



Identification of Invasive Alien Species using DNA barcodes

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General introduction to this factsheet

The Barcoding Facility for Organisms and Tissues of Policy Concern (BopCo) aims at developing an expertise forum to facilitate the identification of biological samples of policy concern in Belgium and Europe. The project represents part of the Belgian federal contribution to the European Research Infrastructure Consortium LifeWatch.

Non-native species which are being introduced into Europe, whether by accident or deliberately, can be of policy concern since some of them can reproduce and disperse rapidly in a new territory, establish viable populations and even outcompete native species. As a consequence of their presence, natural and managed ecosystems can be disrupted, crops and livestock affected, and vector-borne diseases or parasites might be introduced, impacting human health and socio-economic activities. Non-native species causing such adverse effects are called Invasive Alien Species (IAS). In order to protect native biodiversity and ecosystems, and to mitigate the potential impact on human health and socio-economic activities, the issue of IAS is tackled in Europe by EU Regulation 1143/2014 of the European Parliament and Council. The IAS Regulation provides for a set of measures to be taken across all member states. The list of Invasive Alien Species of Union Concern is regularly updated. In order to implement the proposed actions, however, methods for accurate species identification are required when suspicious biological material is encountered.

Because morphology-based species identifications are not always possible (e.g. cryptic species, trace material, early life-stages), the purpose of the present work is to investigate and evaluate the usefulness of DNA sequence data to identify each of the IAS included in the EU Regulation. The results are presented as factsheets (one per IAS) compiled using publicly available DNA sequence data and information aggregated from various sources. Each factsheet consists of two major parts; (i) a short introduction to the specific IAS compiling information on its taxonomy and current occurrence/distribution in Europe; (ii) an investigation with respect to the usefulness of publicly available DNA sequences to identify this IAS to the taxonomic level stated in the EU list using DNA barcoding. For further information about the reasoning behind the applied approach and details on the materials and methods utilised, please see below and Smits *et al.* [1].

More info about BopCo on <http://bopco.myspecies.info/> or contact us via bopco@naturalsciences.be.

More info on the EU Regulation on http://ec.europa.eu/environment/nature/invasivealien/index_en.htm.

Ludwigia peploides

(Kunth) P.H.Raven, 1964

Common names:

English: floating primrose-willow, (creeping, California) water primrose, marsh purslane, clovestrip

French: jussie rampante, jussie d'Orx, ludwigie faux-pépils

German: flutende Heusenkraut

Dutch: kleine waterteunisbloem

Last update: August 2020



General information on *Ludwigia peploides*

Classification

Kingdom	Phylum	Clade	Order	Family	Genus
Plantae	Magnoliophyta	Eudicots	Myrtales	Onagraceae	<i>Ludwigia</i>

Species in the same genus: N = 85 [2]

Note: Hybrids are encountered with other *Ludwigia* species.

Infra-species level: N = 4 [3]

Note: Four subspecies are reported: *L.p. glabrescens* (Kuntze) Raven, *L.p. montevidensis* (Sprengel) Raven, *L.p. stipulacea* (Ohwi) Raven, and *L.p. peploides* (Kunth) Raven.



Native range: [4]

Widespread in Central, South and North America; incl. most of southern United States of America.

Invasive range: [5–6]

Europe (geographical):

Belgium, France, Germany, Greece, Italy, Netherlands, Portugal, Spain, Switzerland, United Kingdom.

For more detailed locality information and the most recent distribution updates, please visit:

<https://www.gbif.org/species/5420991>

<https://gd.eppo.int/taxon/LUDPE/distribution>

<http://alien.jrc.ec.europa.eu/SpeciesMapper>

Outside Europe (geographical):

Asia (Cambodia, Indonesia, Japan, Malaysia, Taiwan, Thailand, Turkey), Africa (Burkina Faso, Madagascar, Mali), Oceania (Australia, New Zealand), United States of America (New York, Oregon, Washington).

Morphology, biology, invasion, negative effects and remedies

For more information on *Ludwigia peploides* please see the references and online information listed at the end of this document.



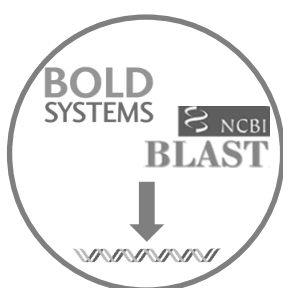
Species identification based on DNA barcodes

Introduction

DNA barcoding is a species identification method that uses a short genetic sequence (DNA barcode) to compare an unknown sample to a database of reference sequences with known species affiliations. The underlying rationale is that the divergence of nucleotide sequences among different species is larger than the nucleotide divergence between sequences within a species. DNA barcoding can facilitate the identification of IAS samples, especially when morphological characteristics are absent or useless. To assure correct species identifications, however, reference libraries need to include a sufficiently large number of sequences of (i) the IAS under investigation, in order to assess the intraspecific genetic divergence; (ii) the closely related species, in order to evaluate the interspecific genetic divergence; (iii) the different geographical areas covering the distribution range (native and invasive) of the IAS in order to detect potential population structure or local hybrids.

Against this background, BopCo evaluated the inclusion of the IAS and their close relatives in both publicly available reference libraries BOLD (www.boldsystems.org/) and GenBank (www.ncbi.nlm.nih.gov/nucleotide/) to estimate the reliability with which a species identification can be obtained using DNA barcoding.

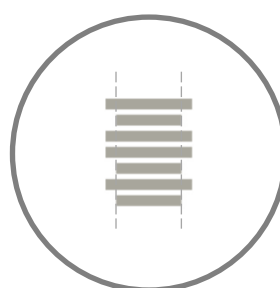
Material and Methods [1]



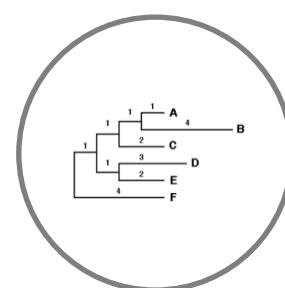
Download all sequence data available for the genus



Filtering the data and selecting 'promising' markers



Aligning and trimming of the sequences



Building Neighbour-Joining tree with Bootstrap support

Conclusion:

Based on the present evaluation of the available sequence data, **matK** and full ITS are the most promising DNA markers for the identification of *Ludwigia peploides*. However, due to the large gaps in available sequence data, it is currently impossible to fully assess the reliability of these markers.

Discussion

DNA markers for which *Ludwigia* sequences were available, were downloaded from GenBank and BOLD for all represented species of the genus *Ludwigia*. Four DNA markers were evaluated (Table 1).

For universal barcode marker **matK**, there is sequence clustering for some *Ludwigia* species, including the sequences of *L. peploides*. However, all *L. peploides* sequences are from a small area in its native region in the USA, obscuring potential intra-specific variation. Additional sequences for *L. peploides* (from the invasive and other native regions) and especially from the many missing congeners would allow to better evaluate the potential of **matK** to distinguish *L. peploides* from related species.

When using **full ITS** supported clustering is observed for *Ludwigia* congeners. However, too few sequences are available for *L. peploides* and a potential misidentification complicates the clustering, the same is true for the **ITS1** region. For the **ITS2** region, with more *L. peploides* sequences, there is no clustering. Additional *L. peploides* sequences for the full ITS region, as well as sequences from the missing congeners would allow to better evaluate the potential of the ITS regions for identifications.

For universal barcode marker **rbcl** there are many sequences for *L. peploides*, both from native and invasive regions, but the marker shows little genetic variation, resulting in non-clustering of *Ludwigia* species. It is not advisable to apply this marker for species identification

For the **trnH-psbA**, **trnL-trnF** and **atpB-rbcl** intergenic spacers, as well as the **phyC** and **rpl32** genes, few species are represented and/or the marker shows little genetic variation for *L. peploides* and the congeneric species. Therefore it is currently impossible to assess the ability of these markers to identify *L. peploides*.



Table 1: Overview of the encountered issues concerning the DNA-based identification of the IAS [1]: (1) Insufficient publicly available DNA sequences of the IAS to capture the intra-species divergence; (2) Poor geographical coverage of the IAS sequences (native or invasive range missing); (3) The IAS sequences do not form supported clusters; (4) Potential misidentification of a specimen which influences the clustering of the IAS sequences; and (5) Not all congeneric species are represented in the final NJ-tree. An 'X' indicates that the issue was encountered.

Markers analysed	1	2	3	4	5
rbcl		X	X		X
matK	X	X			X
Full ITS	X	X		X	X
ITS1	X	X		X	X
ITS2	X	X	X		X
trnH-psbA			X		X

Table 2: Publicly available sequences downloaded (August 2019) from BOLD and GenBank which were withheld as reliable and informative in the final alignment that was used for building the NJ-trees. The species names follow [2]. An 'X' indicates that at least one sequence was used in the final alignment, an (X)² indicates only ITS region 2 was available for analysis. Species names with * are not mentioned in [2] but used on GenBank. The list of species is limited to those members of *Ludwigia* for which at least one sequence was used in any of the NJ-trees

Species in genus	rbcl	matK	Full ITS & ITS1 (ITS2)	trnH-psbA
<i>Ludwigia abyssinica</i>			X	
<i>Ludwigia adscendens</i>	X	X	X	X
<i>Ludwigia affinis</i>			X	
<i>Ludwigia alata</i>			X	
<i>Ludwigia alternifolia</i>	X	X	X	X
<i>Ludwigia arcuata</i>	X	X	X	
<i>Ludwigia bonariensis</i>			X	
<i>Ludwigia brevipes</i>			X	
<i>Ludwigia curtissii</i>	X	X	X	
<i>Ludwigia decurrens</i>			X	
<i>Ludwigia elegans</i>			X	
<i>Ludwigia erecta</i>	X	X	X	
<i>Ludwigia foliobracteolata</i>			(X) ²	
<i>Ludwigia glandulosa</i>	X	X	X	X
<i>Ludwigia grandiflora</i>	X	X	X	X
<i>Ludwigia hassleriana</i>			X	
<i>Ludwigia helminthorrhiza</i>			X	
<i>Ludwigia hirtella</i>			X	
<i>Ludwigia hyssopifolia</i>	X		X	
<i>Ludwigia inclinata</i>	X		X	X
<i>Ludwigia irwinii</i>			X	
<i>Ludwigia jussiaeoides</i>			X	
<i>Ludwigia lagunae</i>			X	
<i>Ludwigia lanceolata</i>			X	
<i>Ludwigia leptocarpa</i>	X	X	X	
<i>Ludwigia linearis</i>	X	X	X	
<i>Ludwigia linifolia</i>	X	X	X	
<i>Ludwigia major</i>			X	
<i>Ludwigia maritima</i>	X	X	X	
<i>Ludwigia martii</i>			X	
<i>Ludwigia microcarpa</i>	X	X	X	
<i>Ludwigia myrtifolia</i>			X	
<i>Ludwigia neograndiflora</i>			X	
<i>Ludwigia nervosa</i>	X	X	X	
<i>Ludwigia octovalvis</i>	X	X	X	X
<i>Ludwigia ovalis</i>	X	X	X	
<i>Ludwigia palustris</i>	X	X	X	X
<i>Ludwigia peploides</i>	X	X	X	X
<i>Ludwigia perennis</i>			X	
<i>Ludwigia perrium</i> *	X			
<i>Ludwigia peruviana</i>	X	X	X	X
<i>Ludwigia pilosa</i>	X	X	X	
<i>Ludwigia polycarpa</i>	X	X	X	
<i>Ludwigia prostrata</i>	X	X	X	
<i>Ludwigia pseudonarcissus</i>			X	
<i>Ludwigia quadrangularis</i>			X	



Species in genus	rbcl	matK	Full ITS & ITS1 (ITS2)	trnH-psbA
<i>Ludwigia ravenii</i>			X	
<i>Ludwigia repens</i>	X	X	X	X
<i>Ludwigia rigida</i>			X	
<i>Ludwigia sedoides</i>	X		X	X
<i>Ludwigia sericea</i>			X	
<i>Ludwigia simpsonii</i>			X	
<i>Ludwigia spathulata</i>			X	
<i>Ludwigia sphaerocarpa</i>			X	
<i>Ludwigia stenorraphe</i>			X	
<i>Ludwigia suffruticosa</i>	X	X	X	
<i>Ludwigia torulosa</i>			X	
<i>Ludwigia virgata</i>	X	X	X	
TOTAL species	27/85	24/85	56 (57)²/85	11/85

For a more elaborate discussion of the available databases, the sequence selection process, the outcome of the NJ-tree analyses, the usefulness of the investigated DNA sequences for species identification, as well as information on how to send samples for analyses please contact BopCo directly.



References and online information

Online information

http://www.q-bank.eu/Plants/Factsheets/Ludwigia_peplodes_EN.pdf

<https://www.nvwa.nl/binaries/nvwa/documenten/plant/planten-in-de-natuur/exoten/risicobeoordelingen/factsheet-kleine-waterteunisbloem/factsheet-kleine-waterteunisbloem-nvwa-20170307.pdf>

Picture credits

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References

- [1] N. Smits, S. Gombeer, K. Meganck, A. Vanderheyden, Y. R. Van Bourgonie, T. Backeljau, and M. De Meyer, "Identifying IAS based on DNA barcoding using currently available sequence data: details on applied material and methods." 2019. [Online]. Available from: <http://bopco.myspecies.info/content/invasive-alien-species-ias-factsheets>.
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- [3] E. M. Zardini, C. Peng, and P. C. Hoch, "Chromosome Numbers in *Ludwigia* sect. *Oligospermum* and sect. *Oocarpon* (Onagraceae)" *Taxon*, vol. 40, no. 2, pp. 221–230, 1991.
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- [6] EPPO, "EPPO Data sheets on invasive alien plants: *Ludwigia grandiflora* and *L. peploides* Onagraceae - Water primroses" 2011.

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