

CONSERVATION

The marsh frog invasion: diversity, pathways, opportunism and effects

Mathieu Denoël

Laboratory of Ecology and Conservation of Amphibians, FOCUS, University of Liege, Belgium
Corresponding author: Mathieu.Denoel@uliege.be

Fabien Pille

Laboratory of Ecology and Conservation of Amphibians, FOCUS, University of Liege, Belgium

Clément Duret

Laboratory of Ecology and Conservation of Amphibians, FOCUS, University of Liege, Belgium

Pablo Padilla

Laboratory of Ecology and Conservation of Amphibians, FOCUS, University of Liege, Belgium

Luca Salomon

Laboratory of Ecology and Conservation of Amphibians, FOCUS, University of Liege, Belgium

Soline Bettencourt

Laboratory of Ecology and Conservation of Amphibians, FOCUS, University of Liege, Belgium

Anne-Constance Comau

Laboratory of Ecology and Conservation of Amphibians, FOCUS, University of Liege, Belgium

Aurore Lacombe

Laboratory of Ecology and Conservation of Amphibians, FOCUS, University of Liege, Belgium

Léa Lorrain-Solignon

Laboratory of Ecology and Conservation of Amphibians, FOCUS, University of Liege, Belgium

Justine Pavis

Laboratory of Ecology and Conservation of Amphibians, FOCUS, University of Liege, Belgium

Laura Pinto

Laboratory of Ecology and Conservation of Amphibians, FOCUS, University of Liege, Belgium

Victorine Renard

Laboratory of Ecology and Conservation of Amphibians, FOCUS, University of Liege, Belgium

Pauline Tendron

Laboratory of Ecology and Conservation of Amphibians, FOCUS, University of Liege, Belgium

Anthony Herrel

Museum national d'Histoire naturelle, CNRS, France

Mattia Falaschi

Università degli studi di Milano, Italy

G. Francesco Ficetola

Università degli studi di Milano, Italy

Daniel Jablonski

Comenius University, Bratislava, Slovakia

Christophe Dufresnes

Museum national d'Histoire naturelle, CNRS, France

Abstract

Amphibians are declining worldwide, but some species stand out for their ability to invade large areas after being introduced. While some invasions are well documented, others are more cryptic and often underestimated despite local warnings. This is the case of the marsh frog, *Pelophylax ridibundus* for which an integrative overview of the invasion patterns, ecology and risks to native amphibians is lacking. To fill this gap, we reviewed published invasion cases in Europe and conducted an interdisciplinary study of the phylogeography, spatial, trophic and thermal ecology of the marsh frog (*Pelophylax ridibundus sensu lato*). We found that introductions have occurred in 19 European countries, involving many lineages of the species from three continents, which fits well with the history of importation of live frogs into Europe, mainly for consumption of their legs, but also for research, education and ornamentation of ponds. These introductions resulted in some country-wide invasions, which led to large spatial niche overlaps with native amphibians. The establishment of the invaders was facilitated by their opportunism, characterized by their tolerance to a wide range of temperatures, their presence in various pond environments, and their ability to prey on a large variety of both aquatic and terrestrial organisms, including other amphibians such as newts and tree frogs. Taken together, these results place the marsh frog as one of the most complex and opportunistic invasive amphibian species in the world. They call for more research and genome-wide molecular analyses to assess patterns of genetic diversity, structure and gene flow between the lineages involved across the whole invaded and native areas. They urge the need for a complete commercial ban on the import of live water frogs to prevent further introductions but also limit the risk of multiplying lineage combinations, a Pandora's box that could boost the invasiveness of the species.

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