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Ecology

A study on monogenean parasites from the gills of some cichlids (Pisces: Cichlidae) from the Brazilian Amazon

Estudio sobre monogéneos parásitos en branquias de cíclidos (Pisces: Cichlidae) de la Amazonia Brasileña

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Abstract

The aim of this study was to investigate monogenean fauna in gills of *Geophagus camopiensis*, *Pterophyllum scalare*, *Satanoperca jurupari*, and *Satanoperca acuticeps* in a tributary from the Amazon River system in Brazil. A total of 2,148 monogenean specimens were collected from 140 fish examined from March 2012 to March 2013, and 84.3% of these fish were parasitized by 1 or more species. Such monogeneans were: *Sciadicleithrum geophagi*, *Sciadicleithrum juruparii*, *Gussevia spiralocirra* and *Gyrodactylus* sp. However, only *G. camopiensis* was parasitized by more than 1 species of monogenean, while *S. jurupari* and *S. acuticeps* were parasitized by the same species. Prevalence, mean intensity and mean abundance varied among host species and the highest levels of infection were by *G. spiralocirra* followed by *S. geophagi*, both parasites with aggregated dispersion. Abundance of monogeneans was not influenced by the size of the host. In *G. camopiensis*, the infection levels by *S. geophagi* did not vary during the rainy or drainage seasons. This is the first study on monogenean infections for *G. camopiensis* and *S. acuticeps*.

Keywords: Amazon; Ectoparasites; Freshwater fish; Helminths; Monogenea

Resumen

El objetivo de este estudio fue investigar la fauna de monogéneos en las branquias de *Geophagus camopiensis*, *Pterophyllum scalare*, *Satanoperca jurupari* y *Satanoperca acuticeps* en un afluente del sistema del río Amazonas en Brasil. De marzo de 2012 a marzo del 2013 se examinaron 140 peces, en los cuales se encontraron 2,148 monogéneos, el 84.3% de los peces resultaron parasitados por una o más especies: *Sciadicleithrum geophagi*, *Gyrodactylus* sp., *Gussevia spiralocirra* y *Sciadicleithrum juruparii*. Sin embargo, solo *G. camopiensis* albergaba más de una especie de monogéneos, mientras *S. jurupari* y *S. acuticeps* resultaron infectadas por la misma especie. La prevalencia, la intensidad media y la abundancia variaron entre especies de hospedero y los niveles más altos de infección fueron causados por *G. spiralocirra*, seguido por *S. geophagi*, ambos parásitos con dispersión agregada. La abundancia de monogéneos no resultó influenciada por el tamaño del hospedero. En *G. camopiensis*, los niveles de infección por *S. geophagi* no variaron durante la estación seca o la temporada de lluvias. Este es el primer estudio de infecciones de monogéneos en *G. camopiensis* y *S. acuticeps*.

Palabras clave: Amazonia; Ectoparásitos; Peces de agua dulce; Helmintos; Monogenea

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Introduction

Monogeneans are helminth ectoparasites parasitizing mainly fish. They can fix to body surfaces, fins, swabs or nasal cavities of the hosts. However, a few species are endoparasites, inhabiting the stomach, intestine or urinary bladder of fishes. They have a direct life cycle and consequently a high reproduction rate. Thus, many ectoparasite species are pathogenic to the host, causing serious problems for fish farms (Boeger & Viana, 2006; Cohen, 2013). They are parasites with high host specificity if compared to other helminths (Bellay, Ueda, Takemoto, Lizama, & Pavanelli, 2012; Boeger & Viana, 2006; Braga, Araújo, & Boeger, 2014; Poulin, 1992), and some monogenean species may have a seasonal infection pattern (Boeger & Viana, 2006; Neves, Pereira, Tavares-Dias, & Luque, 2013; Tavares-Dias, Oliveira, Gonçalves, & Silva, 2014).

Neotropical cichlids are often parasitized by species of *Gussevia* Kohn and Paperna, 1964, *Sciadicleithrum* Kritsky, Thatcher, and Boeger, 1989, *Trinidactylus* Hanek, Molnar and Fernando, 1974, *Tucunarella* Mendoza-Franco, Scholz, and Rozkosna, 2010 (Braga et al., 2014; Melo, Santos, & Santos, 2012; Mendoza-Franco & Vidal-Martínez, 2005; Pariselle et al., 2011; Paschoal, Scholz, Tavares-Dias, & Luque, 2016). However, Brazilian cichlids have been mostly parasitized by *Gussevia* and *Sciadicleithrum* species and infection levels are highly variable (Table 1). Therefore, Dactylogyridae species are the most frequent monogeneans in these freshwater cichlids.

Studies on infections by monogeneans in populations of Amazonian wild cichlids are scarce. For species of economic importance, such as *Satanoperca jurupari* Heckel, 1840; *Satanoperca acuticeps* Heckel, 1840 and *Geophagus camopiensis* Pellegrin, 1903, as well as for fish important for food consumption of riverine populations from Amazon and for ornamental aquaculture information is limited (Soares et al., 2011). In addition, the monogenean fauna is also unknown for *Pterophyllum scalare* Schultze, 1823, a fish utilized in Amazonian aquaculture and the ornamental industry in Asia, Europe and North America (Tavares-Dias, Lemos, & Martins, 2010). However, some monogenean species have been reported in some cichlids from the Amazon Basin.

In the Amazon region, *Gussevia spiralocirra* Kritsky, Thatcher and Boeger, 1986 (Kritsky et al., 1986), and *Sciadicleithrum iphthimum* Kritsky, Thatcher and Boeger, 1989 were described from *P. scalare* (Kritsky et al., 1989). Recently, Tripathi, Agrawal, and Sriivastana (2010) found *S. iphthimum* parasitizing the gills of *P. scalare* in aquariums in India, due to intercontinental translocation of this ornamental fish from the Amazon. *Sciadicleithrum juruparii* Melo, Santos and Portes-Santos, 2012 (Melo et al., 2012), *Sciadicleithrum satanopercae* Yamada, Takemoto, Bellay and Pavanelli, 2009 (Mendoza-Franco, Scholz, & Rozkošná, 2010) and *Sciadicleithrum edgari* Paschoal, Scholz, Tavares-Dias & Luque, 2016 (Paschoal et al., 2016) were described from *S. jurupari*. Therefore, since there are no other studies on parasites of wild *P. scalare*, *S. jurupari*, *G. camopiensis* and *S. acuticeps*, this study investigated the fauna of monogeneans of these hosts from a tributary of the Amazon River system, in Northern Brazil.

Materials and methods

The Matapi River basin, with 2,518 km^2, crosses the city of Porto Grande, flowing into the mouth on the Amazon River, in the municipality of Santana, Amapá State (eastern Amazon, Brazil). This watershed spreads over different cities and has several tributaries, including rivers and streams (Fig. 1), all used by various human riverine communities that earn their living from agriculture, livestock and fisheries. It is strongly influenced by a high rainfall in the Amazon region and also by the daily tides of the Amazon River (Takiyama et al., 2007).

From March 2012 to March 2013, 75 specimens of *G. camopiensis* (12.5 ± 3.1 cm and 62.0 ± 43.0 g), 38 specimens of *P. scalare* (4.5 ± 0.8 cm and 6.0 ± 4.4 g), 15 specimens of *S. jurupari* (11.8 ± 1.6 cm and 58.5 ± 10.4 g) and 12 specimens of *S. acuticeps* (11.6 ± 1.1 cm and 50.0 ± 14.5 g) were collected along the Matapi River (Fig. 1). Fish were caught with cast nets, matapi, longlines, handlines and gillnets (20, 30, 40 and 50 mm between nodes) to study monogeneans from gills.

For *G. camopiensis*, the most captured host species, 39 specimens were collected during the rainy period and 36 during the drought period aiming to study the effects of seasonality in levels of infection. Seasonality was based on rainy and dry seasons, as the region is a tropical forest characterized by a rainy season that runs from December to May (summer and fall) and a dry season that runs from June to November (autumn and winter) (Souza & Cunha, 2010).

For each fish, standard length (cm) and body weight (g) were obtained. The gills were collected and fixed in 5% formalin to collect monogeneans, which were then quantified and preserved in 70% alcohol. To analyze the internal morphology of monogeneans, GAP (picric acid and glycerin) and Hoyer methods were used to study the sclerotized structures. Some parasites were also stained with Masson trichrome (Boeger & Viana, 2006).

The ecological terms used are those recommended by Bush, Lafferty, Lotz, and Shostak (1997). The index of dispersion (ID) and index of discrepancy (D) were calculated using the Quantitative Parasitology 3.0 software to detect the distribution pattern for each infracommunity of parasites (Rózsa, Reiczigel, & Majoros, 2000) in species with a prevalence ≥10%. The significance of ID for each parasite species was tested using the *d*-statistics (Ludwig & Reynolds, 1988).

To study seasonality, the prevalence of parasites was compared between seasons using the Chi-square (χ^2) test, and the abundance was calculated using the Mann–Whitney (*U*) test. Spearman correlation coefficient (*rs*) was used to determine possible correlations between abundance of parasites and length and body weight of hosts (Zar, 2010).

During fish collection, in each sampling site along the Matapi River, the pH, water temperature and dissolved oxygen were measured using the appropriate digital devices for each purpose. The mean rainfall was obtained from the Center for