

Invasive amphibians and reptiles in Italy

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Riassunto. Le specie alloctone invasive sono una delle principali minacce alla biodiversità. In questa rassegna vengono analizzati i principali taxa di anfibi e rettili attualmente invasivi in Italia: *Xenopus laevis*; *Lithobates catesbeianus*; *Pelophylax kurtmuelleri* / *P. ridibundus*; *Trachemys scripta*. Per ogni taxon, si evidenzia la distribuzione nativa ed invasiva, le cause dell'introduzione, e gli effetti sulle specie autoctone. Tutte queste specie possono avere drammatiche conseguenze sulla biodiversità in Italia; sono necessari sia ulteriori studi su queste specie, che sforzi volti al loro controllo.

Keywords. Alien invasive species, biodiversity, distribution impact, introduction pathway.

Invasive species are a major cause of biodiversity loss. They can cause multiple negative consequences on native biota, such as predation, parasitism, competition, diffusion of diseases, hybridization and ecosystem modifications (Strayer *et al.*, 2006). Many species of amphibians and reptiles have been translocated and introduced all around the world, and constitute a threat to native species (Lever, 2003; Kraus, 2009). Current evidences suggest that at least eight species of non-native amphibians and 13 species of non-native reptiles have been introduced in Italy (Lever, 2003; Kraus, 2009), but the success of introductions and the impact was different among taxa. Among these, five species introduced during the last century are considered invasive, i.e., are quickly expanding their non native range, and are posing major conservation issues. Here we review the introduction history of these species, and we present the threats they cause to biodiversity (Table 1).

African Clawed Frog *Xenopus laevis*.

Xenopus laevis has been introduced in Sicily during the nineties (Lillo *et al.*, 2005). This species is among the most commonly used laboratory animals, therefore the population likely originated from laboratory individuals. *Xenopus laevis* is invasive in other European countries, such as France, Portugal and the UK (Kraus, 2009; Rebelo *et al.*, 2010). In Sicily, *X. laevis* is quickly expanding its range, with about 300 km² invaded in 2007, and may

colonize new wetlands even through terrestrial migrations (Faraone *et al.*, 2008). Some native amphibians [*Discoglossus pictus*, *Hyla intermedia* and *Pelophylax* synkl. *hispanicus*] are absent in ponds with *X. laevis*, while they are present in nearby ponds, suggesting a decline of native amphibians (Faraone *et al.*, 2008; Lillo *et al.*, 2008). The reason of this decline are not clear; predation is a possible cause, but no remains of native amphibians were found in *X. laevis* stomach contents (Faraone *et al.*, 2008). Predation by invasive *X. laevis* is a likely cause of the decline of native fish and amphibians both in California and in France (Kraus, 2009). Furthermore, invasive *Xenopus* can spread *Batrachochytrium dendrobatidis*, a chytrid fungus which is the agent chytridiomycosis, a disease causing amphibian decline (Soto-Azat, 2010). Nevertheless, available data suggest that, in Sicily, *X. laevis* are not affected by *B. dendrobatidis* (Lillo *et al.*, 2008).

American bullfrog *Lithobates catesbeianus*.

There have been multiple attempts of introduction of bullfrogs in Europe since the 18th century. The first successful introduction occurred during the 1930's in Italy; historical records report the introduction of two females and one male near Mantova (Albertini, 1970). Some authors questioned these figures, suggesting that a larger number of individuals would need to be introduced to originate a population invading large areas of the river Po plain. However, genetic analyses showed homogeneity of Italian populations of bullfrog, and confirmed a very small number of founders (less than six females) (Albertini and Lanza, 1987; Ficetola *et al.*, 2008). Bullfrogs spontaneously expanded their range in Northern Italy, and have been subsequently introduced to several localities in Piedmont, Friuli, Tuscany, Latium, Campania and Basilicata for a variety of reasons, including attempts of commercial farming and personal initiatives (Albertini and Lanza, 1987; Fattizzo and Nitti, 2007; Ficetola *et al.*, 2007). The patterns of introduction are poorly documented; nevertheless, genetic similarity among populations suggest individuals often originated from the populations initially established in Northern Italy. Some bullfrog populations are currently extinct; populations are currently present in Piedmont, in the Eastern Po Plain, Latium (Maccarese), Basilicata and Tuscany. In northern Italy, the Piedmont populations are still expanding their range; conversely, in the Eastern Po Plain bullfrogs currently seem to be less invasive, probably due to environmental changes such as the lower water availability caused by changes in agricultural practices (Ficetola *et al.*, 2010). Bullfrogs can have multiple consequences on native amphibians. Italian populations of bullfrog are infected by *B. dendrobatidis*, and are implicated in the spread of chytridiomycosis (Garner *et al.*, 2006). Furthermore, bullfrogs are much larger than native amphibians; studies performed in California and France showed that larvae can outcompete the tadpoles, and that adults can be important predators of native amphibians (Moyle, 1973; Kats and Ferrer, 2003; Detaint and Coïc, 2006). A direct assessment of the impact of bullfrogs on native Italian amphibians would be important.

Green frogs (genus *Pelophylax*).

The situation of Italian green frogs is rather complicated, because many taxa occur in the peninsula and they often hybridize according to hybridogenetic mechanisms. The distinction among the different species and their hybrids is difficult and genetic analyses are

sometimes necessary. This fact leads to problems in the identification of alien green frogs that can spread over a large territory without detection. The first known introduction of alien green frogs in Italy dates back to 1941 and occurred in western Liguria for farming purposes (Lanza, 1962). The species expanded its range and now it is surely present in western Liguria and in southern Piedmont (Andreone and Sindaco, 1999), but new findings probably extend its distribution also to Lombardy (Pavia province) (F. Bernini and E. Razzetti, com. pers.). These frogs have been originally described as *P. ridibundus*, but taxonomic attribution is difficult; several Italian population probably came from Albania, thus they should belong to *P. kurtmuelleri* (Bressi, 2006; Razzetti *et al.*, 2006). However, several introductions likely occurred, and therefore multiple invasive taxa can be present in Italy, like in other countries (Holsbeek *et al.*, 2010). Major consequences of its range expansion are the competition and, probably, the hybridization with native green frogs, causing genetic loss of Italian populations and the extinction of native taxa (Razzetti *et al.*, 2006; Holsbeek *et al.*, 2010). No data are available about the role of *P. kurtmuelleri* as a vector of pathogens such as *B. dendrobatidis*; studies should be conducted on this issue. In particular, genetic analyses should be conducted in the whole range of Italian green frogs to ascertain the occurrence of allochthonous genotypes, because recent studies have demonstrated the genetic contamination of green frogs in other countries, like Belgium (Holsbeek *et al.*, 2008; 2010).

Slider turtle *Trachemys scripta*.

Trachemys scripta was first introduced in Italy on early '70s in southern Italy (Bruno and Guacci, 1993), but many findings occurred in the whole Italian territory since the '80s (Di Cerbo and Di Tizio, 2006). This species is commonly traded all over the world as a pet or for food (Thorbjarnarson *et al.*, 2000), but many individuals are abandoned in natural or artificial ponds and rivers; sliders are considered by the IUCN one of the 100 world's most invasive alien species (Lowe *et al.*, 2000). There are multiple records of reproduction of the American slider turtle in Italy, so the species must be considered as acclimatized (Di Cerbo and Di Tizio, 2006; Razzetti *et al.*, 2006; Macchi, 2008). Bioclimatic models suggest that several Italian coastal areas are suitable for reproduction of the sliders; this increases the risk of establishment of this long-lived species in areas where the European pond turtle is still common (Ficetola *et al.*, 2008). The most common traded subspecies was *T. scripta elegans*, but it was banned on 1997 by the European Community; this fact started the trade of other taxa, like *T. scripta scripta* and *T. scripta troostii* that now are recorded also in Italian wetlands (Macchi, 2008). The American slider turtle is a problematic species, because its ecology is similar to that of the European pond turtle (*Emys orbicularis*) and competition between the two species was often hypothesized. Experimental studies conducted in France and in Italy confirm this concern, demonstrating competition for basking sites and for food (Cadi and Joly, 2003; Macchi, 2008; Macchi *et al.*, 2008; Polo-Cavia *et al.*, 2010).

In the last years, the number of studies on alien amphibians and reptiles in Italy is quickly increasing; nevertheless, information of distribution, ecology and impact of these species is not complete. A better knowledge on alien amphibians and reptiles would also help to understand the consequences on native biodiversity, and to identify management strategies.

For these reasons, in 2007 the Societas Herpetologica Italica promoted a countrywide monitoring of alien herpetofauna. The records of this monitoring project are providing a better picture of distribution of slider turtle and bullfrog. Nevertheless, the number of records remains limited, and the majority of observations came from a few regions, mostly in Central and Northern Italy. More records are necessary for a better picture of the whole Italian territory.

Tab. 1. Summary of distribution and impact of invasive amphibians and reptiles in Italy.

	<i>X. laevis</i>	<i>L. catesbeianus</i>	<i>P. ridibundus</i> / <i>P. kurtmuelleri</i>	<i>T. scripta</i>
Date of introduction	1990's	1930's	1941	Early 1970s
Pathway	Unknown	Personal initiatives, farming	Personal initiatives, farming	Pet release (personal initiatives)
Native distribution	Central and Southern Africa	Eastern Northern America	Central-eastern Europe, Asia	South-Eastern USA, North Eastern Mexico
Distribution in Italy	Sicily	Po lowland, Tuscany, Latium, Basilicata	Friuli-Venezia Giulia, Liguria, Piedmont	Multiple locality across Italy
Impact:				
Predation	P	P	P	P
Competition	P	P	P	O
Spread of diseases	P	O	P	P
Hybridization			P	

O: impact observed in Italy; P: possible impact.

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