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Low levels of crustacean parasite infestation in fish species from the Matapi River in the state of Amapá, Brazil

Baixos níveis de infestação de parasitos crustáceos em espécies de peixes do Rio Matapi no estado do Amapá (Brasil)

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Abstract

This first study investigated the crustacean parasite fauna in 66 species of fish from the Matapi River basin, state of Amapá (Brazil). Fish were collected every two months between March 2012 and August 2013, encompassing dry and rainy seasons. Among the 66 species examined (corresponding to 722 fish specimens) only 11 species were parasitized. The infestation prevalence was 2.2%, and a total of 48 specimens of parasites were distributed between three different parasite groups. These included *Argulus elongatus*, *Dolops reperta* and *Argulus multicolor* (Branchiura), *Ergasilus xinguensis* and *Gamidactylus* sp. (Copepoda), and Isopoda (*Braga patagonica*), but branchiuran species were predominant. This was the first report of these parasite species for *Leporinus fasciatus*, *Astyanax bimaculatus*, *Curimata incompta*, *Pygocentrus nattereri*, *Crenicichla cincta*, *Crenicichla johanna*, *Geophagus camopiensis*, *Pterophyllum scalare*, *Plagioscion squamosissimus*, *Hypostomus plecostomus* and *Propimelodus eigenmanni*. Lastly, this study expands the range of occurrence of these six parasite species to the Matapi River basin in eastern Amazon.

Keywords: Amazon, ectoparasites, freshwater fish, infestation.

Resumo

Este primeiro estudo investigou a fauna parasitária de crustáceos em 66 espécies de peixes da bacia do Rio Matapi, estado do Amapá (Brasil). Os peixes foram coletados bimestralmente no período de março de 2012 a agosto de 2013, nas estações de estiagem e chuvosa. Entre as 66 espécies (correspondendo a 722 espécimes) somente 11 espécies estavam parasitadas. A prevalência de infestação foi 2,2% e um total de 48 espécimes foram distribuídos em três grupos de parasitos. Esses incluem Branchiura (*Argulus elongatus*, *Dolops reperta* e *Argulus multicolor*), Copepoda (*Ergasilus xinguensis* e *Gamidactylus* sp.) e Isopoda (*Braga patagonica*), mas a dominância foi de espécies de branchiuras. Este foi o primeiro relato dessas espécies de parasitos para *Leporinus fasciatus*, *Astyanax bimaculatus*, *Curimata incompta*, *Pygocentrus nattereri*, *Crenicichla cincta*, *Crenicichla johanna*, *Geophagus camopiensis*, *Pterophyllum scalare*, *Plagioscion squamosissimus*, *Hypostomus plecostomus* e *Propimelodus eigenmanni*. Por fim, este estudo expande a ocorrência dessas seis espécies de parasitos para a bacia do Rio Matapi na Amazônia oriental.

Palavras-chave: Amazônia, ectoparasitos, peixes de água doce, infestação.

The Matapi River basin is located in the coastal-estuarine sector of the state of Amapá, within the municipality of Santana (Brazil). The Flexal and Pirativa rivers and the Maruanum and Lago creeks are the main tributaries of the basin. The predominant vegetation is composed of aquatic macrophytes. There is still little human influence in this basin, despite various urban and agricultural activities. This basin is flooded daily by tides of the Amazon River, which considerably influence the hydrodynamics of the floodplain forest environments and other flooded areas (CUNHA et al., 2011; SILVA et al., 2016).

The highest water velocities, reaching approximately 1 m/s, occur during relatively short periods, amounting to close to two-fifths of the complete tidal cycle (12.9 h). Outside of these periods, the water velocity is approximately 0.5 m/s (CUNHA et al., 2011). Consequently, these hydrodynamic conditions also influence the lives of the 104 known species of fish in this basin, which include Characiformes (70.2%), Cichliformes (17.2%), Siluriformes (8.8%), Clupeiformes (1.7%), Tetraodontiformes (1.6%), Gymnotiformes (0.2%) and Beloniformes (0.05%) (SILVA et al., 2016). Despite

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the rich ichthyofauna of the Matapi River, little is known about the diversity of crustacean parasites infesting these fishes.

Among crustaceans, there are many ectoparasites of fish. These are found in various habitats and require a host during at least one phase of their life cycle (MAMANI et al., 2004; TAVARES-DIAS et al., 2015; OLIVEIRA et al., 2017). Ergasilidae, Argulidae, Lernaeidae, Lernaeopodidae and Cymothoidae are the families most frequently found, and these infest the gills, oral cavity, nostrils and tegument of fish in Brazil. Parasitic crustaceans are just some of the ectoparasites taxa found on freshwater fish species in Brazil (TAVARES-DIAS et al., 2015). Many of these parasites have received significant attention because of the damage that they cause to fishery resources, which includes reduced fish growth, reproduction and host activities such as natation (MAMANI et al., 2004; TAVARES-DIAS et al., 2015). Some of these parasite crustaceans require specific fish as hosts and parasitize specific sites, particularly in fish with certain lifestyles, while other parasites do not have any preferences (TAVARES-DIAS et al., 2015; OLIVEIRA et al., 2017). Thus, some species of these ectoparasites have a broad pattern of distribution in different places, while others are restricted to certain geographical areas (TAVARES-DIAS et al., 2015) and host species.

The objective of the present study was to investigate the species of crustaceans infesting the gills of 66 species of fish in the Matapi River basin, in state of Amapá, northern Brazil.

Between March 2012 and August 2013, 66 species of fish were sampled every two months from the Matapi River (Table 1), in the municipality of Santana, state of Amapá, Brazil (Figure 1) for analyses on crustacean parasites in their gills, operculum and tegument. Fish were collected using gill nets of various mesh sizes (20, 25, 30, 35, 40 and 70 mm between knots), matapi traps, casting nets, hand lines and longlines, and the mean duration of fishing was 8 hours. Sampling was conducted in two seasonal periods: the dry period between July and November 2012 and in August 2013 (temperature of 28.3 ± 1.6 °C, pH 5.5 ± 0.7, electrical conductivity 3.1 ± 1.9 µS/cm, suspended solids 24.0 ± 22.5 mg/L, transparency 83.9 ± 55.3 cm and rainfall 100.5 ±128.1 mm); and the rainy period between March and May 2012 and between January and March 2013 (temperature of 27.6 ± 1.0 °C, pH 5.5 ± 0.6, electrical

Table 1. Body parameters of the fish species collected in Matapi River, state of Amapá (Brazil).

Order/Family/Species	N	Weight (g)	Length (cm)
CHARACIFORMES			
Acestrorhynchidae			
Acestrorhynchus falcatus Bloch, 1794	2	88.0 ± 8.4	23.5 ± 0.7
Acestrorhynchus falcirostris Cuvier, 1819	2	62.0 ± 0	17.8 ± 0.4
A**nostomidae**			
Leporinus fasciatus Bloch, 1794	2	165.6 ± 110.9	22.7 ± 9.6
Leporinus friderici Bloch, 1794	50	44.6 ± 31.2	14.0 ± 3.8
Schizodon fasciatum Spix & Agassiz, 1829	1	85.0 ± 34.8	18.7 ± 2.0
Characidae			
Astyanax bimaculatus Linnaeus, 1758	75	11.7± 4.8	8.2 ± 0.9
Bryconamericus stramineus Eigenmann, 1908	5	20.4 ± 8.0	12.2 ± 1.1
Hemibrycon surinamensis Géry, 1962	4	13.5 ± 5.7	7.6 ± 0.4
Moenkhausia lepidura Kner, 1858	8	9.6 ± 5.5	9.5 ± 1.5
Tetragonopterus chalceus Spix & Agassiz, 1829	40	19.6 ± 17.4	9.3 ± 2.1
Triportheidae			
Triportheus albus Cope, 1872	1	12.0 ± 0	12.5 ± 0
Triportheus angulatus Spix & Agassiz, 1829	4	51.5 ± 15	15.1 ± 1.6
Triportheus elongatus Günther, 1864	2	135.0 ± 9.8	23.7 ± 0.3
Triportheus rotundatus Jardine, 1841	1	32.0 ± 0	10.0 ± 0
Curimatidae			
Curimata acutirostris Vari & Reis, 1995	1	64.0 ± 0	16.0 ± 0
Curimata cyprinoides Linnaeus, 1766	8	45.7 ± 30.1	13.5 ± 3.0
Curimata incompta Vari, 1984	132	33.7 ± 17.9	12.5 ± 2.7
Curimatella alburna Muller & Troschel, 1844	1	96.0 ± 0	18.5 ± 0
Curimata inornata	5	30.0 ± 6.0	10.1 ± 0.8
Cynodontidae			
Rhaphiodon vulpinus Spix & Agassiz, 1829	1	28.0 ± 0	15.0 ± 0
Erythrinidae			
Hoplias malabaricus Bloch, 1794	2	68.0 ± 28.2	16.7 ± 0.3
Hemiodontidae			
Hemiodus unimaculatus Bloch, 1794	48	30.8 ± 13.1	12.4 ± 3.2

N: Sample number.

Table 1. Continued...

Order/Family/Species	N	Weight (g)	Length (cm)
Serrasalmidae			
Metynnis lippincottianus Cope, 1870	89	11.1 ± 6.8	7.4 ± 1.2
Myleus rubripinnis Muller & Troschel, 1844	4	41.5 ± 33.1	10.3 ± 2.5
Pygocentrus nattereri Kner, 1858	6	36.6 ± 28.7	10.5 ± 2.5
Serrasalmus calmoni Steindachner, 1908	4	24.2 ± 31.9	9.7 ± 2.8
Serrasalmus rhombeus Linnaeus, 1766	9	17.7 ± 20.5	6.5 ± 2.5
Serrasalmus spilopleura Kner, 1858	6	14.6 ± 9.8	9.3 ± 2.5
CLUPEIFORMES			
Engraulidae			
Anchoviella guianensis Eigenmann, 1912	3	6.6 ± 1.1	8.0 ± 2.5
Lycengraulis batesii Günther, 1868	1	16.0 ± 0	14.0 ± 0
Pterengraulis atherinoides Linnaeus, 1766	4	45.0 ± 23.0	16.6 ± 2.1
Pristigasteridae			
Ilisha amazonica Miranda Ribeiro, 1920	3	26.6 ± 3.0	14.8 ± 1.0
Pellona flavipinnis Valenciennes, 1847	2	86.0 ± 16.9	19.2 ± 1.7
Pellona harroweri Fowler, 1917	1	286.0 ± 0	34.5 ± 0
Pristigaster cayana Cuvier, 1829	3	1.5 ± 0.5	5.0 ± 1.0
GYMNOTIFORMES			
Gymnotidae			
Gymnotus carapo Linnaeus, 1758	1	10.0 ± 0	15.5 ± 0
CICHLIFORMES			
Cichlidae			
Crenicichla cincta Regan, 1905	1	0.188 ± 0	24.0 ± 0
Crenicichla johanna Heckel, 1840	2	136.0 ± 73.5	21.7 ± 3.8
Crenicichla strigata Günther, 1862	2	25.0 ± 21.2	13.2 ± 4.5
Geophagus camopiensis Pellegrin, 1903	4	47.2 ± 22.2	13.5 ± 2.7
Mesonauta festivus Heckel, 1840	6	19.6 ± 10.8	9.5 ± 1.5
Pterophyllum scalare Schultze, 1823	12	9.8 ± 5.4	7.6 ± 1.5
Sciaenidae			
Pachypops fourcroi La Cepède, 1802	4	18.6 ± 13.2	11.6 ± 2.2
Plagioscion auratus Castelnau, 1855	14	101.6 ± 86.6	19.9 ± 5.5
Plagioscion squamosissimus Heckel, 1840	51	56.3 ± 54.4	15.7 ± 5.7
Plagioscion surinamensis Bleeker, 1973	5	13.6 ± 8.1	8.9 ± 3.1
Eleotridae			
Eleotris pisonis Gmelin, 1789	1	2.0 ± 0	6.0 ± 0
SILURIFORMES			
Ageneiosidae			
Ageneiosus ucayalensis Castelnau, 1855	10	55. 8 ± 19.6	19.8 ± 4.5
Auchenipteridae			
Centromochlus heckelii De Filippi, 1853	9	2.1 ± 0	5.9 ± 1.1
Parauchenipterus galeatus Linnaeus, 1766	1	38.0 ± 0	15.5 ± 0
Heptapteridae			
Pimelodella eigenmanni Boulenger, 1891	8	18.0 ± 8.3	16.1 ± 2.1
Pimelodella altipinnis	7	29.7 ± 4.3	13.1 ± 0.8
Loricariidae			
Ancistrus hoplogenys Gunther, 1864	3	22.3 ± 2.0	11.6 ± 0.2
Ancistrus sp.	1	28.0 ± 0	9.0 ± 0
Hypostomus plecostomus Linnaeus, 1758	7	155.7 ± 104.8	45.2 ± 61. 7
Hypostomus ventromaculatus Boeseman, 1968	1	86.0 ± 0	18.5 ± 0
Hypostomus watwata Hancock, 1828	1	82.0 ± 0	19.0 ± 0
Loricaria cataphracta Linnaeus, 1758	8	1186.5 ± 3310.6	15.3 ± 1.6
Panaque Eigenmann & Eigenmann, 1889	1	20.0 ± 0	8.0 ± 0
Peckoltia brevis La Monte, 1935	1	16.0 ± 0	9.0 ± 0

N: Sample number.

Table 1. Continued...

Order/Family/Species	N	Weight (g)	Length (cm)
Peckoltia lineola Armbruster, 2008	1	38.0 ± 0	11.5 ± 0
Pimelodidae			
Pimelodus blochii Valenciennes, 1840	1	10.0 ± 0	9.5 ± 0
Pimelodus ornatus Kner, 1858	4	76.0 ± 73.9	16.3 ± 5.0
Platynematichthys notatus Jardine, 1841	1	72.0 ± 0	20.0 ± 0
Propimelodus eigenmanni Van der Stigchel, 1946	8	20.8 ± 9.4	15.9 ± 2.0
TETRAODONTIFORMES			
Tetraodontidae			
Colomesus asellus Muller & Troschel, 1849	17	17.7 ± 9.1	8.6 ± 1.2
Total	**722**	-	-

N: Sample number.

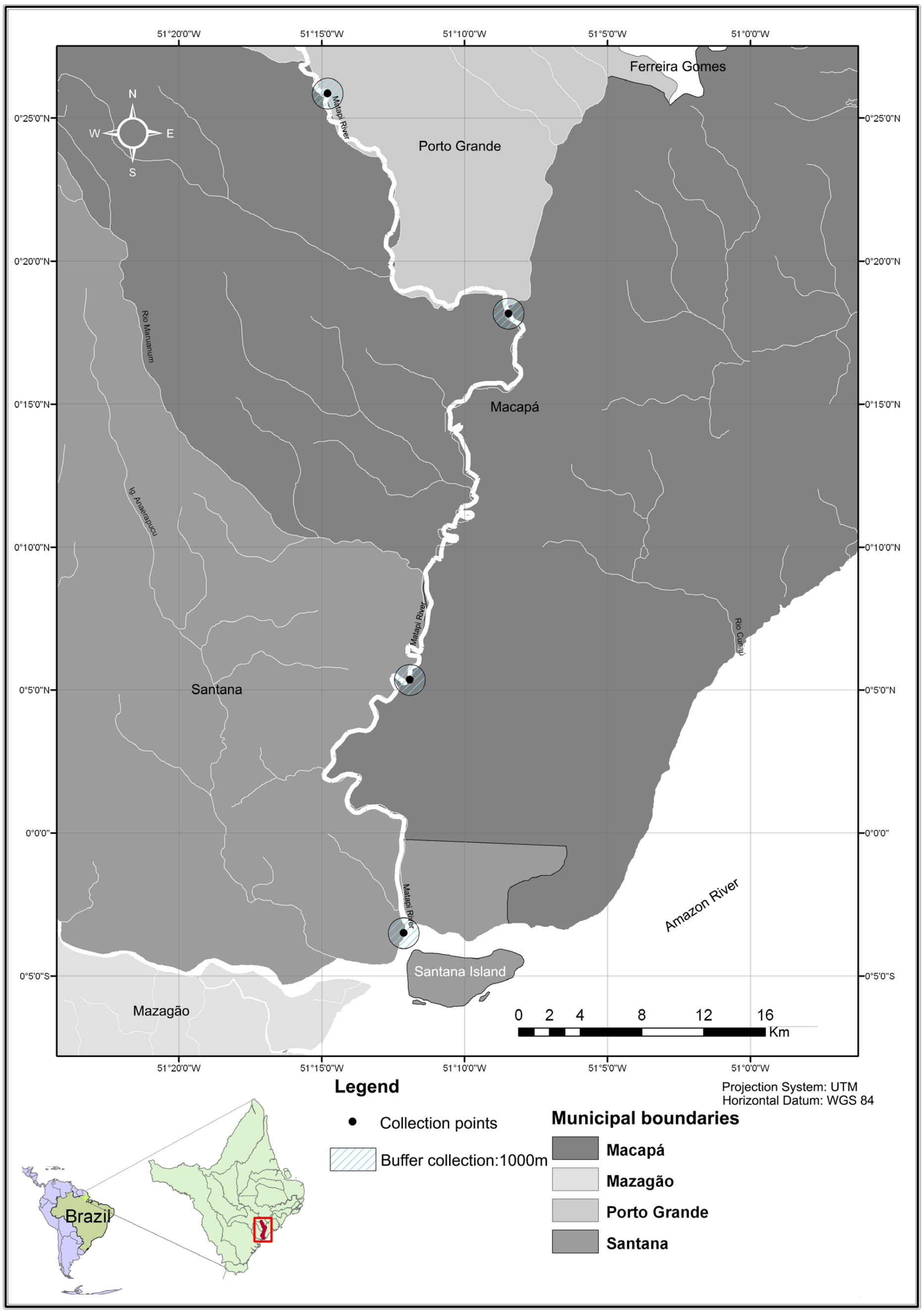

Figure 1. Collection sites of the fish species in Matapi River, state of Amapá, Brazil.

conductivity 2.5 ± 2.0 μS/cm, suspended solids 26.8 ± 30.5 mg/L, transparency 86.2 ± 61.5 cm and rainfall 338.4 ±111.6 mm).

The present study was conducted in accordance with the recommendations of the Brazilian College for Animal Experimentation (Colégio Brasileiro de Experimentação Animal, COBEA) and with authorization from the Ethics Committee for Use of Animals of Embrapa Amapá (Protocol Nº 014 - CEUA/CPAFAP).

The tegument and operculum of all the fish were examined at the collection site and the gills were then fixed in formalin (5%). The gills were removed and analyzed using a stereomicroscope. The crustaceans found were fixed in 70% ethyl alcohol with 10% glycerin (EIRAS et al., 2006) and were then identified (LUQUE et al., 2013; TABORDA et al., 2016). The ecological terms used were those recommended by Bush et al. (1997).

A total of 722 fish of 66 species were collected. Their length and weight are described in Table 1. The host families Serrasalmidae and Characidae predominated, and nine species accounted for 70% of all the individuals examined: *Metynnis lippincottianus, Curimata incompta, Astyanax bimaculatus, Hemiodus unimaculatus, Tetragonopterus chalceus, Moenkhausia lepidura, Leporinus friderici* and *Plagioscion squamosissimus*. However, *M. lippincottianus* and *C. incompta* were the most abundant species (Table 1), and they were present in all sampling sites. The number of individuals collected was greater during the dry season, corresponding to 63% of the total sample.

The prevalence of crustacean parasites was 2.2% among the 722 fish of 66 species that were examined. Among the 48 parasite specimens collected, there was high abundance of three taxa (Branchiura, Copepoda and Isopoda) with diversity of six species (Table 2). Alsarakibi et al. (2014) reported that the density of argulids was lower in lotic environments such as rivers, in comparison with lentic environments such as fish farms. Vasconcelos & Tavares-Dias (2016) studied the crustacean parasite fauna in six species of fish in a reservoir in the state of Amapá and reported prevalence of 30.4%. They collected 878 parasites, which included one species of Branchiura, one of Copepoda and one of Isopoda. Oliveira et al. (2017) reported that in 13 host species of the Jari River (state of Amapá), the prevalence of parasites was 63.8%; they collected 399 parasite specimens. However, the diversity of crustacean parasites and their levels of infestation can be influenced by various factors relating to the biology of parasites and hosts, and by environmental factors, among others (CARVALHO et al., 2003; MAMANI et al., 2004; FONTANA et al., 2012; ALSARAKIBI et al., 2014; MIKHEEV et al., 2015; VASCONCELOS & TAVARES-DIAS, 2016). Fish hosts may be are used by these parasites for transportation (CARVALHO et al., 2003), which could be facilitated by migrating fish species. However, this low prevalence of parasites in the hosts of the Matapi River may be due to the influence of daily tides from the Amazon River, considering that certain crustacean parasites respond to water movement to reach their hosts (MIKHEEV et al., 2015).

No crustacean parasites were found on the body surface of the fish from the Matapi River that were examined. However, among fish living in lotic environments, it is more difficult to estimate the prevalence of parasite crustaceans in the tegument when hosts are caught using fishing nets because these fish make strong movements and attempt to resist. Moreover, with time, the hosts' stress increases and their metabolism tends to decrease, which could stimulate these ectoparasites in the tegument of the fish to explore new habitats for their survival (BRANDÃO et al., 2013). Another factor that needs to be considered is the strong influence of diary tides from the Amazon River on the velocity of the Matapi River (CUNHA et al., 2011; SILVA et al., 2016), given that these parasites need to swim to find adequate hosts, while others depend on the flow of water and swimming speed (FONTANA et al., 2012; MIKHEEV et al., 2015).

Among the hosts in the Matapi River, Argulidae species predominated. Among these, *Argulus elongatus* Heller, 1857, and *Dolops reperta* Bouvier, 1899, were the most prevalent. However, *Ergasilus xinguensis* Taborda, Paschoal & Luque, 2016, was the most abundant species, even though it only infested the cichlids *Crenicichla johanna* Heckel, 1840, *Crenicichla cincta* Regan, 1905 and *Geophagus camopiensis* Pellegrin, 1903, and sciaenid *Plagioscion squamosissimus* Heckel, 1840 (Table 2). Branchiurans

Table 2. Species of parasite crustaceans in fish gills from the Matapi River, state of Amapá (Brazil).

Host species	*Dolops reperta*			*Argulus elongatus*			*Argulus multicolor*			*Ergasilus xinguensis*			*Braga patagonica*			*Gamidactylus* sp.		
	P (%)	MI	MA	P (%)	MI	MA	P (%)	MI	MA	P (%)	MI	MA	P (%)	MI	MA	P (%)	MI	MA
Leporinus fasciatus	0	0	0	20.0	1.0	0.2	0	0	0	0	0	0	20.0	1.0	0.2	0	0	0
Astyanax bimaculatus	1.3	1.0	0.01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Curimata incompta	0.7	1.0	0.007	0	0	0	0	0	0	0	0	0	0	0	0	0.7	1.0	0.007
Pygocentrus nattereri	0	0	0	12.0	1.0	0.1	0	0	0	0	0	0	0	0	0	0	0	0
Crenicichla cincta	0	0	0	0	0	0	0	0	0	100	18.0	18.0	0	0	0	0	0	0
Crenicichla johanna	0	0	0	0	0	0	0	0	0	100	7.5	7.5	0	0	0	0	0	0
Geophagus camopiensis	0	0	0	0	0	0	0	0	0	25.0	2.0	0.5	0	0	0	0	0	0
Pterophyllum scalare	8.3	1.0	0.08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Plagioscion squamosissimus	0	0	0	0	0	0	0	0	0	3.9	1.0	0.03	0	0	0	0	0	0
Hypostomus plecostomus	0	0	0	0	0	0	28.0	1.0	0.2	0	0	0	0	0	0	0	0	0
Propimelodus eigenmanni	0	0	0	0	0	0	0	0	0	0	0	0	12.0	2.0	0.2	0	0	0

P: Prevalence, MA: Mean abundance, MI: Mean intensity.

are known for frequently switching hosts and for having lower host specificity than that of other parasite groups. Among the factors that influence the infestation rates of these ectoparasites are the genetic similarities of the hosts and ecological factors that may be involved (MAMANI et al., 2004; OLIVEIRA et al., 2017).

To conclude, in 66 host species, the rates of infestation with crustacean parasites were low, and most of the fish examined had low abundance of parasites, except *C. johanna* and *G. camopiensis.* Lastly, this study reports these fish species as new hosts for the crustacean parasites species that were found and expands the range of occurrence of the six parasite species to the Matapi River basin in eastern Amazon (Brazil).

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