
The turtle *Trachemys scripta elegans* (Testudines, Emydidae) as an invasive species in a polluted stream of southeastern Brazil

BRUNO O. FERRONATO^{1,4}, THIAGO S. MARQUES^{1,2}, ISABELA GUARDIA^{1,2}, ANA L. B. LONGO¹, CARLOS I. PIÑA^{1,3}, JAIME BERTOLUCI² and LUCIANO M. VERDADE¹

¹ *Laboratório de Ecologia Animal, Departamento de Ciências Biológicas, Escola Superior de Agricultura “Luiz de Queiroz”, Universidade de São Paulo, Avenida Pádua Dias, 11, CP. 09, CEP 13418-900, Piracicaba, SP, Brazil.*

² *Departamento de Ciências Biológicas, Escola Superior de Agricultura “Luiz de Queiroz”, Universidade de São Paulo, Avenida Pádua Dias, 11, CP. 09, CEP 13418-900, Piracicaba, SP, Brazil.*

³ *CICyTTP-CONICET. Projecto Yacaré, Min. Prod. Bv. Pellegrini 3100, PO Box 3000, Santa Fe, Argentina.*

⁴ Corresponding author: brunoferronato@hotmail.com

ABSTRACT - The north American freshwater turtle *Trachemys scripta elegans* has been recently reported as an exotic species in several regions of the world. During an investigation on the ecology of the Chelid turtle *Phrynops geoffroanus* in a Brazilian anthropogenically altered stream, we captured four *T. s. elegans* (two males and two females) and observed several other individuals basking. Reproduction was recorded for captive individuals. The occurrence of feral *T. s. elegans* in southeastern Brazil is considered and aspects that could favor the long term persistence of *T. s. elegans* at the study site are discussed.

INTRODUCTION of alien species can alter the organization and functioning of resident communities by various ecological processes such as predation, parasite transfer, or competitive exclusion (Cadi & Joly, 2004). For these reasons, introduction of exotic species is considered one of the leading causes of biodiversity loss in the world (Clavero & García-Berthou, 2005).

The freshwater turtle *Trachemys scripta elegans* (Wied, 1838) occurs naturally in the Mississippi Valley, from Illinois to the Gulf of Mexico (Ernst & Barbour, 1989). Since the 1970s, the species has been farmed in large numbers in the USA for pet trade (Cadi et al., 2004). Pet owners inadvertently release grown turtles in the wild and also in urban areas. As a consequence, the species has been introduced in several countries, including Italy (Luiselli et al., 1997), France (Cadi et al., 2004; Prévot-Julliard et al., 2007), Spain (Gómez de Berrazueta et al., 2007), Taiwan (Chen & Lue, 1998), Australia (Burgin, 2006), South Africa

(Newbery, 1984), British Virgin Islands (Perry et al., 2007) and Chile (Iriarte et al., 2005). For this reason, *T. s. elegans* has been included in the top 100 “World’s Worst” invaders (ISSG, 2008). This species has been reported to compete with the European Pond Turtle *Emys orbicularis* (Cadi & Joly, 2003; 2004). Biological characteristics that favor *T. s. elegans* as an invasive species are its early sexual maturity, high fecundity rate and relatively large adult body size (Arvy & Servan, 1998). From November 2005 to August 2007, we studied the ecology of a native south American freshwater turtle, *Phrynops geoffroanus* (Chelidae), in anthropogenic water courses in the state of São Paulo, in southeastern Brazil. During that study, we incidentally captured individuals of another native species, *Hydromedusa tectifera* (Chelidae), and the exotic *T. s. elegans*. This is the first report of the occurrence of this species in feral state in Brazil. We discuss possible implications and management measures.

METHODS AND MATERIALS

The Piracicamirim stream is 24.6 km long from its headwaters to its mouth, at Piracicaba River, with a mean width of 4.26 m and a mean depth of 1.56 m (Ometo et al., 2000). Its final portion is located in a heavily urbanized area of Piracicaba City (Ometo et al., 2004). Piracicamirim drainage (133 Km²) spreads over three counties in the state of São Paulo, in southeastern Brazil: Piracicaba, Rio das Pedras, and Saltinho (Ometo et al., 2000), with about 95,000 inhabitants (Toledo & Ballester, 2001). The region is intensively altered due to non-planned urban settlements and ethanol production. Sugar Cane crops occupy approximately 80% of its area, and the stream conserves only 2% of its original riparian forest (Ometo et al., 2004). In 1985 Piracicamirim was considered the most polluted tributary of Piracicaba River. Although a sewage treatment station had been established in 1997, this stream is still considered heavily polluted (Ballester et al., 1999). Its main pollution sources are domestic untreated sewage and fertilizers used in Sugar Cane production (Ometo et al., 2004).

In this study, turtles were captured inside the University of São Paulo campus (22° 42'51"S, 47° 37'36"W), in the suburban area of Piracicaba City (Fig. 1). We used four gill nets (nylon; mesh size 3-5 cm; 1.5-2 m deep; 15 m long) extended transversely in the stream (as suggested by Souza & Abe, 2000) and checked them every three hours. Captures occurred from November 2005 to August 2007 for a total of 39 days of field work.

RESULTS

During the investigation, we captured four *T. s. elegans* (two males and two females) (Fig. 2). Turtles were sexed by the following characteristics: carapace length, tail length, cloacae position and

plastron concavity (Ernst & Barbour, 1989; Pritchard & Trebbau, 1984). Mean body mass (\pm SD) was 900 ± 141 g (range: 800-1000 g) for males and 1250 ± 352 g (1000-1500 g) for females. Mean straight-line carapace length was 179 ± 5.6 mm (175-183 mm) for males and 184.5 ± 3.5 mm (182-187 mm) for females (Table 1).

DISCUSSION

The most likely cause of *T. s. elegans* occurrence in the Piracicamirim stream was release by pet owners, as previously reported in literature (Cadi & Joly, 2004). Piracicamirim stream crosses an urbanized area of Piracicaba City and its final portion is located inside of the University of São Paulo Campus, with easy access by local people.

Moll (1980) registered the occurrence of *T. s. elegans* within its natural range, but in the polluted Illinois River. Its occurrence in a tropical urban polluted river in Brazil supports evidence of its capacity to use anthropogenic environments. *T. s. elegans* is omnivorous, feeding on a variety of items such as filamentous algae, macrophytes, snails, Diptera (larvae and pupae), terrestrial insects, crustaceans and small vertebrates (Chen & Lue, 1998; Prévot-Julliard et al., 2007). Polluted rivers can offer a high amount of organic residues and food items, which can represent an advantage for such a generalist freshwater turtle species (Moll, 1980; Lindeman, 1996; Souza & Abe, 2000). *Phrynops geoffroanus* feeds mainly on Chironomidae larvae (Souza & Abe, 2000), which could possibly also be a prey for *T. s. elegans*.

After release, one of the main limiting factors to a successful invasion is reproductive success (Cadi et al., 2004; Gibbons & Greene, 1990). Successful reproduction of *T. s. elegans* has been reported for temperate regions, outside of its natural range (Cadi

	Body mass (g)	SLCL (mm)	Date of capture
♂1	1000	183	24 May 2006
♂2	800	175	15 August 2006
♀1	1000	182	6 June 2006
♀2	1500	187	21 November 2006

Table 1. Biometry of *Trachemys scripta elegans* captured in Piracicamirim stream, São Paulo State, southeastern Brazil. SLCL= straight-line carapace length.



Figure 1. The polluted Piracicamirim stream. Turtles basking in bottom left hand corner.
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et al., 2004; Ficetola et al., 2002; Luiselli et al., 1997). However, it is likely that the local tropical climate may not prevent the survival of hatchlings (Caiagro, 2008).

During survey we observed one *T. s. elegans* female laying six eggs, in a platform placed in the middle of an artificial pond, at the University of São Paulo Campus. In addition, other females exhibited nesting behaviour in other ponds at the same area. *P. geoffroanus* nests have also been found in the remaining anthropogenic gallery forest of Piracicamirim stream. This area could be suitable as nesting habitat for *T. s. elegans* as well. We observed signs of predation of *P. geoffroanus* nests possibly by Coatis (*Nasua* sp.), Opossums (*Didelphis* sp.) or Tegu lizards (*Tupinambis* sp.). *T. s. elegans* nests can be located at great distances from the water (Mount, 1975) and their eggs can be laid 140 cm deep (Packard et al., 1997). These characteristics could act defensively against local predators.

Cadi & Joly (2003; 2004) suggested that

there may be some competition for basking sites between European Pond Turtles (*E. orbicularis*) and introduced *T. s. elegans* caused a loss of body mass and an increase in mortality rate of *E. orbicularis* when both species are raised together under experimental conditions. Although some individuals of *T. s. elegans* have been seen basking in Piracicamirim stream we have no evidence of competition with native species (*Hydromedusa tectifera* and *P. geoffroanus* [Figs. 3 and 4]) as water temperature is considerably milder than in temperate areas like southern Europe. There is little information on the natural history of *H. tectifera* (Souza, 2004; Ribas & Monteiro-Filho, 2002). Demography of this species is virtually unknown, especially for polluted rivers. However, *P. geoffroanus* is recorded to be abundant in polluted rivers and streams of southeastern Brazil (Souza and Abe, 2000; Souza, 2004).

T. s. elegans has a large dispersal (Gibbons, 1990) and dispersion capacity (Bodie & Semlitsch, 2000). It also seems to be more aggressive than



Figure 2. A captured *Trachemys scripta elegans*.

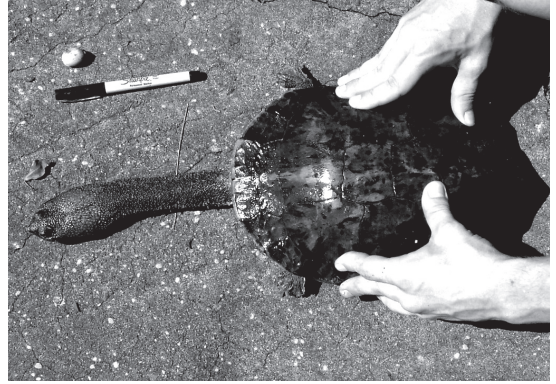


Figure 3. A native *Hydromedusa tectifera*.

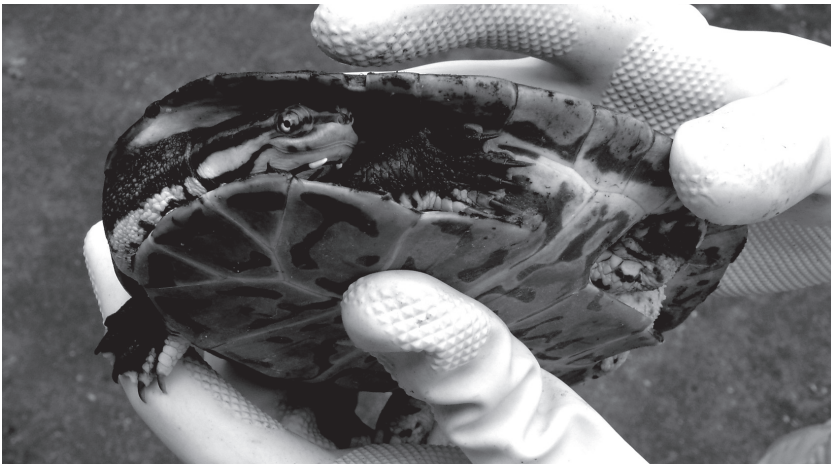


Figure 4. A native *Phrynops geoffroanus*.

other freshwater turtles (Bels et al., 2008). These characteristics can enable it to outcompete native species. For these reasons, future studies on the possible influence of the introduction of *T. s. elegans* on Neotropical freshwater turtles should be prioritized.

Although Brazilian Law prohibits the trade of exotic reptiles, the release of exotic pets is still common. A survey carried out by the Brazilian Environmental Agency (IBAMA) in 2004 revealed that 1,300 *T. s. elegans* individuals were received by zoos and wildlife centres in Brazil from private donors or as a result of law enforcement (Instituto Hórus, 2008).

The illegal trade of *T. s. elegans* should be halted by law enforcement in Brazil and neighbouring countries. In addition, education efforts aimed at the general public may help to elucidate the potential

environmental impacts of exotic species. Last but not least, individual control of this and other exotic species should commence, even in polluted rivers, as such areas may serve as meta-population centres for the species and promote migration into native pristine habitats (Cadi et al., 2004). In Brazil, such control action would require a change in the Wildlife Law as paradoxically, even exotic species are currently fully protected (Verdade, 2004).

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