Acta Limnologica Brasiliensia

Publication of the Brazilian Association of Limnology

Short Research Notes
Acta Limnologica Brasiliensia, 2024, vol. 36, e37
https://doi.org/10.1590/S2179-975X2224
ISSN 2179-975X on-line version

Use of submerged trunks by stream fishes in the Lower Negro River, Amazon

Uso de troncos submersos por peixes de igarapés no Baixo Rio Negro, Amazonas

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Cite as: Garrido, M. et al. Use of submerged trunks by stream fishes in the Lower Negro River, Amazon. *Acta Limnologica Brasiliensia*, 2024, vol. 36, e37. https://doi.org/10.1590/S2179-975X2224

Abstract: Fish make use of different microhabitats, such as submerged trunks, branches, foliage, crevices and stones, with different purposes, in search of shelter, refuge, food and even as a substrate for reproduction. The present study aimed to increase the knowledge about fish species that make use of the micro-habitat of trunks on the banks of streams in the protected area known as the Tupé Sustainable Development Reserve, Lower Negro River region, Amazonas. The data analyzed come from two days of collections, carried out in the falling water periods of 2020 in the Central stream. Six species, *Pseudanos trimaculatus*, *Tatia strigata*, *Trachelyopterichthys taeniatus*, *Trachelyopterichthys* sp. "negro", *Ancistrus dolichopterus* and *A. hoplogenys* were captured inside the submerged trunks. The order Siluriformes was the most abundant and represented (83.33%) of all individuals. The most abundant species were *T. strigata* (N=46), followed by *A. dolichopterus* (N=35). Although most species belonged to the order Siluriformes, it is worth mentioning the sampling of one Characiformes, *P. trimaculatus* (N=1). In addition, an individual of *A. hoplogenys* was found in association with eggs deposited and fixed within a trunk, displaying protective behavior. The record of these species inside trunks may be associated with their foraging site, refuge and parental care to increase the chances of survival of the offspring. Therefore, the conservation of these microhabitats is important for the maintenance of some fish species.

Keywords: ichthyofauna; microhabitats; ornamental fish; Siluriformes.

Resumo: Os peixes fazem uso de diferentes microhabitats, como troncos submersos, galhos, folhagens, fendas e entre pedras, com diversas finalidades, seja em busca de abrigo, refúgio, alimento e até como substrato para reprodução. O presente estudo teve como objetivo ampliar o conhecimento

sobre as espécies de peixes que fazem uso do micro-habitat de troncos às margens dos riachos da unidade de conservação (UC) conhecida como Reserva de Desenvolvimento Sustentável do Tupé, região do Baixo Rio Negro, Amazonas. Os dados analisados são provenientes de dois dias de coletas, realizadas nos períodos de vazantes de 2020 no igarapé Central. Seis espécies, *Pseudanos trimaculatus*, *Tatia strigata*, *Trachelyopterichthys taeniatus*, *Trachelyopterichthys* sp. "negro", *Ancistrus dolichopterus* e *A. hoplogenys* foram capturados dentro dos troncos submersos. A ordem Siluriformes foi a mais abundante e representada (83,33%) da amostra. As espécies mais abundantes foram *T. strigata* (N=46), seguida por *A. dolichopterus* (N=35). Embora a maioria das espécies seja da ordem Siluriformes, vale ressaltar o encontro de uma espécie de Characiforme, *P. trimaculatus* (N=1). Além disso, foi encontrado um indivíduo de *A. hoplogenys* associado a ovos depositados e fixados dentro de um tronco, realizando comportamento de cuidado e proteção. O encontro dessas espécies no interior de troncos pode estar associado ao local de forrageamento, refúgio e cuidado parental, a fim de aumentar as chances de sobrevivência da prole. Portanto, a conservação desses microhabitats é importante para a manutenção dos organismos aquáticos.

Palavras-chave: ictiofauna; microhabitats; peixe ornamental; Siluriformes.

Streams are fundamental environments in the Amazon Rainforest, contributing to the diversity of aquatic habitats, occurring in flooded areas (floodplains) and in *terra-firme* forests not subject to seasonal flooding (Junk et al., 1989). Despite their significance, streams remain understudied compared to other Amazon basin environments, such as lakes and rivers (Beltrão & Soares, 2019; Vieira et al., 2021; Fróis et al, 2021). These streams contain essential microhabitats such as submerged trunks and litter, serving as refuges, nurseries for egg deposition, and feeding grounds for various species (Sabino & Zuanon, 1997). Some fish species, like Loricariidae, exhibit specific preferences for certain microhabitats, such as large trunks or rocky substrates (Brejão et al., 2013). This microhabitat diversity is vital for the survival and reproduction of aquatic species in the Amazon region.

In streams, submerged trunks are common underwater structures; however, knowledge about the species that make use of this micro-habitat is still scarce. Therefore, the present study aimed to expand the knowledge regarding the fish species that make use of this microhabitat in the protected area Tupé Sustainable Development Reserve (RDS Tupé), Lower Negro River region, Amazonas.

The study was carried out in the Central stream (Figure 1), in the RDS Tupé. The samplings were carried out over two days, with a duration of two hours each, in the months of October and December 2020, which correspond to the dry period (Bittencourt & Amadio, 2007). During the low-water period, the Central stream has an average depth of about 20.47 cm and an average temperature of 27.70 °C.

In this environment, submerged trunks of over 3 m in length were identified among the banks of the stream. Then, three members of the team moved towards the chosen trunk, one responsible to remove the trunk from the water and move it towards the shore, while the other two operated hand nets to catch fish that tried to escape. In an area of approximately 16 m^2 (4 m x 4 m) around the selected submerged trunk, fish were caught with the aid of seines (5 mm between opposite knots), sieves and hand nets. Subsequently, the trunks were removed from the water in order to remove eventual fish out of the cracks and holes. In total, eight trunks were sampled, four on each day of sampling.

The samplings were carried out under licenses No. 76320-1 (SISBio/ICMBio) and No. 016/2017 (Secretary of State for the Environment, SEMA), due to SDR being a state protected area.

After the fish were removed from the trunks, photographs were taken, and the trunks were returned to the stream. The trunks were measured (meters) and categorized into five size ranges (≤ 1.0 m; ≤ 1.5 m; ≤ 2.0 m; ≤ 2.5 m and ≤ 3.0 m). The collected fish were anesthetized in a clove oil solution, fixed in 10% formalin, and placed in properly labeled plastic bags for transportation to the Ichthyology Laboratory at the Federal University of Amazonas (LABIC/UFAM). In the laboratory, each specimen was identified with the aid of taxonomy keys (Eigenmann & Eigenmann, 1889, 1890; Armbruster, 2004; Birindelli et al., 2012; Souza, 2018) and assistance from experts. The handling and manipulation of the fish was carried out under authorization issued by the Ethics Committee for the Use of Animals of the Federal University of Amazonas (CEUA/UFAM: 024/2020). All species were deposited in the Regional Ichthyological Collection of the Federal University of Amazonas.

Within the investigated trunks, we collected 21 individuals from six species (Table 1), most

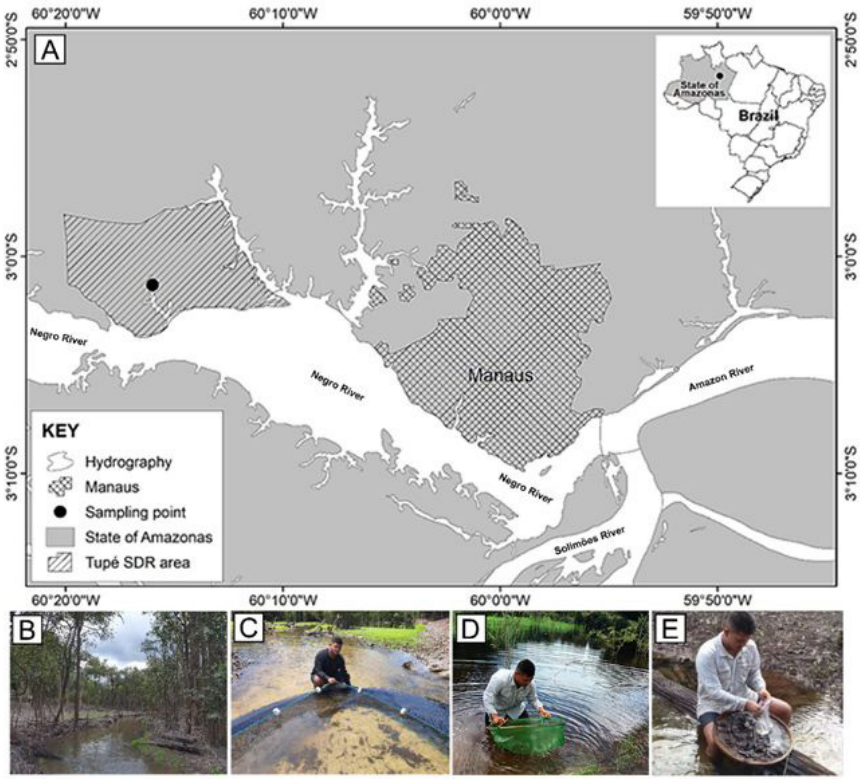

Figure 1. A) Location of the Central stream in the Tupé Sustainable Development Reserve in the Lower Negro River, state of Amazonas, Brazil; B) Igarapé Central; C) Seine used for sampling the area around the trunks; D) Hand net; and E) Sieve, used to catch the fish that tried to escape from the trunks.

Table 1. Fish species collected within submerged trunks, in the low-water period, in the Central stream of the Tupé SDR, State of Amazonas, Brazil.

Taxa	Sampling 1 (S1)		Sampling 2 (S2)		Features of trunks
	N	Trunk size (m)	N	Trunk size (m)	
Characiformes					
Anostomidae					
Pseudanos trimaculatus (Kner, 1858)	1	≤ 1.0			One trunk sampled (S1): simple trunk, i.e., only one entrance and one exit.
Siluriformes					
Auchenipteridae					
Tatia strigata Soares-Porto, 1995	9	≤ 2.5	37	≤ 1.5	One trunk collected in each sampling (S1 and S2): complex trunk, i.e., many cracks of varying sizes (Figure 2F).
Trachelyopterichthys taeniatus (Kner, 1858)	1			≤ 3.0	One trunk sampled (S2): simple trunk, i.e., only a large crack used as entrance and exit (Figure 2D and 2E).
Trachelyopterichthys sp. "negro"*	1				
Loricariidae					
Ancistrus dolichopterus Kner, 1854	7	≤ 2.0 and ≤ 2.5	30	≤ 3.0	Three trunks collected (2 trunks in S1 and 1 trunk in S2): mixed trunks, i.e., they had some cracks, but also a large entrance and exit (Figures 2A-C).
Ancistrus hoplogenys (Günther, 1864)	2		3		

Sampling 1: November 10, 2020; Sampling 2: December 11, 2020; N: number of individuals; Trunk size: length class of the sampled trunks (meters). *undescribed species (Souza, 2018).

belonging to the order Siluriformes (83.33%), followed by Characiformes (16,67%). The most representative family was Auchenipteridae (52,38%), followed by Loricariidae (42,86%) (Table 1). The most abundant species were *Tatia strigata* Soares–Porto, 1995 and *Ancistrus dolichopterus* Kner, 1854 (Table 1), while the least ones were *A. hoplogenys* and *Pseudanos trimaculatus* (Kner, 1858) (Table 1). One individual of *A. hoplogenys* was collected inside the trunk, close to its nest (Figure 2).

Trunks are microhabitats often found on the banks of streams in Amazonian environments. The most abundant species found in this microhabitat are small catfishes (Siluriformes), which in their reproductive phase make use of this specific environment for nesting and egg deposition. The use of submerged trunks by these fish has been reported previously (Ferraris Junior, 2003; Akama & Ribeiro, 2013; Calegari et al., 2019; Rocha et al., 2020).

Auchenipterids have a twilight to nocturnal habit; therefore, during the period of greater luminosity they tend to seek deeper waters where they hide, while some species seek refuge in crevices of submerged trunks and other structures (Ferraris Junior, 2003; Calegari et al., 2019). The two most abundant species in the study were *T. strigata* (Figure 2) and *A. dolichopterus* (Table 1). These species can be caught manually on woody or rocky substrates (Collins et al., 2015), usually in association with other Siluriformes (Rocha et al., 2020). In our study, the species *T. strigata*, *A. hoplogenys* and *A. dolichopterus* were found together occupying the same trunk (Figure 2).

Although most of the species found were catfishes, a species of the order Characiformes, *P. trimaculatus*, was also found. According to Ferreira et al. (2007), this species inhabits streams and, during the day, it defends its territory and feeds on invertebrates and algae that are attached to submerged trunks. Sarmiento et al. (2014) cite that this species can also remain hidden in crevices or under submerged trunks. Thus, finding the species within the trunk may be associated with its foraging and/or refuge needs (Santos & Jegu, 1996).

It was possible to observe the presence of eggs deposited inside a submerged trunk (Table 1) and, close to this nest, we found an individual of *A. hoplogenys* (Figure 2). Our hypothesis is that it was a strategy of egg care, because, according to Malabarba (2006), the females of *A. multipinis* (Regan, 1912) lay eggs in nests built in burrows in the banks of rivers or in submerged trunks; this author found females with oocytes between May and October, coinciding with one of the collection months in our study (October).

After laying the oocytes, the females of *A. multipinis* abandon the eggs, and the males take

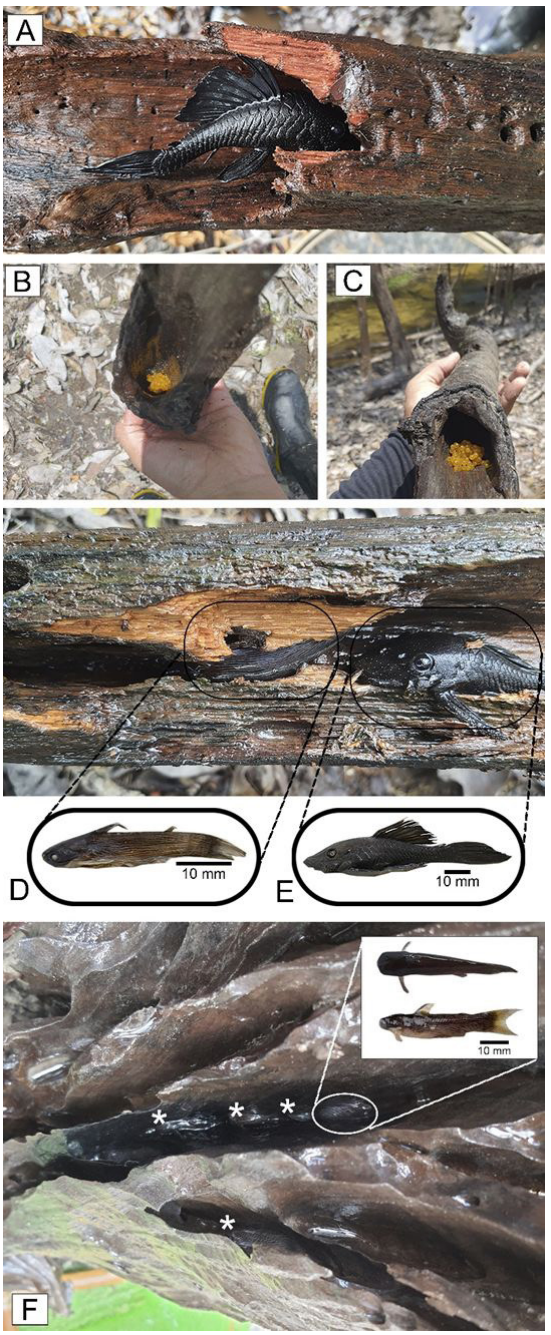

Figure 2. A) *Ancistrus hoplogenys* (Günther, 1864), B) and C) eggs of *A. hoplogenys,* D) *Tatia strigata* Soares-Porto, 1995, E) *Ancistrus hoplogenys* (Günther, 1864) and F) *Tatia strigata* Soares-Porto, 1995 in trunks sampled in the Central stream of the Tupé SDR, in the region of the Lower Rio Negro, state of Amazonas, Brazil. "*" indicates each fish.

care of them until the larval stage. In this situation, males display aggressive behavior (Malabarba, 2006). The author also cites that males use their mouths and pectoral fins to clean and aerate the eggs. The species occurred in simple and/or complex trunks. Finding these species inside trunks may be associated with their place of foraging, refuge and reproduction (egg deposition), which must increase the chances of survival of the offspring. Complex habitats play a crucial role in structuring the ichthyofauna. In environments with submerged trees, catches per unit effort (CPUEn) were nearly twice than those in non-structured areas (Gois et al., 2012). The same pattern was observed for floating litter bank habitats, which harbor a rich assembly of fish; these habitats serve as refuges during peak flood seasons (Carvalho et al., 2013) and also during dry periods when predation risk is greater.

Despite the sampling limitation of the study (collected over two days), the importance of submerged log habitats for stream fish fauna is evident. Therefore, further studies are needed to assess whether ecological attributes such as diversity, richness, and functional aspects are affected in more or less structured habitats, and whether these potential differences are influenced by river level. Furthermore, the species identified in the study exhibit ornamental appeal, underscoring the need for additional research, especially considering their potential use as ornamental species. Therefore, the conservation of these microhabitats is essential for maintaining aquatic organisms, as they provide conditions that maximize reproductive success and fish growth.

Acknowledgements

The authors would like to thank Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES), Universidade Federal do Amazonas (UFAM), Fundação de Amparo à Pesquisa do Estado do Amazonas (FAPEAM), Laboratório de Ictiologia (LABIC/UFAM), "Seu Pepe" and Alice Carolina for assistance during the collections, as well as the researcher Hélio Beltrão for assistance during species identification.

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Received: 07 March 2024
Accepted: 07 August 2024

Associate Editor: Fernando Mayer Pelicice