

First record of the pirarucu in the Doce River basin

**BEYOND THE AMAZON: FIRST SCIENTIFIC RECORD OF THE
PIRARUCU *ARAPAIMA GIGAS* (SCHINZ, 1822) IN THE DOCE RIVER
BASIN, SOUTHEASTERN BRAZIL**

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Abstract: *Arapaima gigas* is one of the largest Neotropical freshwater fish, native to the Amazon and Araguaia–Tocantins river basins, whose distribution has recently expanded beyond its natural range due to escapes from aquaculture tanks and recreational activities. In this study, we report the first occurrence of *A. gigas* in the Doce River basin, southeastern Brazil. The record is based on one juvenile collected in a lagoon in the state of Espírito Santo in January 2025. Species identification was confirmed using diagnostic morphological characters. This finding represents a new range expansion of the pirarucu, an alert of potential colonization, and, consequently, a threat to native fish populations. Considering the long history of non-native species introductions

and environmental degradation in the Doce River basin, the presence of *A. gigas* highlights the importance of early detection and monitoring to support management actions and the conservation of native freshwater fish assemblages.

Keywords: Amazon giant; biodiversity impacts; biological invasion; non-native species.

Arapaima Müller, 1843 is a genus of Neotropical bony-tongued fishes belonging to the family Arapaimidae and comprises five species: *Arapaima agassizii* (Valenciennes, 1847), *Arapaima arapaima* (Valenciennes, 1847), *Arapaima gigas* (Schinz, 1822), *Arapaima leptosoma* Stewart, 2013, and *Arapaima mapae* (Valenciennes, 1847) (Fricke, 2025). These species are found in tropical freshwater environments across the Amazon region, spanning Brazil, Colombia, Ecuador, and Peru, as well as the Rupununi River basin in Guyana (Fricke, 2025). Among them, *A. gigas*, also known as "pirarucu" (Brazil), "warapaima" (Colombia), "arapaima" (Guyana), and "paiche" (Peru and Ecuador), is native to and commonly found in Amazonian lowlands and in the Tocantins-Araguaia river system (Farias *et al.*, 2019).

However, in recent decades, its distribution has expanded due to commercial aquaculture, releases from the ornamental fish trade (Magalhães *et al.*, 2017), and sport fishing, driven by its aesthetic appeal and high meat yield. This species is the largest scaled freshwater fish, reaching up to 3 m in length and approximately 200 kg in weight (Castello and Stewart, 2010). The giant arapaima has also been introduced into other Brazilian basins, such as the Parnaíba River basin, northeastern Brazil (Ramos *et al.*, 2014), the upper Paraná River basin (Carvalho *et al.*, 2015), and the Paranapanema River basin, in the state of São Paulo (Casimiro *et al.*, 2018). Additionally, journalistic reports have informally documented the species in the São Francisco and Paraíba do Sul River basins, as well as into other countries outside of South America, including Mexico, Java (Indonesia), and the Philippines (Fricke, 2025). Therefore, our study aimed to formally report, for

the first time, the occurrence of *A. gigas* in the Doce River basin, thereby expanding the known extent of its invasion into other Brazilian river basins.



Figure 1. Collected specimen of *Arapaima gigas*, MZUFV 13229, 16.24 cm total length (TL), Doce River basin, Cacimbas lagoon, state of Espírito Santo, Brazil. Photo by Víctor de Queiroz.

The record of *A. gigas* (Fig. 1) in the Doce River basin was obtained from one sampling event in the Cacimbas lagoon, a freshwater lagoon located in the municipality of Linhares, in the state of Espírito Santo, southeastern Brazil (19° 39' 9.14" S, 39° 52' 50.51" W) (Fig. 2 and Fig. 3). The sampling was conducted as part of Programa de Monitoramento da Biodiversidade Aquática (PMBA) for the Doce River Basin, implemented as a compensation action following the collapse of the Fundão iron ore tailings dam in Mariana, Minas Gerais. The juvenile specimen was collected on January 16, 2025, with gillnets (stretched mesh size 2.5 cm between opposite nodes). This specimen was anesthetized with eugenol at a concentration of 0.3 gL⁻¹ (Lucena *et al.*, 2013), fixed in 10% formalin, and deposited in the Ichthyology Collection of the João Moojen Zoology Museum (MZUFV) at the Federal University of Viçosa, Minas Gerais State, Brazil. The animal experimentation was approved by the Ethics Committee on Animal Use of the Federal University of Viçosa (CEUA 67/2018), and specimen collection was authorized under SISBIO license No. 64191. The specimen was identified as *Arapaima gigas* following Stewart (2013a)

and Stewart (2013b): (1) 26 maxillary teeth; (2) two to three rows of teeth on the dentary; (3) 30 teeth on the single branch of the dentary; and (4) an oval sensory cavity, more laterally positioned on the preopercle. Thus, for the first time, we confirmed the presence of *A. gigas* in the Doce River basin in January 2025, based on a collection of a single juvenile specimen in the Cacimbas lagoon in the state of Espírito Santo. This new record corresponds to an approximately 3,000 km eastward extension of its distribution range from its native range.

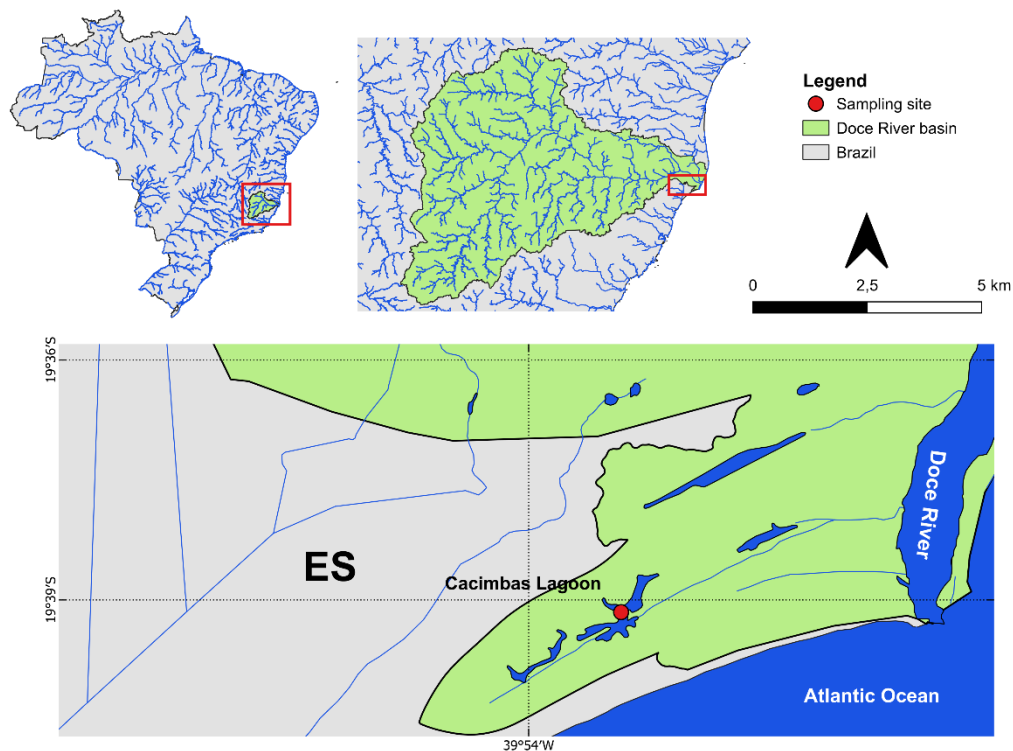


Figure 2. Map of the new record of *Arapaima gigas* in Doce River basin, state of Espírito Santo (ES), Brazil.



Figure 3. Sampling site of the *Arapaima gigas* in the Cacimbas lagoon, state of Espírito Santo, Brazil.

Arapaima gigas is threatened by overfishing for human consumption in Brazil, a threat exacerbated by its preference for lentic environments, which has led to low levels of differentiation in natural populations, endogamy (Silva and Duncan, 2016; Hrbek *et al.*, 2005), and local extinctions next to big Amazonian cities since the 1970s (Goulding, 1980). Despite

these issues, the species was listed as Near Threatened under the Brazilian endangered species list (ICMBio, 2018) and as Data Deficient globally (IUCN, 1996). As a conservation management measure, pirarucu farming in Brazil was authorized to reduce pressure on wild populations (Imbiriba, 2001; de Oliveira *et al.*, 2012), which led to its introduction into several Brazilian river basins (Carvalho *et al.*, 2015; Casimiro *et al.*, 2018) and other parts of the world, such as southeastern Peru and northwestern Bolivia, since the 1980s (Miranda-Chumacero *et al.*, 2012).

In the Doce River basin, Magalhães *et al.* (2021) reported, based on an analysis of YouTube videos, the cultivation of *A. gigas* in garden ponds followed by the release of seven individuals into an impounded stream in the state of Espírito Santo in the lower course of the basin. However, the exact location of this event was unknown. Additionally, some fishermen and local communities reported the existence of several pirarucu aquaculture tanks in the lower Doce River basin (personal communication during sampling expeditions). The collection of a juvenile pirarucu may be attributed to either an escape from one of these ponds or a new intentional introduction into the Cacimbas lagoon, given its location on private property and its use as a recreational area. The escape of pirarucu from fish farming tanks was also one of the introduction pathways into the upper Paraná River basin after a period of heavy rains (Carvalho *et al.*, 2015). Additionally, news reports indicate the presence of *A. gigas* in the Riacho River basin, adjacent to the Doce River basin. The specimen represents an adult pirarucu captured by recreational rod-and-line anglers in January 2026 at Aguiar Lagoon, within the municipality of Linhares (Sena, 2026). Furthermore, the collection of a juvenile and the occurrence of an adult in different nearby lagoons five years after the documentation of pirarucu aquaculture by Magalhães *et al.* (2021) suggest a likely establishment of this species in the north-central region of the state of Espírito Santo.

The Doce River basin has a long history of non-native species introductions dating back to the 1950s. Furthermore, on November 15th, 2015, the Doce River was deeply impacted by the

release of 50 million tons of ore-mining tailings following the rupture of the Fundão dam (Lambertz and Dergam 2015; Gomes *et al.* 2017), which represents a stressor for the aquatic biota. Non-native fish species have benefited from degraded environmental conditions, leading to population increases, intensified competition and predation, and consequent changes in ichthyofaunal dynamics, particularly affecting the conservation of native fish populations (Pelicice and Agostinho, 2009; Muniz *et al.*, 2021; Salvador *et al.*, 2022; Assis *et al.*, 2024; Souza *et al.*, 2026). Despite pirarucu larvae being susceptible to predation by several opportunistic species, such as *Tetragonopterus* spp. and *Astyanax bimaculatus* (Lima *et al.*, 2022), the adults occupy a high trophic level within the trophic chain as piscivores, feeding primarily on fish and, to a lesser extent, on invertebrates (Queiroz, 2000; Carvalho *et al.* 2018). Moreover, stable isotope analyses suggest an omnivorous feeding strategy, with piscivorous tendencies (Rejas *et al.* 2023), which pose a significant threat to native omnivorous fishes in the ecosystems where it occurs (Castello *et al.*, 2013; Marková *et al.*, 2020). Rejas *et al.* (2023) observed isotopic niche overlap between *A. gigas* and native species in Bolivian Amazon lakes, particularly with native piscivorous species. This indicates competitive interactions that could also occur in the Doce River basin in the future.

Some authors have pointed out some difficulties in establishing viable populations of *A. gigas* in other river basins due to specific physiological traits, such as temperature tolerance and dietary requirements (Imbiriba, 2001; Lawson *et al.*, 2015), as well as complex reproductive behaviors, including batch spawning, pair bonding, selection and spatial segregation of spawning sites, nest construction, and post-hatching parental care (Silva & Duncan, 2016). In the municipality of Linhares, where both lagoons are located, the mean annual temperature is 24.3 °C (Incaper, 2020), within the species' tolerance limits. Additionally, the absence of natural predators and the abundance of potential prey in the Doce River basin (Souza *et al.*, 2026), combined with the lentic nature of these lagoons, may facilitate the species' reproductive

behavior. However, records from the Parnaíba River basin, northeastern Brazil, suggest the potential for successful colonization of this species (Ramos *et al.*, 2014). Additionally, Neto *et al.* (2025) indicate the increasing occurrence of Amazonian fish species (“Amazonization”), including the pirarucu, worldwide, especially in South America and the USA. The establishment of these species depends on several factors, including the biotic characteristics of ecosystems and the traits of non-native species; the former has been increasingly favored by climate change, which has created more suitable conditions for establishment.

Our record provides evidence of the expansion of this iconic Amazonian species beyond its natural limits, likely driven by human-mediated introductions associated with aquaculture and recreational activities. Given its large body size, high trophic position, and feeding plasticity, the establishment of *A. gigas* in a basin historically impacted by non-native species raises serious concerns regarding potential ecological impacts on native fish assemblages. The Doce River basin lies at the heart of the Atlantic Forest, one of the world’s most endangered biodiversity hotspots (Myers, 2000; Mittermeier *et al.*, 2011). Nisin *et al.* (2023) highlighted the high likelihood of pirarucu invasion in the Western Ghats, another biodiversity hotspot, further emphasizing the need to control its spread to preserve rich ecosystems, as our findings do. Hence, our work underscores the urgency of early detection, continuous monitoring, and stricter management of non-native species to prevent further spread and reinforce conservation actions in Neotropical freshwater ecosystems.

ACKNOWLEDGEMENTS

We would like to thank all the fishermen and members of the Laboratório de Sistemática Molecular e Biologia da Reprodução (Beagle) for their help with the processing and fieldwork.

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Submitted: 17 January 2026

Accepted: 29 April 2026

Published online: 26 May 2026

Associate Editor: Dr. Felipe Polivanov Ottoni