



First record of the exotic species platyfish *Xiphophorus maculatus* (Günther, 1866) in an urban floodplain of a Brazilian neotropical river

Primeiro registro da espécie exótica, plati *Xiphophorus maculatus* (Günther, 1866), na área de inundação urbana de um rio neotropical brasileiro

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Abstract: Aim: This work reports the first occurrence of the exotic species *Xiphophorus maculatus* (Günther, 1866) in the Sorocaba River Basin. The introduction of non-native fish species has become common and many species have been introduced mainly through sport fishing, aquaculture and aquarium keeping. In the case of the Poeciliidae, most of the introduced species that have been recorded come aquarium keeping. The environment where the specimens were captured had a large number of macrophytes due to anthropization and is located in a strictly urbanized area of the municipality. **Methods:** The collection was done through a rectangular dip net, with measures of 70 cm x 60 cm and a mesh of 1 mm. The specimens were anesthetized in eugenol solution, fixed in 10% formalin solution and preserved in 70% alcohol. The specimens were later deposited in a scientific collection. **Results:** The record includes two female specimens from an urban wetland on the Sorocaba River, São Paulo State, Brazil. **Conclusions:** In the municipality of Sorocaba, 63 species of fish have already been identified, belonging to 7 orders and 19 families and 6 are exotic, such as the *Xiphophorus maculatus*. Urban floodplains are poorly studied environments, thus presenting great potential for the occurrence of species that have not yet been inventoried. The monitoring and inventory of exotic species must be carried out systematically so that mitigating measures can be proposed in relation to the control of these species, and this is one of the major causes of biodiversity loss. In addition, developing a program for returning unwanted fish to aquarium stores can be effective in preventing the introduction of new aquarium fish and displaying warnings informing of the negative ecological effects of releasing aquarium fish in all bags, fish plastics, and aquarium store websites.

Keywords: aquarium trade; exotic species; ornamental fish; urban floodplain.



Resumo: Objetivo: Este trabalho relata a primeira ocorrência da espécie exótica *Xiphophorus maculatus* (Günther, 1866) na bacia do Rio Sorocaba. A introdução de espécies de peixes não nativas tornou-se comum e muitas espécies foram introduzidas principalmente através da pesca esportiva, aquicultura e aquarismo. No caso dos Poeciliidae, a maioria das espécies introduzidas que foram registradas são provenientes do aquarismo. O ambiente onde os espécimes foram capturados apresentava grande quantidade de macrófitas flutuantes devido à antropização e está localizado em área estritamente urbanizada do município. **Métodos:** A coleta foi feita através de rede retangular, com medidas de 70 cm x 60 cm e malha de 1 mm. Os espécimes foram anestesiados em solução de eugenol, fixados em solução de formol a 10% e conservados em álcool 70%. Os exemplares foram posteriormente depositados em uma coleção científica. **Resultados:** O registro inclui dois espécimes femininos de um pantanal urbano no rio Sorocaba, estado de São Paulo, Brasil. **Conclusões:** No município de Sorocaba já foram identificadas 63 espécies de peixes, pertencentes a 7 ordens e 19 famílias e 6 exóticas, como o *Xiphophorus maculatus*. As várzeas urbanas são ambientes pouco estudados, apresentando assim um grande potencial para a ocorrência de espécies ainda não inventariadas. O monitoramento e inventário das espécies deve ser realizado, além de medidas para o combate as invasões, como desenvolver um programa para peixes indesejados serem devolvidos às lojas de aquários assim como a exibição de avisos informando sobre os efeitos ecológicos negativos de liberar peixes de aquário em todas as sacolas, plásticos de peixes e sites de lojas de aquários.

Palavras-chave: aquarismo; espécie exótica; peixes ornamentais; várzea urbana.

The Poeciliidae family is the second most numerous within the Cyprinodontiformes order, currently with 27 genera and 275 valid species. The Poeciliinae subfamily has 25 genera and 273 valid species (Fricke et al., 2020). The species belonging to this subfamily are recognized by a very striking feature, the presence of the gonopodium. The gonopodium is a modification of anal fin rays 3, 4, and 5 in a copulatory organ in males of this subfamily (Parenti, 1981), and is different in each species (Lucinda and Reis, 2005). The platyfish *Xiphophorus maculatus* (Günther, 1866) occurs from northeastern Mexico to southeastern Honduras in streams that flow into the Atlantic. In the last decade, the introduction of non-native fish species has become extremely common and constant in Brazil. These species have been introduced mainly through sport fishing, aquaculture, and aquarium keeping, through the aquarium trade. In the case of the Poeciliidae, most of the introduced species that have been recorded coming from aquarium keeping (i.e., aquarium dumping, Oliveira et al., 2014; Azevedo Santos et al., 2015; Magalhães & Jacobi, 2017). To be considered invasive, the species must be established (i.e., recruitment: the presence of young), thus expanding its distribution in its new habitat (Simberloff, 2013; Reaser et al, 2020). These species are considered a major threat to biodiversity around the world (Vitule, 2009), as they compete for resources and habitat, generating environmental imbalance. Poeciliids have great invasive potential and can cause changes in resource availability and native fish community structure (Ramos et al., 2020; Magalhães et al., 2021). Among the potentially

invasive species of the Poeciliidae family in Brazil, the platyfish *Xiphophorus maculatus* (Günther, 1866) is one of the most found (Magalhães et al., 2009; Magalhães & Jacobi, 2013, 2017). It can be considered a species of economic importance and is easily found for sale in aquarium stores, being widely distributed along the rivers of Brazil. This is another indication of the gap in the inventory of fish species in South America, even in places that are relatively more studied such as watersheds of southeastern and southern Brazil. Therefore, the objective of this manuscript is to detect for the first time the occurrence of the platyfish *Xiphophorus maculatus* in the Sorocaba River Basin, State of São Paulo, southeastern Brazil.

Xiphophorus maculatus specimens were collected in a lowland area of the Sorocaba River (23°25'48.95" S 47°27'07.11" W), in the urban area of the municipality of the same name, state of São Paulo, Brazil (Figures 1 and 2). The sampling was done through a rectangular dip net, with measures of 70 cm x 60 cm and a mesh of 1 mm. Fish were anesthetized and sacrificed by immersion in Eugenol, fixed in 10% formalin, and transferred to 70% alcohol. These procedures were in accordance with the 'Ethical Principles in Animal Research' guidelines adopted by the Brazilian College of Animal Experimentation (COBEA).

The species was identified by Prof. Dr. Francisco Langeani Neto, at the Ichthyology Laboratory of the Institute of Biosciences, Letters and Exact Sciences at UNESP in São José do Rio Preto. Subsequently, they were deposited at the Laboratory of Structural and Functional Ecology of Ecosystems at Universidade

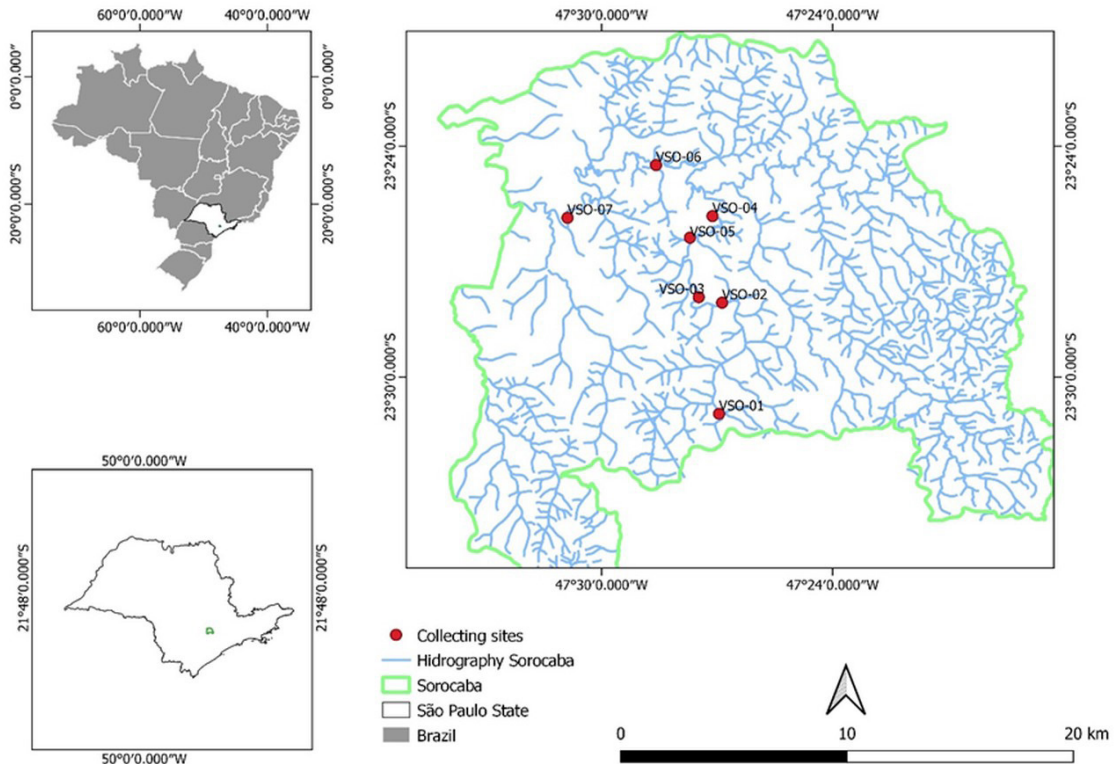


Figure 1. Floodplains sampled along the Sorocaba River, state of São Paulo, Brazil.



Figure 2. Place of specimens' samples in an urban floodplain of the Sorocaba River, São Paulo State, Brazil.

Paulista, Sorocaba campus (Voucher LEEF 0138). The samplings were carried out under authorization from the Chico Mendes Institute for Biodiversity

Conservation-ICMBio, granted through the System of Authorization and Information on Biodiversity-SISBIO, nº 24151-1, and under the authorization



Figure 3. Southern platyfish *Xiphophorus maculatus* (Günther, 1866) collected in the floodplain of the Sorocaba River, municipality of Sorocaba, São Paulo State, Brazil. Adult female, 19 mm SL.

of the Ethics Committee in the Use of Animals of Universidade Paulista (CEUA/UNIP) CEUA nº 5740090420.

The floodplain where the specimens were captured has little connection with the river, an average depth of 55 cm and a sandy substrate, and a large number of aquatic macrophytes such as *Pistia stratiotes* L. Two female specimens were collected, the first specimen measuring 1.9 cm (CP) (Figure 3), and the second specimen measuring 1.2 cm (CP). They have an elongated body, pale yellow, without spots, an upper mouth with numerous small teeth, and dorsal and ventral fins hyaline.

The platyfish was sampled for the first time in the Sorocaba River basin in habitats which are holders of a considerable native ichthyofauna. In the municipality of Sorocaba, 63 species of fish have already been identified, belonging to 7 orders and 19 families. Of these species, 6 (9.52%) are exotic (including *Xiphophorus maculatus*) (Smith et al., 2020). In addition, *Phalloceros harpagos* should be mentioned as a species that may be threatened by invasive and other small species, mainly those typical of streams and marginal areas of rivers and lakes. Invasive fish species are widely distributed along Brazilian rivers, being responsible for a great loss of biodiversity (Garcia et al., 2019; Bueno et al., 2021).

Adaptations to the Poeciliidae family organisms have several factors which facilitate invasion, such as tolerance to environments with low oxygen levels, high reproduction rate, and behavior considered generalist (Souza and Tozzo, 2013). In this Family, females do not depend on the constant presence of males to reproduce because they can retain active sperm in ovarian tissues for long periods and bear successive broods without reimpregnation.

According to Deacon et al. (2011), these attributes of invasiveness allow them to colonize any environment by themselves. Another factor that must be considered is characteristic of the place where the species was found (i.e., invasibility). The site has abundant macrophytes that provide shelters that help reduce predatory pressure on the individuals. This observation is corroborated by Magalhães et al. (2002) who consider that vegetal coverage is determining factor for the survival of invasive poeciliids introduced into new habitats.

The presence of this species in the indicated environments is mainly due to disposal by aquarists. It is known that the species *Xiphophorus maculatus*, once established in the environment, can reduce populations of microcrustaceans and macroinvertebrates (Ramos et al., 2020), altering the food chain and interfering with resources for other species, such as the native *Phalloceros harpagos*. Inventories of exotic species in the basin in question should be encouraged, so that the presence of this genus in other places can be verified. In addition, continuous awareness campaigns by wholesalers, retailers, and aquarists in the Metropolitan Region of Sorocaba should be encouraged, showing that discarding aquarium fish in natural environments is an environmental crime with imprisonment and a fine, pursuant to Federal Law No. 9605 of 1998, a strategy indicated by Oliveira et al. (2014). In addition, we recommend developing a program to return unwanted fish to aquarium stores. This procedure can reduce the introduction of new fish into the environment. We also consider it essential to display notices informing shoppers of the adverse ecological effects of releasing aquarium fish on plastic fish bags and on store websites.

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