



ECOLOGICAL ASPECTS OF METAZOAN PARASITES IN *Trachelyopterus galeatus* (SILURIFORMES: AUCHENIPTERIDAE) FROM THE PERICUMÃ RIVER, STATE OF MARANHÃO, NORTHEAST BRAZIL

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Abstract: The driftwood catfish, *Trachelyopterus galeatus*, is widely distributed in South American rivers and plays crucial role in the transfer of energy from terrestrial to aquatic ecosystem. Despite this importance, the structure of the parasite community of *T. galeatus* has not yet been investigated for lowlands of Maranhão State, Brazil. We evaluated 57 specimens of *T. galeatus* bought from local fisherman at Pericumã river (2°32'22"S, 45°04'27"W), municipality of Pinheiro. Parasitological analysis revealed that 27 hosts were infected with at least one parasite taxon, with a mean of 1.07 ± 1.82 parasites per fish. We found three parasite taxa: a branchiuran, a digenetic and a nematode (larva); all with aggregated distribution. The presence of both adult and larvae indicated that *T. galeatus* occupies an intermediate trophic level. The community had low diversity and was dominated by the digenean *Doradamphistoma parauchenipteri*. Fish sex and body length had little influence on the structure of the parasite community.

Keywords: catfishes; freshwater; helminths; parasitic crustaceans; parasite community.

The state of Maranhão it is a famous place of transition between the Amazonia and Semi-Arid ecosystems of Brazil (UEMA 2016). In this locality, the lowlands of Maranhão are a vast region with a rich biodiversity, in particular fishes, encompassing the rivers, Aurá, Mearim, Pericumã, Pindaré, and Turiaçu, which form a complex of wetlands (Limeira-Filho *et al.* 2023). The Pericumã Hydrographic Basin consists of an extremely complex aquatic environment, with diverse structures, functions and high biological diversity,

where fishing is one of the main economic activities for local communities (Marques *et al.* 2021, Mello *et al.* 2021). This unique aquatic pattern together with fish attributes such as sex, body size, behavior, and feeding habits, may affect parasite community structure (Kennedy & Bush 1994, Neves *et al.* 2013). However, only the study of Mello *et al.* (2021) is known to evaluate the parasitic fauna in fishes from the Pericumã river basin.

The driftwood catfish, *Trachelyopterus galeatus* (Linnaeus, 1766) (Siluriformes: Auchenipteridae), locally called “bagrinho”, is widely distributed in rivers throughout South America, being found in the Amazonas, Orinoco, Paraguay, Paraná and São Francisco basins (Michelan *et al.* 2024), Caroni River, and Trinidad Island in the West Indies (Fricke *et al.* 2024). This species is well-adapted to hypoxic environments and is able to survive hours emerged (Sousa *et al.* 2017). Regarding its biology, *T. galeatus* is omnivorous, feeding on small fishes, arthropods, worms and sometimes fruits, which makes this species an important link in the transfer of energy from the terrestrial to the aquatic system (Sousa *et al.* 2017, Froese & Pauly 2024). In the lowlands of Maranhão, only the nematode *Contraecaecum* sp. and an unidentified species of cestode were recorded in this host (Mello *et al.* 2021). Therefore, with the ecological importance of this siluriform and the scarcity of studies about fish parasites in

the Maranhão State, the present study aimed to evaluate, for the first time, the community structure of the metazoan parasites of *T. galeatus* from the Pericumã river.

From September to December 2023, we evaluated 57 specimens of *T. galeatus* (total length: 9.5 ± 18.0 [12.9–2.1] cm; weight 20.0 ± 80.0 [37.4–17.4] g) captured in the Pericumã River ($2^{\circ}32'22''\text{S}$, $45^{\circ}04'27''\text{W}$) (Figure 1), near the municipality of Pinheiro, State of Maranhão, Northeast Brazil. Fishes were bought directly from local fisherman and transported in isothermal boxes to the Aquatic Organisms Laboratory, located at the Universidade Federal do Maranhão/Bacanga Campus. Most of the fishes were analyzed fresh, but some were maintained frozen at -20°C , prior to examination.

Fish taxonomic identification was according to Santos *et al.* (2004), and nomenclature and classification updated according to Eschmeyer’s Catalog of Fishes (Fricke *et al.* 2024). After

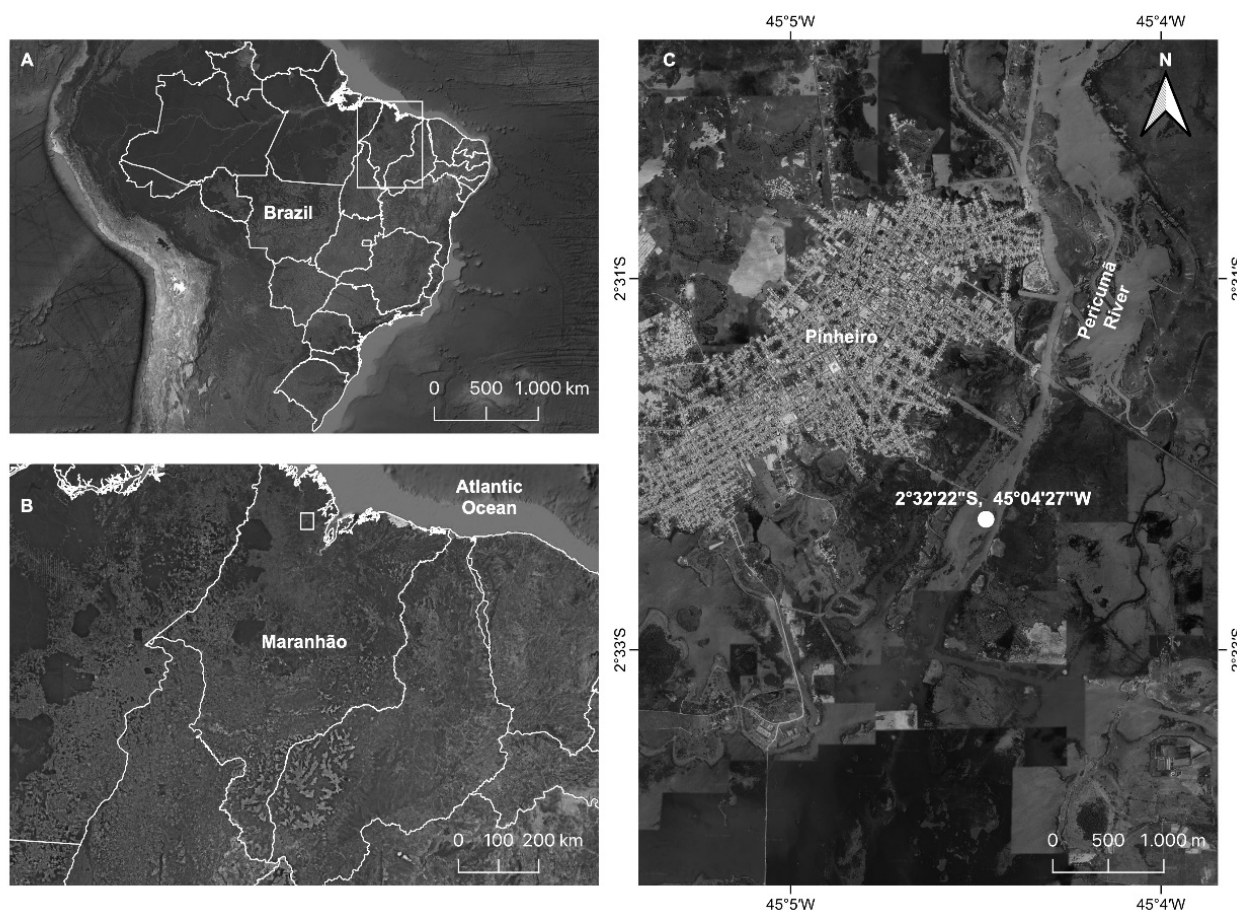


Figure 1. Map indicating the sampling site of the present study (modified from Google Earth): (A) Brazil, showing position of the State of Maranhão (at the center of the white square); (B) State of Maranhão, showing the municipality of Pinheiro; (C) Pericumã River, with the white dot, georeferenced, showing sampling site.

identification, the fishes were necropsied to study their metazoan parasite infracommunities, and all organs, body cavities, and body surface were examined. The metazoan parasites were collected and processed according to standard parasitological techniques (Eiras *et al.* 2006). The taxonomic identification was carried out using an optical microscope and based on the literature of Moravec (1998), Thatcher (2006) and Pantoja *et al.* (2019).

To evaluate the parasite community structure, we considered prevalence, mean intensity and mean abundance as population descriptors, according to Bush *et al.* (1997). Confidence intervals (95% CI) for prevalence were calculated using the Sterne interval method, and for mean intensity as well as mean abundance by bootstrap tests ($n = 2000$) (Reiczigel *et al.* 2019).

Diversity measured by Brillouin index (HB), frequency of dominance and parasite richness were used as community descriptors (Rohde *et al.* 1995, Magurran 2004). The discrepancy index (D ; which ranges from 0 = fully random or uniform to 1 = fully aggregated) was used to evaluate the distribution of parasite species within the host population (Poulin 1993). The difference in body length between male and female fishes was tested using the Mann-Whitney test (U) (Zar 2010). Differences in abundance of each parasite species and HB between male and female hosts were evaluated using the Mann-Whitney test (Zar 2010). The correlation between host body length and abundance of each parasite species or HB was tested using Spearman rank correlation (rs) (Zar 2010). Differences in parasite prevalence between male and female hosts were evaluated using Fisher's exact test (Zar 2010).

Only non-parametric inferential statistics were used because the data distribution was not normal, even after transformation, and the statistical significance level was evaluated at $p \leq 0.05$ (Zar 2010). Analyses were performed using the *software* Quantitative Parasitology (Reiczigel *et al.* 2019) and RStudio (RStudio Team 2020).

A total of three parasite taxa were collected in 57 *T. galeatus* analyzed (Table 1). *Dolops* sp. could not be assigned to a specific species due to its unique morphological characteristics, which differed it from the other 12 known species of the genus. Twenty-seven hosts (47%) were parasitized by at least one taxon of parasite and a total of 61 metazoan parasite specimens was collected, with mean 1.07 ± 1.82

parasite/fish. The mean parasite species richness was 0.56 ± 0.68 . Twenty-three specimens (40%) were infected by a single parasite species, three (5%) were infected with two species and one (2%) was infected with three species. The nematode *Cystidicoloides* sp. was the most abundant species, representing 55% of the metazoan parasites collected; in contrast, the digenean *Doradamphistoma parauchenipteri* (Lunaschi 1985) was the most prevalent and dominant species (Table 1). All parasites of *T. galeatus* had the typical aggregated distribution pattern observed in most macroparasite systems (see Table 1). The mean HB of the parasite component community was 0.03 ± 0.11 (0.00–0.57).

The average total length of male (12.9 ± 2.22 , $n = 29$) and female (13.1 ± 2.03 , $n = 28$) fishes in the studied sample was not significantly different ($U = 377$, $p = 0.643$). The HB was not different between male and female hosts ($U = 392$, $p = 0.823$) and was not correlated with fish body length ($rs = 0.236$, d.f. = 55; $p = 0.076$). The abundances of the nematode *Cystidicoloides* sp. ($U = 308$, $p = 0.117$), of the digenean *D. parauchenipteri* ($U = 318$, $p = 0.16$) and of the crustacean *Dolops* sp. ($U = 393$, $p = 0.835$) were not different between male and female hosts. The abundance of the digenean *D. parauchenipteri* was positively correlated with the host total length ($rs = 0.450$, $p < 0.001$). The only difference regarding the parasitism between male and female hosts was in the prevalence of *Cystidicoloides* sp., which was higher in females (17.5%) than in males (5.2%) ($X^2 = 5.20$, $p = 0.029$).

Previous studies of the parasite fauna of *T. galeatus* have reported 22 taxa (larvae and adults) in Brazil, including Monogenea (7), Digenea (5), Nematoda (5), Cestoda (1), Protozoa (3) and Copepoda (1), of which 16 of these taxa have been reported in Paraná River floodplain (State of Paraná), seven in Igarapé Fortaleza basin, tributary of the Amazon River, (State of Macapá), two in Mogi-Guaçu River (State of São Paulo) and one in the Paraná River basin (State of Mato Grosso do Sul) (see Pantoja *et al.* 2016; Hasuike *et al.* 2023; Locke *et al.* 2020; Michelan *et al.* 2024). The presence of *D. parauchenipteri* and *Cystidicoloides* sp. have been reported in this host (Michelan *et al.* 2024); however, the presence of the argulid *Dolops* sp. represents a new parasite record for this host. The present results support that *T. galeatus* has a well-known parasite fauna.

Table 1. Metazoan parasites of *Trachelyopterus galeatus* associated with their parasitological descriptors (prevalence - P; mean intensity - MI; mean abundance and range in parentheses - MA; standard deviation - SD), 95% confidence intervals (CI), frequency of dominance (FD), discrepancy index (D) and site in host from the Pericumã River, northeast Brazil.

Parasite species	P(%)	CI(P%)	MI±SD	CI(MI)	MA±SD	CI(MA)	FD(%)	D	Site in host
Nematoda									
<i>Cystidicoloides</i> sp. (larva)	22.8	13.47 – 35.85	2.62 ± 2.56	1.62 – 4.62	0.60 ± 1.62 (0–10)	0.30 – 1.19	21	0.855	Mesenteries
Digenea									
<i>Doradamphistoma parauchenipteri</i>	24.6	14.65 – 37.63	1.57 ± 0.85	1.21 – 2.07	0.39 ± 0.79 (0–4)	0.21 – 0.63	22	0.799	Intestine
Branchiura									
<i>Dolops</i> sp.	8.8	3.53 – 19.09	1	-	0.08 ± 0.28 (0–1)	0.02 – 0.16	3	0.897	Operculum

The community of parasites in *T. galeatus* from Pericumã River was numerically dominated by endoparasites, while the ectoparasite *Dolops* sp. was poorly represented. In fact, of the three species of parasites found in the present study, the larval stage of *Cystidicoloides* sp. was the most representative. Among cystidicolid nematodes, adult forms of the genus *Cystidicoloides* Skinker, 1931 are found strictly from freshwater fishes in the Neotropical region (Pereira *et al.* 2018), and the presence of this nematode in the third larval stage in *T. galeatus* indicates that this fish may be an important paratenic host in Maranhão rivers. Regarding the distribution of the organisms, the parasite species of the present study exhibited the typical aggregated pattern, which is the most common for parasite populations (Poulin 1993, 2007).

In the present study, the digenean *D. parauchenipteri* was the most prevalent and dominant species in the parasite community of *T. galeatus* and its abundance was positively correlated with the body length of the hosts. In the case of digeneans, this relationship is expected as a consequence of the fish growth and is commonly explained by ontogenetic changes in diet composition and spatial availability of the hosts (Polyanski 1961, Tavares & Luque 2004, Soares *et al.* 2014). Details of the life cycle of digeneans that parasitize fishes are scarce, but it is well known that mollusks act as the first intermediate obligatory hosts (Cribb *et al.* 2003, Paschoal *et al.* 2024). Sousa *et al.* (2017) identified a total of 12 animal prey items in the diet of *T. galeatus*, in which there was preference for mollusks and shrimps, while insects (those that live at least one stage of the life cycle in the aquatic environment: Coleoptera, Odonata, Diptera, Ephemeroptera, Hemiptera, Trichoptera) and fishes were less consumed. The present findings are possibly related to cumulative infection, in which the consumption of potential intermediate hosts of this digenean (*e.g.*, mollusks) increases proportionally with fish body growth.

For some authors, sex of the host does not appear to influence parasite populations, mainly when fish populations share the same habitat, behavior and feeding habits (Tavares & Luque 2004, Neves *et al.* 2013). Regarding the biology of *T. galeatus*, both sexes reach sexual maturity at similar body length and share similar reproductive behaviors. Notably, females exhibit internal fertilization and

can store sperm for up to several months after mating (Meisner *et al.* 2000, Garcia *et al.* 2020). The fact that the prevalence of *Cystidicoloides* sp. was higher in females of *T. galeatus* may be explained by casual factors which can increase the susceptibility of females to parasites and pathogens, such as changes in gonadal hormones, sample size, immune system competence and even pregnancy, and so influencing the endoparasite loads (Poulin 1996, Lizama *et al.* 2005).

According to Luque *et al.* (2017), parasite richness and diversity tend to be high for freshwater fishes in South America. However, the parasite community of *T. galeatus* from Pericumã River does not corroborate this pattern, as it exhibited low diversity and parasite indexes, and when compared to previous studies on this host (Pantoja *et al.* 2016; Hasuike *et al.* 2023). Nevertheless, the present study represents an initial step toward understanding the patterns of the parasite community of *T. galeatus* in the lowlands of Maranhão.

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