









## Here comes the large catfish “jaú” *Zungaro jahu* (Ihering 1898) (Teleostei, Pimelodidae): a new alarming case of fish introduction in a high-endemism Neotropical ecoregion

Aqui vem o grande “jaú” *Zungaro jahu* (Ihering 1898) (Teleostei, Pimelodidae): um novo caso alarmante de introdução de peixes em uma ecorregião neotropical com alto endemismo

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**Abstract: Aim:** Non-native fish species have been closely related to serious damage to aquatic biodiversity due to their negative effects on native fauna. We aim to report the first and alarming occurrence of the non-native catfish “jaú” *Zungaro jahu* in the Iguaçu River basin above the Iguaçu Falls, a high-endemism Neotropical ecoregion for fish. **Methods:** Fish samplings were taken with a bottom gill net in the Segredo Reservoir, where they were anesthetized in benzocaine hydrochloride and fixed in formaldehyde in the field, later identified in the laboratory and housed at the Museu de História Natural do Capão da Imbuia (MHNCI). **Results:** Our recent samplings in the Iguaçu River basin recorded one non-native individual of the catfish “jaú” *Zungaro jahu* in the Segredo



Reservoir. **Conclusions:** We mainly intend to alarm about the risk of expansion of the occurrence of this non-native species throughout the cascading reservoirs in the Iguazu River where it could potentially develop serious damage to the trophic chain, predation of small-sized endemic species, and competition, especially in the sites where the endemic and endangered pimelodid “surubim-do-iguazu” (*Steindachneridion melanodermatum*) maintains viable populations, currently restricted to the Lower Iguazu River basin exhibiting recent signs of a population bottleneck.

**Keywords:** cascading reservoirs; competition; endemic species; extinction risk; non-native species.

**Resumo: Objetivo:** Espécies de peixes não nativas têm sido intimamente relacionadas aos sérios danos à biodiversidade aquática devido aos efeitos negativos sobre a fauna nativa. Nosso objetivo é relatar a primeira e alarmante ocorrência do bagre não nativo “jaú” *Zungaro jahu* na bacia do rio Iguazu acima das Cataratas do Iguazu, uma ecorregião neotropical com alto endemismo de peixes. **Métodos:** As amostragens dos peixes foram realizadas com rede de emalhar de fundo no Reservatório de Segredo, onde foram anestesiados em cloridrato de benzocaína e fixados em formol em campo, posteriormente foram identificados em laboratório e depositados no Museu de História Natural do Capão da Imbuia (MHNCI). **Resultados:** Nossas amostragens recentes na bacia do rio Iguazu registraram um indivíduo não nativo do bagre “jaú” *Zungaro jahu* no Reservatório de Segredo. **Conclusões:** Pretendemos, principalmente, alertar sobre o risco de expansão da ocorrência desta espécie não nativa ao longo da cascata de reservatórios do rio Iguazu, onde potencialmente poderá desenvolver sérios danos à cadeia trófica, predação de espécies endêmicas de pequeno porte e competição, especialmente nos locais onde o pimelodídeo endêmico e ameaçado de extinção “surubim-do-iguazu” (*Steindachneridion melanodermatum*) mantém populações viáveis, atualmente restrita à bacia do Baixo rio Iguazu, exibindo sinais recentes do efeito de gargalo.

**Palavras-chave:** cascata de reservatórios; competição; espécies endêmicas; espécies não nativas; risco de extinção.

Freshwater fish introductions can cause catastrophic ecological consequences. Non-native fish species have been very closely related to serious damage regarding biodiversity loss (Vitule et al., 2009; Pelicice et al., 2014; Moi et al., 2021) due to their negative effects on native fauna such as competition, predation, habitat alteration, hybridization, parasitism, changes in the food webs, nutrient cycling, and in the last instance, ecosystem function [see Vitule et al. (2009); Gois et al. (2015); Rodrigues et al. (2018); Ganassin et al. (2021a); Moi et al. (2021)]. Although the negative impacts of the introduction of non-native fish species have a well-structured scientific basis, several new species continue to be introduced in aquatic environments of the Neotropical region (Gubiani et al., 2018; Doria et al., 2021; Magalhães et al., 2021), especially for economic reasons (e.g. aquaculture and sport fishing; Ribeiro et al., 2017; Garcia et al., 2018; Forneck et al., 2021), often sustained by public policies disqualified from scientific and technical criteria (Pelicice et al., 2014; Ota et al., 2019; Latini et al., 2021).

The fish fauna from the Iguazu River basin in Brazil, where there is a significant number of endemic species [64, according to Reis et al. (2020); Mezzaroba et al. (2021)] is severely threatened by impoundments and the introduction of non-native species [see Baumgartner et al. (2012);

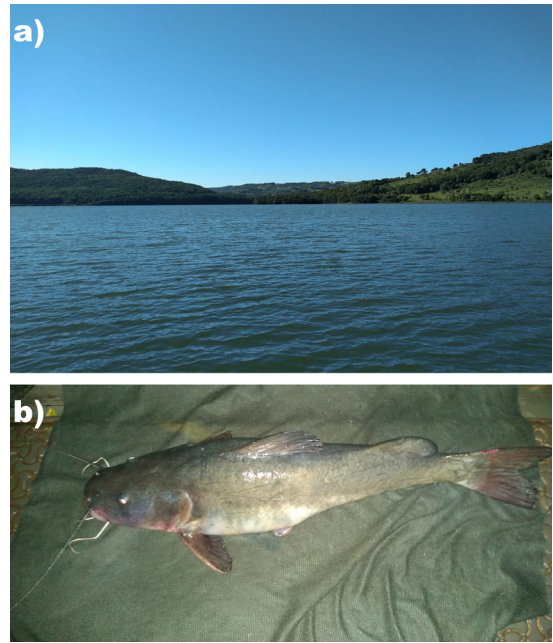
Daga & Gubiani (2012); Daga et al. (2016); Mezzaroba et al. (2021); Pini et al. (2021)]. Unfortunately, the introduction of fish species in this aquatic ecoregion is subsidized by supposed local economic attractions, sport-fishing programs, and even by the proposals of new environmental laws [see Vitule et al. (2014); Ribeiro et al. (2017); Geller et al. (2021a, b)].

Since 1944, the number of fish introductions in the Iguazu River basin has shown a steady increase (Daga et al., 2016). Current records indicate that the number of non-native fishes reached an expressive rate of 30% (40 species) of the total species recorded in this aquatic ecoregion (Gubiani et al., 2018; Mezzaroba et al., 2021). The introduction of species, in association with other environmental changes, such as deforestation, urbanization, dams, and pollution, impose severe threats to the native ichthyofauna, especially to endemic species (Baumgartner et al., 2012; Daga & Gubiani, 2012; Daga et al., 2016; Neves et al., 2018; Ganassin et al., 2021b; Mezzaroba et al., 2021). Over the last few decades, there has been a marked population decline [see Ganassin et al. (2021b)] and potential risk of extinction of native/endemic fish species in the Iguazu River basin (Instituto Chico Mendes de Conservação da Biodiversidade, 2018). Thirteen endemic fish species (20% of all endemic species from the

basin) are listed under some international level of threat, i.e., critically endangered, endangered, or vulnerable (Instituto Chico Mendes de Conservação da Biodiversidade, 2018; Standards and Petitions Committee of the IUCN Species Survival Commission, 2022; Mezzaroba et al., 2021). For example, the pimelodid “surubim-do-iguauçu” *Steindachneridion melanodermatum* Garavello 2005 is categorized as endangered (Instituto Chico Mendes de Conservação da Biodiversidade, 2018) representing the largest native fish of the basin, which nowadays only inhabiting small free-flowing river stretches and deep pools in the Lower Iguauçu River basin (Garavello, 2005; Assumpção et al., 2021a, b; Pini et al., 2021). Here we aim to report the first and alarming occurrence of the non-native catfish “jaú” *Zungaro jahu* (Ihering 1898) in the Iguauçu River basin above the Iguauçu Falls and discuss the potential ecological consequences on the native and endemic fish fauna of the basin, in particular on species phylogenetically close, as the “surubim-do-iguauçu”.

Fish samplings were taken with a bottom gill net (approximate depth of 10 m) in the night of November 1, 2021, in the Segredo Reservoir (locally named Governador Ney Aminthas de Barros Braga Hydroelectric Power Plant) at the coordinates 25°47'21.94"S/52°7'27.57"W (Figure 1a). Segredo Reservoir is the second of six Hydroelectric Power Plants along the Iguauçu River down to the Iguauçu Falls (Figure 2). The specimen was anesthetized in benzocaine hydrochloride and fixed in 10% formalin in the field. In the laboratory, it was identified according to Ota et al. (2018), transferred to 70% ethanol, and housed at the Museu de História Natural do Capão da Imbuia (MHNCI 12785).

We record one young specimen (55 cm standard length and 2,0 kg; Figure 1b) of the catfish “jaú” *Zungaro jahu* captured in the Segredo Reservoir. Captive stocks of *Zungaro jahu* in the sampled region are currently unknown. Therefore, although aquaculture or stocking activities have always comprised a significant proportion of the main vectors of fish introductions (Daga et al., 2016), we believe that the motive for the introduction was intentional, probably to aquarism (ornamental purposes) or sport-fishing purposes. Indeed, aquarism and sport-fishing are among the main vectors for fish introduction into the Iguauçu River basin (Mezzaroba et al., 2021). Given the easiness of acquiring juveniles of *Zungaro jahu* in the Brazilian aquarium market, our record could represent



**Figure 1.** Photographs were taken during fieldwork showing (a) partial view of the Segredo Reservoir located in the Iguauçu River where the capture of the (b) non-native catfish “jaú” *Zungaro jahu* (55 cm standard length) took place.

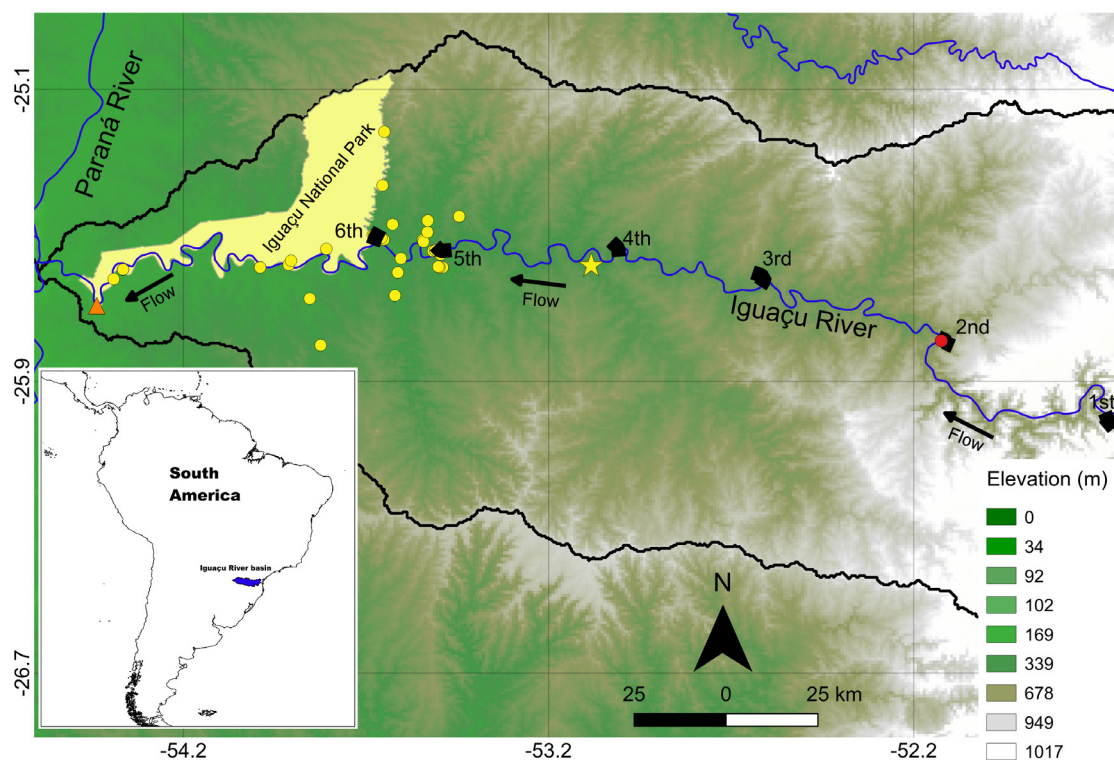
another case when the individual grows substantially in the aquarium and then is improperly released into the river, or the record may be another case attitude of recent eco-vandalism in favor of sport-fishing in the Iguauçu River basin [see Ribeiro et al. (2017)].

*Zungaro* Bleeker 1858 species can reach expressive sizes (140 cm standard length) and weigh up to 150 kg (Lundberg & Littmann, 2003; Pires et al., 2017). *Zungaro jahu* naturally inhabits the Paraná and Paraguay river basins and its natural absence in the Iguauçu River basin is very likely due to the geographic isolation provided by the Iguauçu Falls (Garavello et al., 1997; Baumgartner et al., 2012; Reis et al., 2020; Mezzaroba et al., 2021). With a piscivorous diet (Hahn et al., 2004), based mainly on small-sized fishes, this large catfish requires great daily prey biomass for growth, therefore, it can play an important top-down control in the Iguauçu River basin and may cause serious damage to populations of small-sized endemic species in this basin, e.g. *Astyanax jordanensis* Vera Alcaraz, Pavanelli & Bertaco 2009, *A. minor* Garavello & Sampaio 2010, *Diapoma potamohadros* Ito, Carvalho, Pavanelli, Vanegas-Ríos & Malabarba 2022, and *Psalidodon gymnogonys* (Eigenmann 1911), (Baumgartner et al., 2012; Ribeiro et al., 2017; Reis et al., 2020; Mezzaroba et al., 2021;

Ito et al., 2022). In addition, it is a migratory species (Agostinho et al., 2003; Alves et al., 2007) usually found in fast-flowing waters, rocky bottoms, and deep waters in stretches of rivers wherein the natural flow is preserved (Agostinho et al., 2003; Suzuki et al., 2004). Thus, there is support to expect that *Zungaro jahu* can become an invasive species in the Iguaçu basin and develop great competition for food resources and space in sites reported as ecological sanctuaries for the endemic pimelodid *Steindachneridion melanodermatum* [see Assumpção et al. (2021a, b)]. In a more pessimistic scenario, *Zungaro jahu* could contribute to extirpate or even extinguish by competition the phylogenetically close endemic species [e.g. Gois et al. (2015); Rodrigues et al. (2018); Ganassin et al. (2021a), already at serious risk of extinction.

In fact, another large pimelodid herein recorded for the first time in the Iguaçu River basin above the Iguaçu Falls could cause serious new future damages to populations of native and endemic species in this basin. Previous studies have shown that richness, biomass, and beta-diversity between

native and non-native fishes weakened over time with a gradual reduction on native, while non-native evidenced an increase in these metrics in Neotropical environments (Ganassin et al., 2021b; Magalhães et al., 2021; Moi et al., 2021). Whilst the alert is imminent, the succession of dams (cascading reservoirs) along the Iguaçu River could difficult the dispersion of this non-native species through the main river channel, from our record in the Segredo Reservoir until the arrival at the ecological sanctuaries of the “surubim-do-iguacu”. Although there are records of *Steindachneridion melanodermatum* below the fourth reservoir in cascade in the Iguaçu River (Figure 2; Salto Osório Reservoir), including the type locality [see Garavello (2005); Instituto Chico Mendes de Conservação da Biodiversidade (2018)], the species is currently restricted to environments below the Salto Caxias and Baixo Iguaçu dams, respectively, the fifth and sixth reservoirs where its last sanctuary refuges occur (Assumpção et al., 2021a, b; Pini et al., 2021). In addition to the restriction of favorable environments, the population of *Steindachneridion melanodermatum* presents an



**Figure 2.** Map highlighting the Iguaçu River basin in South America. 1st = Foz do Areia Dam; 2nd = Segredo Dam; 3rd = Salto Santiago Dam; 4th = Salto Osório Dam; 5th = Salto Caxias Dam; 6th = Baixo Iguaçu Dam. Red dot represents the site where the non-native *Zungaro jahu* was captured in the Segredo Reservoir. Yellow star represents the type locality of the endemic catfish *Steindachneridion melanodermatum* and yellow dots represent the main sites that are effective sanctuaries to this species. Orange triangle represents the Iguaçu Falls located in the Iguaçu National Park.

adequate level of genetic diversity; however, there are clear recent signs of bottleneck effects, which increases the probability of deleterious consequences related to genetic drift (Souza-Shibatta et al., 2022).

In conclusion, whatever the introduction vector of *Zungaro jahu* in the Segredo Reservoir, we are concerned that this non-native species may expand its distribution to other reservoirs along the Iguaçú River. We hope that our warning is incorporated into educational programs/citizen science to reach the population, possibly with an emphasis on sport fishers, wholesalers, retailers, ornamental fish keepers, reservoir managers, environmental managers, and environmental police, as well as representing the need for environmental programs that monitor aquatic fauna in favor of the conservation and effective management of the several endemic species living in the Iguaçú River basin, especially the endangered “surubim-do-iguaçú”.

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