

Short communication

Occurrence of the non-native fish *Salminus brasiliensis* (Cuvier, 1816), in a global biodiversity ecoregion, Iguaçu River, Paraná River basin, Brazil

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Abstract

We register here the first occurrence of the “dourado” *Salminus brasiliensis* (family: Characidae) in Salto Santiago Reservoir in the Iguaçu River basin, Paraná State, Brazil, a global biodiversity ecoregion with an extremely rich endemic ichthyofauna. The single specimen captured, an adult female measuring 480-mm total length, was taken with gillnet in January 2008. No additional *S. brasiliensis* were captured during general fish surveys conducted at four sites in the reservoir even though multiple types of gear were used (gill and trammel nets and long-line fishing) over a period of nearly two years (bimonthly from July 2006 to September 2008). The presence of *S. brasiliensis*, a large, predacious freshwater species native to other parts of Brazil, may be related to its use as a sport fish, and the single specimen taken from the reservoir may have escaped from ponds built by aquaculturists for recreational angling. Before appropriate management measures are taken, additional field work is needed to determine the status and distribution of *S. brasiliensis* in the Iguaçu basin and to assess possible negative effects of the introduction on native fishes.

Key words: alien species, *Salminus brasiliensis*, dourado, invasion, first record, Iguaçu River

The introduction of non-native species is second only to habitat loss as the largest cause of biodiversity decline (Miller et al. 1989; Soulé 1990; Lodge 1993). In Brazil, introduction of non-native fishes into freshwater environments continues despite growing evidence that the presence of non-native fishes harm native fishes and fisheries (Agostinho and Julio Jr. 1996; Agostinho et al. 2005). Many fish translocations occurred during the 1960s and 1970s, most commonly this consisted of the transplant of commercially-important native species from the Amazon Basin to northeastern and southeastern sections of the country (Agostinho et al. 1994; Agostinho 1996; Agostinho and Júlio Jr. 1996). Introduced fishes that have become established in Brazil include a range of transplanted South American natives, for example *Arapaima gigas* (pirarucu), *Cichla* spp. (tucunarés) and *Prochilodus argenteus* (curimatá), as well as various species imported from other continents, such as carps and tilapias (Alves et al. 2007).

The Iguaçu River (70,800 km²) is the largest drainage area in the State of Paraná, South Brazil. Its headwaters are in the Serra do Mar, 1,000 m above sea level, near the city of Curitiba, and it flows 1,060 km west to the Paraná River near the city of Foz do Iguaçu (Paiva 1982; Figure 1). The Iguaçu River basin is considered a separate fish ecoregion (Abell et al. 2008), extremely rich in endemic ichthyofauna (Garavello et al. 1997) and many undescribed species (Pavanelli and Bifi 2009). The region's fauna is threatened by construction of numerous impoundments and by the introduction of non-native fishes (Agostinho et al. 1999). The Iguaçu River contains several rapids, falls and narrow stretches. Its channels are extremely incised in the landscape (Maack 1981) and contain a linked cascade of large reservoirs (>100 km² except Salto Osório and Segredo reservoirs) that were built since the late 1970s primarily to meet the fast-growing energy demand of this highly-populated region (Figure

1). Fish fauna of the Iguazu River basin evolved in an essentially fluvial setting compartmentalized by numerous waterfalls, some difficult to pass. Ichthyofauna remained isolated from the Paraná basin by these waterfalls, which were formed approximately 22 million years ago. The Iguazu waterfalls are considered the main cause of allopatric speciation of fish species in the Iguazu River basin and have resulting in high endemism (Agostinho et al. 1999). Several reservoirs built in the cascade increased this isolation (Severi and Cordeiro 1994; Garavello et al. 1997).

The Salto Santiago Reservoir (52°36'56"W, 25°37'46"S to 52°07'30"W, 25°46'31"S; Figure 1) is the third reservoir in the cascade and was constructed between the municipalities of Rio Bonito do Iguazu and Saudade do Iguazu. Downstream of the Salto Santiago Reservoir is the Salto Osório Reservoir and upstream is the Segredo Dam. Construction of the Salto Santiago Reservoir was completed in 1979, and it extends 80 km in length over an area of 208 km². It has a maximum volume of 6.775 x 10⁹ m³, a residence time of 50.8 days and an average depth of 35 m, and its power plant has an installed capacity of 1,420 MW (Tractebel Energia and ECSA 2002).

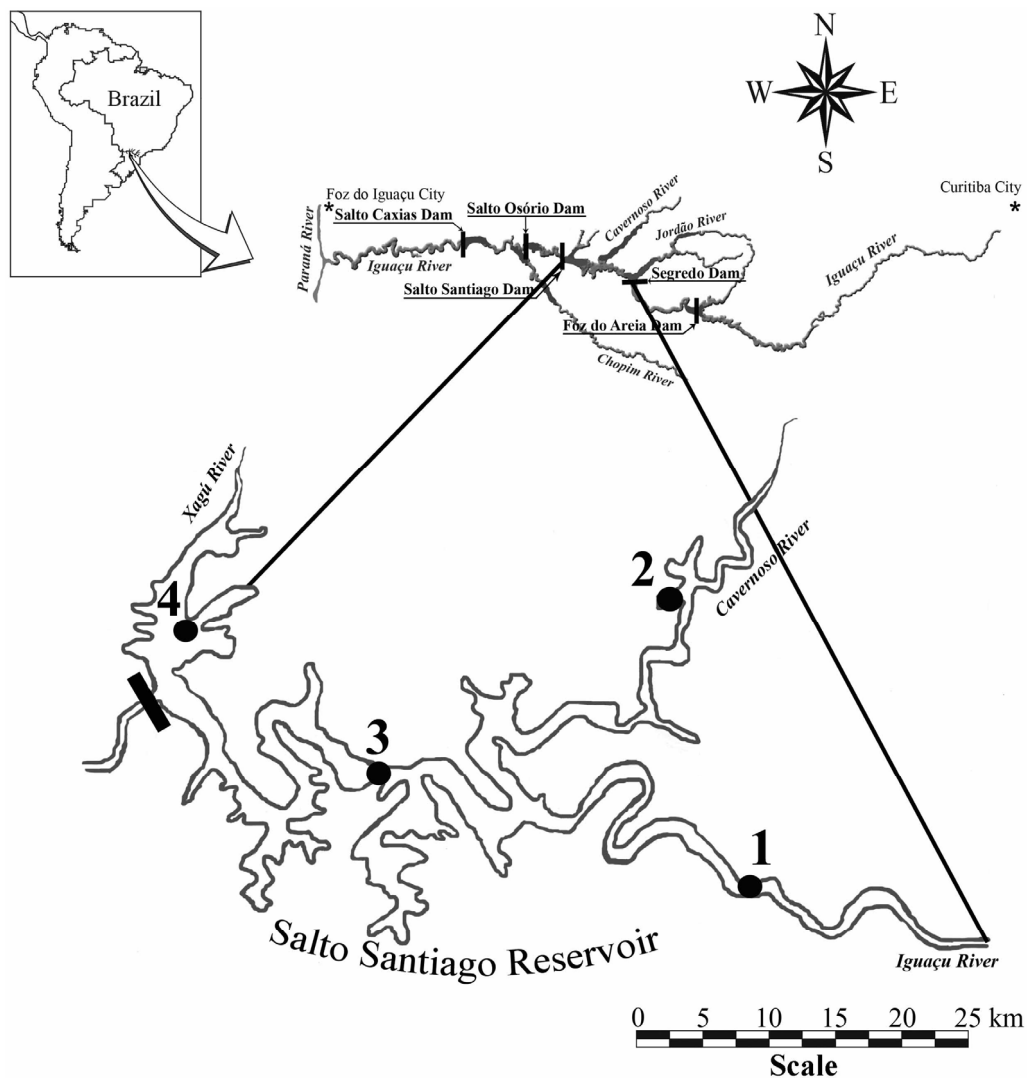


Figure 1. Map showing the Salto Santiago Reservoir. Fishes were sampled at 4 sites: 1 – Iate; 2 – Cavernoso; 3 – Porto Santana; and 4 – Barragem. The non-native *Salminus brasiliensis* (Cuvier, 1816) was taken at site 1 in January 2008.



Figure 2. Specimen of the adult female *Salminus brasiliensis* (480 mm total length) captured in the Salto Santiago Reservoir in January 2008 (Photograph by Vitor A. Frana).

Fish samples were conducted bimonthly from July 2006 to September 2008 in four sampling sites located in the Salto Santiago Reservoir (Iate 52°14'58"W, 25°44'54"S; Cavernoso 52°17'52"W, 25°35'13"S; Porto Santana 52°28'46"W, 25°40'05"S; Barragem 52°34'52"W, 25°35'02"S) (Figure 1), using gill nets (mesh size of 2.4, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.0, 12.0, 14.0 and 16.0 cm between opposite knots), trammel nets (with inner mesh size of 6.0, 7.0, and 8.0 cm between opposite knots) and long lines with 50 hooks. Nets and long lines remained set for 24 h and checked every 8 h.

During the study period, we registered the first specimen of *Salminus brasiliensis* (Cuvier, 1816) (Figure 2; Voucher number: NUP 6222) ever reported for the Iguaçú River. The specimen, an adult female, was captured in the Salto Santiago reservoir at the Iate sampling station in January 2008 (Figure 1), with gillnet, 12-cm mesh size. The fish measured 480 mm total length and 390 mm standard length. The single voucher specimen was preserved in 10% formaldehyde and deposited in the Ichthyological Collection of the “Núcleo de Pesquisas em Limnologia, Ictiologia e Aquicultura (Nupelia)”, of Maringá State University (NUP-UEM) together with preserved voucher material of other representative fish species taken during sampling of the reservoir.

Salminus brasiliensis (family Characidae), commonly known as “dorado” or “dourado,” is native to southern South American in the Paraná, Paraguay and Uruguay rivers (de la Plata River Basin), Laguna dos Patos drainage, and the Chaparé and Mamoré rivers (Amazon Basin)

(Reis et al. 2003; Graça and Pavanelli 2007). Most commonly used synonyms are *S. brevidens* and *S. maxillosus*, names often used in biological and fishery literature (Rodríguez-Olarte and Taphorn 2006). This species inhabits riverine systems, including the channels of large and small rivers and streams as well as reservoirs (Hahn et al. 2004). The reproductive period extends from October to January and mature individuals make annual spawning migrations (up to 1000 km; Petrere Jr. 1985). First maturity in females occurs at about 378 mm and in males at about 324 mm (Suzuki et al. 2004; but see Rodríguez-Olarte and Taphorn 2006). On the other hand, Barbieri et al. (2001) found 447.4 mm for females and 346.7 mm for males, in the Mogi Guaçu River, São Paulo State, to first sexual maturation. *Salminus brasiliensis* adults are aggressive predators, mainly piscivorous. Adults, in the upper Paraná River floodplain, it fed on mainly characid of small size (Almeida et al. 1997). Its maximum size nearly 1 m long (Britski et al. 1999), and highly prized by anglers (Banducci Jr. 2000; Barbieri et al. 2001). In aquaculture conditions, young *S. brasiliensis* exhibit cannibalistic behavior (Companhia Energética de Minas Gerais 2000). It ranks among the 50 most cultivated fish species in the Brazil due to reintroduction programs (Vieira and Pompeu 2001) and commercial fishing (Ostrensky 2000). Because *S. brasiliensis* is widely stocked outside its native range in South America, we were interested in learning about the potential effect of this predator on local biodiversity.

Past studies have documented that large, non-native predacious species may have negative effects on the native fish fauna. The classical example is the introduction of the Nile perch (*Lates niloticus* (Linnaeus, 1758)) to Lake Victoria that damaged the fish fauna (Goldschmidt 1996). Elvira (1995) discusses the introduction of pike (*Esox lucius* Linnaeus, 1758) and largemouth bass (*Micropterus salmoides* (Lacepède, 1802)), two predatory game species, to Iberian rivers, whose introduction negatively affected the native ichthyofauna. Additionally, Raghavan et al. (2008) emphasizes the effect of non-native fish species in a global biodiversity hotspot, the Chalakudy River of India, a system very similar to the Iguazu River because it contains many endemic species threatened with extinction. These authors affirm that the occurrence of non-native fish species in a fish diversity hotspot is of critical concern. Locally endemic and threatened fish species typically have small population sizes and are therefore highly vulnerable to further decline and possible extinction. The introduction of non-native predators is of particular concern because many native species present may lack morphological or behavioral adaptations allowing them to avoid new or novel predators (Alves et al. 2007).

Non-native introductions of *Salminus* have been documented for other parts of Brazil. A non-native population of *Salminus maxillosus* (= *Salminus brasiliensis*) was discovered in the Rio Doce Basin, Espírito Santo State, where the species became established and reportedly had a negative effect on crustacean communities and, over time, on the basin's fishes (Ruschi 1965). *Salminus* was also introduced into the Rio Paraíba do Sul Basin, Rio de Janeiro State. Introduction in that waterway provided few, if any benefits, to commercial fishermen (Alves et al. 2007). In the Brazil, others studies with another groups of larges South American predatory fishes have been related (Godinho et al. 1994; Latini and Petrere Jr. 2004; Pelicice and Agostinho 2009) and the effects on native ichthyofauna were deleterious.

In the Iguazu River, the threat to the native fish fauna is considered substantial due to the high degree of endemism (Garavello et al. 1997) and relatively small body size of many of the system's native fish species (Benedito-Cecilio and Agostinho 1997). In particular, *S. brasiliensis* has potential to negatively impact the ichthyofauna in and around Salto Santiago

reservoir where many endemic species. Among endemics present are such species as *Astyanax gymnogonys*, *Austrolebias carvalhoi*, *Hasemania maxillaris*, *Hyphessobrycon taurocephalus* and *Hasemania melanura*, native species already designated as endangered in two recent publications, the "Red book of Brazilian fauna threatened of extinction" (Rosa and Lima 2008) and the "Red book of the fauna threatened in the Paraná State" (Abilhoa and Duboc 2004). The importance of managing and maintaining native biodiversity is of critical concern. Data on habitat use, feeding habits and reproduction of the new species should be obtained and, ideally, experimental studies of direct and indirect effects of the new species should be carried out. Moreover, when examining the benefits of future introductions to sport fishery and local economies, the negative impacts to biodiversity should be considered, particularly with regard to endemic ichthyofauna.

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