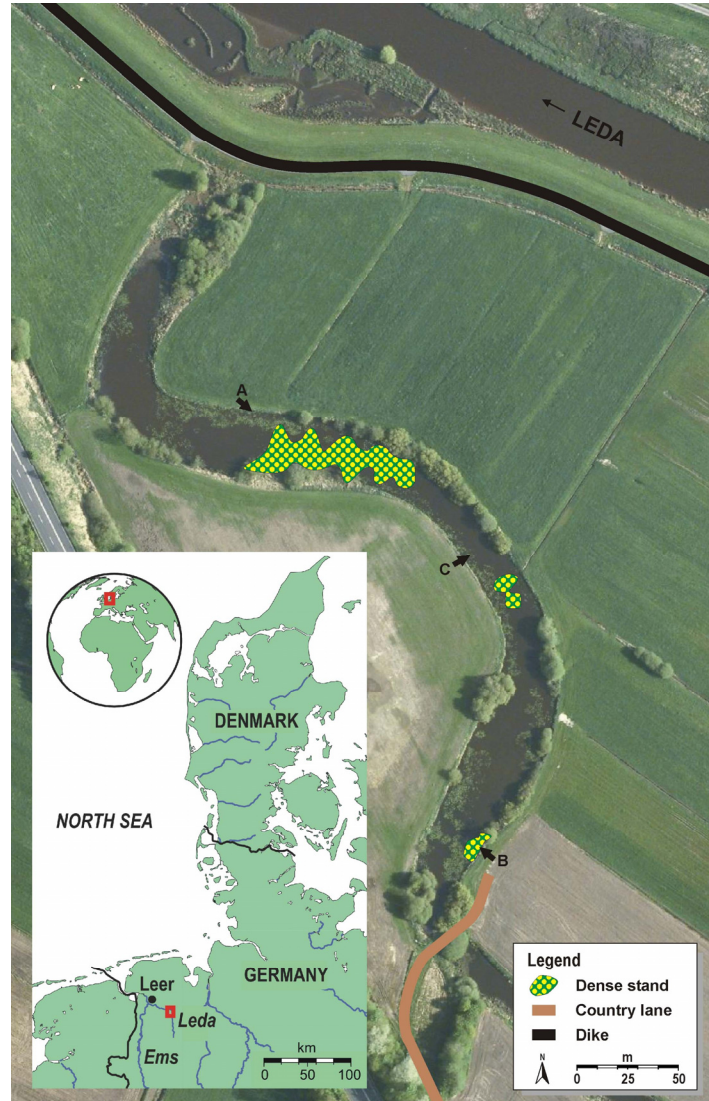
Figure 1. The invasive water primrose *Ludwigia grandiflora* in an old branch of the River Leda, Germany, 11 September 2010. **A)** Colonization in the central part. **B)** Dense stand at the southern end; insert: bright yellow flower with five petals, approx. 5 cm in diameter. **C)** Scattered young plants. Perspectives of photos are marked in Figure 2 (photographs by Stefan Nehring).

(Figure 2). At the southern end of the old branch, a dense mat covered a surface area of about 40 m². The center of the invasion was situated in the central part of the branch; *L. grandiflora* occurred in two distinct areas more or less across the whole branch. The smaller area was about 15 m in length, and the larger area was about 90 m in length. In both areas, the greatest concentrations of plants were in the middle of the branch, at which the water depth is only 0.3 m due to silting tendencies. In summer, these zones partially dry up. Between both areas, several single plants could be observed as emergent or floating forms. In summary, *L. grandiflora* was found to cover a surface area of roughly 1100 m² in total, which was equivalent to 7.2 % of the whole water surface area. On 19 August 2010, control surveys of

several other stagnant water bodies nearby did not yield any additional detection of water primrose.

The old branch has been used for fishing for many decades and several anglers noted that they had first observed *L. grandiflora* in 2004. The mechanism that introduced *L. grandiflora* into this water remains unknown, but the pathway may have been human activity. The starting point of the invasion was at the southern end of the old branch, where the only paved country lane in that area ends. Thus, it is very likely that the occurrence there could be attributed either to a person who illegally disposed of aquatic material from a garden pond or to an angler who stocked fish or used fish as bait taken from a pond in which *L. grandiflora* was occurring. It is well-known that small plant fragments of water

Figure 2. Spatial distribution of dense stands of the invasive water primrose *Ludwigia grandiflora* in an old branch of the River Leda, Germany, 11 September 2010. Arrows indicate perspectives of photos in figure 1. Digital orthophoto © Surveying administrations of federal states and Federal Agency for Cartography and Geodesy (<http://www.bkg.bund.de>).



primrose are sufficient for establishing a new population (Dandelot 2004).

There is some taxonomic confusion in the *Ludwigia* complex (Dandelot et al. 2005). Several older European records refer to *L. uruguayensis* (Camb.) Hara (e.g., Bauchau et al. 1984; Kleuver and Holverda 1995), which is, according to Nesom and Kartesz (2000), a synonym of *L. grandiflora*. There is one native *Ludwigia* species in Germany, *L. palustris* (L.) Elliott, which is known as marsh-purslane; it is very rare and very different in appearance (Lakmann and Cordes 1996).

Ecological impacts and risk assessments

The discovery of a dense, well-established population of *Ludwigia grandiflora* in German waters is of significant concern. Invasions of *L. grandiflora* have been associated with negative effects on biodiversity and water quality in Belgium, France and Switzerland.

Under appropriate conditions it can double in mass in 15-20 days (Dandelot 2004). The growth form shades out other plants and *L. grandiflora* stands are typically monospecific (Dandelot

2004; SKEW 2009). In addition to shading, decaying mats of *Ludwigia* bring about deoxygenation of the water with potential damage to fish stocks and to other fauna (Lambert et al. 2010; Stiers et al. 2009). Large plant biomass also results in an increase in sedimentation with diverse effects on native biocoenosis (Danelot 2004). *L. grandiflora* possesses an allelopathic activity that influences the water quality throughout the year and reduces the germination and survival rates of other plant species (Danelot et al. 2008). Whole lake systems in France have been taken over by *Ludwigia*, with a resulting loss of water for waterfowl (Danelot 2004). This species has also been associated with several human activity nuisances in water bodies (Danelot 2004).

Ecological risk assessments of *L. grandiflora* have been performed in several European countries and by the EPPO to allow the prioritization of management measures (Table 1). However, the ecological impacts of this species in Germany have not yet been characterized and evaluated. In 2008, a newly developed and tested risk assessment tool for invasive alien species, the “German-Austrian Black List Information System” (GABLIS), was implemented by competent authorities in both countries (Essl et al. 2008; Nehring et al. 2010). It has been developed as a trans-national and taxonomically universal risk assessment system. This assessment is criteria based, i.e. a set of specific criteria is used to assess the alien species’ impact. Data used for assessment may result from scientific reports and peer-reviewed publications as well as from expert judgement, and they may refer either to a reference area or to climatically and ecologically similar areas. In accordance with the GABLIS guidelines, *L. grandiflora* is considered a threat to German biodiversity and has been assigned to the German Black List of invasive species (Table 2).

In GABLIS, the Black List is further separated into three specific sub-lists (warn, action and management lists), according to the current distribution of the alien species and emergency measures available. Because up until now *L. grandiflora* occurs only in one locality and since eradication measures are feasible, it appears on the German Black List – action list (BfN 2010). Here, immediate, intense and sustained eradication measures make sense to eliminate all free-living individuals in order to avoid further spreading and to prevent loss of biodiversity. This management approach is in

agreement with Article 40 paragraph 3 of the new Federal Nature Conservation Act (BNatSchG 2009, entered into force 1 March 2010), which prescribes that the competent Federal and Länder authorities should immediately implement suitable measures aimed at eliminating, or preventing the spread of, newly appearing plants and animals of invasive alien species.

Management measures

Each invasive alien species and each site has its own management plan based on individual characteristics. Thiébaud (2007) summarized various solutions that could be adapted to individual sites of *L. grandiflora* colonization. At the beginning of *Ludwigia* colonization, manual removal is usually practicable. When the plant has become well-established, mechanization is necessary. Although chemical treatment can replace or enhance manual removal operations, it has been used only as a last resort, where water use and environmental considerations made it possible and if it is permitted by the applicable regulation. In the case of the present invasion, management policies are being developed by the appropriate authority to eliminate the population. It is essential to remove all plant material because *L. grandiflora* can regrow from small root and stem fragments and to install a careful transport and disposal system to prevent further spreading. After treatment, monitoring for the early recognition of re-emergence is essential.

The prevention of the (re)introduction of invasive species is a key management issue. In Europe, *L. grandiflora* has a high potential of invasiveness (Brunel et al. 2010; EPPO 2004), but it is still being sold as an ornamental plant for garden ponds in most countries (Brunel 2009). However, for several years, the commercialization of water primrose has been prohibited in France (MEDD 2007), Portugal (MDA 1999) and Switzerland (SBR 2008). In the Netherlands, a new code of conduct regarding alien plants was signed (EPPO 2010), in which the signatories reached an agreement to stop selling six invasive species including *L. grandiflora* by 1 January 2011. Regulation appears to be the most appropriate option for preventing the detrimental effects of invasive alien species in the long run. Thus, the invasive *L. grandiflora* should be banned from sale, especially in high-risk countries such as Germany.

Table 1. Results of ecological risk assessment of *Ludwigia grandiflora* in Western European countries and by the European and Mediterranean Plant Protection Organization (EPPO).

Country	Protocol	Result	Reference
Belgium	ISEIA vers. 2.6	High risk (black list A2)	Branquart et al. 2010
Germany	GABLIS	Invasive (black list – action list)	this study
Great Britain	GB NNS risk assessment	High risk	NNSS 2010
Switzerland	Weber and Gut	High risk / invasive (black list)	Weber and Gut 2004; SKEW 2010
Europe	EPPO pest risk analysis	Invasive (list of (potential) invasive alien plants)	EPPO (Brunel et al. 2010)

Table 2. Ecological risk assessment of *Ludwigia grandiflora* inclusive Black List classification for Germany (Assessment protocol: “German-Austrian Black List Information System” (GABLIS); for further information, see Essl et al. (2008), Nehring et al. (2010)).

a) General Information	
Systematics and nomenclature	<i>Ludwigia grandiflora</i> (Michaux) Greuter and Burdet Spermatophyta, Onagraceae Water primrose (EN), Großblütiges Heusenkraut (DE)
Important synonyms	<i>Jussiaea grandiflora</i> , <i>Ludwigia uruguayensis</i>
Habitat	Freshwater
Status	established
Native region	South America
Introduction	deliberate
Import vectors	Horticulture
First introduction	unknown
<i>In 1823, the first European import into France (Dandelot 2004); about 1888 cultivated in the Botanical Garden of Marburg, Germany (Goebel 1889), however, no figures regarding date of first import are available.</i>	
First record	2004 (this study)
b) The Main Criteria - Risks To Biodiversity	
1 Inter-specific competition	yes
<i>Strong inter-specific competition with native plants (Belgium, Stiers et al. 2009; France, Dandelot 2004; Switzerland, SKEW 2009); possesses an allelopathic activity that reduces the seedling survival of other plant species (France, Dandelot et al. 2008).</i>	
2 Predation and Herbivory	not assessed
3 Hybridization	unknown
<i>Hybridization with other (native) Ludwigia species in the wild should not be excluded (Neson & Kartesz 2000) because in laboratory conditions, hybridization between L. grandiflora and L. peploides is possible (Dandelot 2004).</i>	
4 Transfer of pathogens or organisms	no
<i>Currently, no endangerment of native species is known.</i>	
5 Negative effects on ecosystems	yes
<i>Monospecific stands can cover the whole surface of larger water bodies, altering the whole ecosystem by reducing light transmission, water flow and oxygen content, as well as by increasing sedimentation (Belgium, Stiers et al. 2009; France, Dandelot 2004, Lambert et al. 2010).</i>	
c) Additional Criteria	
1 Current distribution	small-scale
<i>Only one free-living population in an old branch of the River Leda is known (this study).</i>	
2 Emergency measures	available
<i>Mechanical measures, chemical control, prevention of intentional release, public relations. Successful control measures e.g. in France (Thiébaud 2007), Switzerland (SKEW 2009) and United Kingdom (NNSS 2010).</i>	

Table 2 (continued).

d) Biological-Ecological Criteria	
1 Occurrence in natural, semi-natural or other high nature value habitats	yes
<i>The species is found in marshes and in shallow sites of inland waters, especially in still or slow-flowing waters (Dandelot 2004, this study).</i>	
2 Reproductive capacity	high
<i>In Europe, reproduction is mainly vegetative, and the plant can re-grow from small root and stem fragments (Dandelot 2004); sexual reproduction is thermal limited (Ruaux et al. 2009).</i>	
3 Spread capacity	high
<i>Mainly by passive dispersal of plant fragments and seeds (Dandelot 2004, Ruaux et al. 2009).</i>	
4 Current spread history	expansive
<i>In the recent past strong expansion in Europe (Belgium, France, Italy, The Netherlands, Spain, Switzerland, United Kingdom) (e.g. Dandelot 2004, Denys et al. 2004, Kleuver and Holverda 1995).</i>	
5 Monopolization of resources	yes
<i>Under favourable site conditions, biomass could double in 15-20 days (Dandelot 2004, Sheppard et al. 2006).</i>	
6 Facilitation by climate change	yes
<i>Increasing temperatures will favour stock development and spreading (Hussner 2009).</i>	
e) Additional Information	
1 Negative economic effects	yes
<i>Fishing, boating, tourism, water management (Dandelot 2004).</i>	
2 Positive economic effects	no
3 Negative effects on human health	no
4 Knowledge gaps and research needs	yes
<i>The genus <i>Ludwigia</i> needs a taxonomic revision.</i>	
f) Assessment Result ^{a)}	
Black List – action list	

a) Classification methodology

Step 1: Scaling results in section b)

At least one “yes” in b1-b5 -> Black List

Step 2: Classification result of Step 1 and scaling results in section c)

“Black List” in Step 1 and “small scale” in c1 and “available” in c2 -> Black List – action list

The European and Mediterranean Plant Protection Organization (EPPO) has actually finalized a pest risk analysis on this species (Brunel et al. 2010) that could help regulating international trade and importation of this species in the future.

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