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**Original Article**

# Diversity of metazoan parasites in fish *Triportheus angulatus* and *Triportheus auritus* living in sympatry in the Brazilian Amazon

## Diversidade de parasitos metazoários em peixes *Triportheus angulatus* e *Triportheus auritus* vivendo em simpatria na Amazônia brasileira

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## Abstract

The aim of this study was to compare the diversity and community structure of metazoan parasites in sympatric populations of *Triportheus angulatus* and *Triportheus auritus* in the Jari River basin, in the eastern Brazilian Amazon. All the specimens of *T. angulatus* and *T. auritus* examined were infected by *Anacanthorus furculus*, *Anacanthorus pithophallus*, Digenea gen. sp., *Procamallanus* (*Spirocamallanus*) *inopinatus*, *Rhabdochona acuminata*, *Contracaecum* sp., *Ergasilus* sp. and Acarina gen. sp. These parasites displayed aggregated or random dispersion. The parasite community in *T. angulatus* and *T. auritus* presented a similarity of 78%. The diversity indice and richness of parasite species were greater in *T. auritus* and there were differences in levels of host parasite infection for some infracommunities. *Phyllodistomum spatula* occurred only in *T. angulatus*, while metacercariae of *Clinostomum marginatum* and Digenea gen. sp.2 occurred only in *T. auritus*. The species richness of the parasites was influenced by host size, as well as the abundance of some parasite infracommunities. This is the first report of these parasites for *T. angulatus* and *T. auritus*, except for *P.* (*S.*) *inopinatus* and *Contracaecum* sp. for *T. angulatus*.

**Keywords:** Amazon, community, fish, helminth, parasites, similarity.

## Resumo

O objetivo deste estudo foi comparar a diversidade e comunidade de parasitos metazoários em populações simpátricas de *Triportheus angulatus* e *Triportheus auritus* da bacia do Rio Jari, na Amazônia oriental brasileira. Todos os espécimes de *T. angulatus* e *T. auritus* examinados estavam infectados por *Anacanthorus furculus*, *Anacanthorus pithophallus*, Digenea gen. sp., *Procamallanus* (*Spirocamallanus*) *inopinatus*, *Rhabdochona acuminata*, *Contracaecum* sp., *Ergasilus* sp. e Acarina gen. sp. Esses parasitos apresentaram dispersão agregada ou randômica. A comunidade de parasitos em *T. angulatus* e *T. auritus* apresentou uma similaridade de 78%. A diversidade e riqueza de espécies de parasitos foram maiores em *T. auritus* e houve diferenças nos níveis de infecção parasitária entre os hospedeiros para algumas infracomunidades. *Phyllodistomum spatula* ocorreu somente em *T. angulatus*, enquanto metacercárias de *Clinostomum marginatum* e Digenea gen. sp.2 ocorreram somente em *T. auritus*. A riqueza de espécies de parasitos foi influenciada pelo tamanho dos hospedeiros, bem como pela abundância de algumas infracomunidades de parasitos. Este é o primeiro relato desses parasitos para *T. angulatus* e *T. auritus*, exceto *P.* (*S.*) *inopinatus* e *Contracaecum* sp. para *T. angulatus*.

**Palavras-chave:** Amazônia, comunidade, peixe, helminto, parasito, similaridade.

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## Introduction

The Jari River basin is located in the division between the south of the state of Amapá and the north of the state of Pará, in the north of Brazil. Its source is found in the Serra do Tumucumaque mountain range on the border between Brazil and French Guiana, and it is approximately 800 km long, with its mouth on the Amazon River to the south of the state of Amapá. It has a clear water basin system, and the region is comprised of tropical rainforest (EPE, 2010). There is the presence of anthropic action in the south of the basin, where the original forest was replaced by agricultural activities and silvicultural explorations (Cunha & Cunha, 2010; Abreu & Cunha, 2015). In addition, the region has a great diversity of birds, zooplankton and several other invertebrates that form part of the diet of fish, and which can be hosts for different species of fish parasites.

*Triportheus* are freshwater fish of the Triportheidae family and Characiformes order, which contains 19 valid species (Froese & Pauly, 2021), including *Triportheus angulatus* (Spix & Agassiz, 1829) and *Triportheus auritus* (Valenciennes, 1850). *Triportheus angulatus* is distributed in the Amazon and Essequibo River basins, while *T. auritus* is more widely distributed, and is found in the Amazon, Essequibo, Tocantins, and Araguaia river basins, and on the Ilha de Trindade (Trindade Island) (Lima et al., 2003; Lasso & Sánchez-Duarte, 2011; Malabarba, 2004; Froese & Pauly, 2021). Both species are benthopelagic and have omnivorous feeding habits, feeding mainly on insects, fruits, seeds, fragments of fish, plankton and crustaceans (Almeida, 1984; Yamamoto et al., 2004; Lasso & Sánchez-Duarte, 2011; Sá-Oliveira et al., 2014; Rojas et al., 2016; Froese & Pauly, 2021). In general, the reproduction of these fish occurs in the rainy season, when there are lateral migrations to floodplain areas (Santos et al., 1984; Soares et al., 2011; Lasso & Sánchez-Duarte, 2011; Araújo et al., 2012), a favorable environment for fish larvae feeding. As such, in general, *T. angulatus* and *T. auritus* are caught in schools in rivers and flooded forests (Lasso & Sánchez-Duarte, 2011; Sá-Oliveira et al., 2014). *Triportheus angulatus* and *T. auritus* (Ponte et al., 2016; Goulding et al., 2018) are consumed in the Amazon basin, and are species whose biology has been little studied, notably their parasite diversity and communities.

In wild fish populations, studies on parasite fauna are important not only for understanding diversity, biogeography and population distribution, but also parasite-host-environment interactions (Tavares-Dias et al., 2014; Oliveira et al., 2016; Moreira et al., 2017; Baia et al., 2018). In several species of fish in the Amazon Basin, an ecosystem that serves as a habitat for a number of parasite species, parasite community and infracommunities are yet to be studied, and include species of hosts living in the same environment (sympatry), which tend to have similar parasite communities and infracommunities (Muñoz et al., 2006; Oliveira et al., 2016; Hoshino et al., 2016; Santos-Bustos et al., 2018). However, the community and infracommunities of parasites of sympatric populations of *T. angulatus* and *T. auritus* have not yet been investigated. As such, the aim of the present study was to compare the diversity and community structure of metazoan parasites of *T. angulatus* and *T. auritus* living in sympatry in the Jari River basin, in the eastern Brazilian Amazon.

## Material and Methods

### Study area and collection of fishes

Twice monthly, from January to July 2020, *T. angulatus* and *T. auritus* were collected in river and stream bank areas and lowland regions of the lower Jari River, close to the Jarilândia District, in the municipal region of Vitória do Jari, in the state of Amapá, Brazil (Figure 1). Fish were collected using reeds, hand lines, nets and gillnets with 25 mm and 30 mm meshes.

The collection of fish was authorized by the Brazilian Ministry of the Environment (SISBio No 73550-1). This study was developed in accordance with the principles adopted by the Brazilian College of Animal Experimentation (COBEA) and was conducted under authorization from the Ethics Committee for Animal Use of Embrapa Amapá (Protocol No 014/2018).

### Parasite collection and analysis procedures

Each fish was weighed (g) and measured (standard length, cm), before being necropsied for parasitological analysis. The body surface, opercula, gastrointestinal tract and viscera were examined at the collection site, while the gills were fixed in heated 5% formalin (60-70 ºC) and analyzed at the Embrapa Amapá Aquaculture and Fisheries Laboratory, Macapá (Brazil). The mouth, gills, opercula and fins were examined to check for the presence of

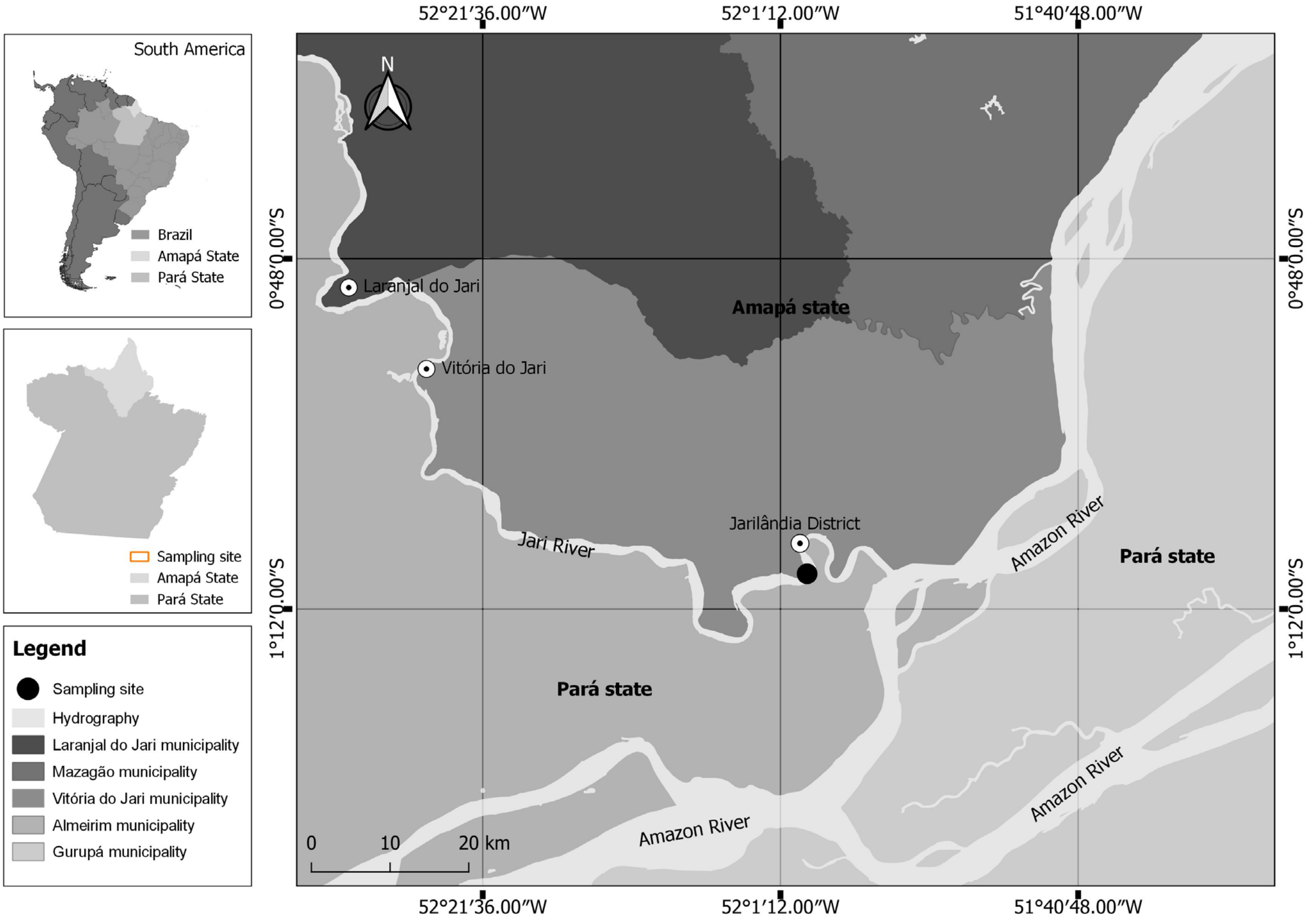

**Figure 1.** Collection site of *Triportheus angulatus* and *Triportheus auritus* in lower Jari River, in Amazon River system (Brazil).

ectoparasites and the viscera and gastrointestinal tract for the presence of endoparasites. The collection, fixation, conservation and preparation of the parasites for identification followed previous recommendations (Eiras et al., 2006). The ecological terms used were those recommended by Bush et al. (1997).

## Statistical analyses

The normality and homoscedasticity of the data were evaluated using the Shapiro-Wilk and Bartlett tests, respectively. The Brillouin index (HB), Uniformity, Berger-Parker dominance index, species richness (Magurran, 2004) and frequency of dominance, that is, the percentage of infracommunities in which a given parasite species is numerically dominant (Rohde et al., 1995), were calculated to assess the parasite component community using Diversity software (Pisces Conservation Ltd, UK). For comparison of prevalence between *T. angulatus* and *T. auritus* the chi-square test ($\chi^2$) was used, followed by Yates's correction. The mean intensity, mean abundance, species richness, diversity index, *evenness* and Berger-Parker dominance between both hosts were compared with the Mann–Whitney (*U*) test (Zar, 2010).

The dispersion index (DI) and discrepancy index (D) of Poulin were calculated using the Quantitative Parasitology 3.0 software package, to detect the distribution patterns of the parasite infracommunities (Rózsa et al., 2000) for species with prevalence >10%. The significance of the DI, for each infracommunity, was tested using the d-statistic test (Ludwig & Reynolds, 1988).

Using the R software package (R Core Team, 2020), Non-metric Multidimensional Scaling (NMDS) was performed to order the parasite abundance data from the similarity matrix generated through the Bray-Curtis quantitative index. To test the differences between the parasite component communities of *T. angulatus* and *T. auritus*, the ANOSIM test was used with 999 permutations using the Jaccard (J) similarity index (presence/absence of species), and Bray-Curtis dissimilarity index (B) (abundance). The Similarity Percentage test (SIMPER) was used to detect the contribution of each parasite species in the sampling.

The body weight (W) and the total length (L) data were used to calculate the relative condition factor (Kn) of the host fish, as well as the length–weight relationship ($W = aL^b$) after the logarithmic transformation of the length (L) and weight (W) and subsequent adjustment of two straight lines, thereby obtaining $\ln y = \ln a + b \ln L$ (Le Cren, 1951).

The Spearman correlation coefficient (*rs*) was used to determine possible correlations of the abundance of parasites with the length, weight and Kn of hosts, as well as of hosts length with the species richness and HB.

## Results

All specimens of *T. angulatus* and *T. auritus* examined (100%) were infected with one or more species of parasites, and a total of 2,410 parasites were collected. Both the hosts were parasitized by *Anacanthorus furculus* (Kritsky, Boeger & Van Every, 1992), *Anacanthorus pithophallus* (Kritsky, Boeger & Van Every, 1992), Digenea gen. sp.1; *Procamallanus* (*Spirocamallanus*) *inopinatus* (Travassos, Artigas & Pereira, 1928), *Rhabdochona acuminata* (Molin, 1860), *Contracaecum* sp., *Ergasilus* sp. e Acarina gen.sp. However, *Phyllodistomum spatula* (Odhner, 1902) occurred only in *T. angulatus*, while the metacercariae of *Clinostomum marginatum* (Rudolphi, 1819) and Digenea gen. sp.2 occurred only in *T. auritus*. However, in both hosts, the monogeneans *A. furculus* and *A. pithophallus* were dominant (Table 1).

**Table 1.** Parasites in *Triportheus* spp. from lower Jari River, in Brazilian Amazon.

| Parasite species | ***Triportheus angulatus* (n = 30)** | | | | | | ***Triportheus auritus* (n = 34)** | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **P (%)** | **MI** | **MA** | **TNP** | **FD (%)** | **SI** | **P (%)** | **MI** | **MA** | **TNP** | **FD (%)** | **SI** |
| *Anacanthorus furculus* and *Anacanthorus pithophallus* | 96.7 | 37.4±41.8 | 36.2±41.7 | 1085 | 77.1 | Gills | 97.1 | 16.9±17.2 | 16.4±17.5 | 558 | 55.7 | Gills |
| Digenea gen. sp.1 (metacercariae) | 20.0 | 1.8±0.5 | 0.4±0.9 | 11 | 0.8 | Gills | 23.53 | 1.3±0.3 | 0.3±0.6 | 10 | 1.0 | Gills |
| *Phyllodistomum spatula* (metacercariae) | 30.0 | 6.6±2.1 | 2.0±5.5 | 59 | 4.2 | Swim bladder | - | - | - | - | - | - |
| Digenea gen. sp.2 (metacercariae) | 3.33 | 1.0±0.2 | 0.0 | 1 | 0.07 | Liver | - | - | - | - | - | - |
| *Clinostomum marginatum* (metacercariae) | - | - | - | - | - | - | 5.88 | 1.5±0.2 | 0.1±0.4 | 3 | 0.3 | Muscle |
| Digenea gen. sp.2 (metacercariae) | - | - | - | - | - | - | 17.65 | 1.0±0.1 | 0.2±0.4 | 6 | 2.1 | Intestine |
| *Procamallanus* (*S.*) *inopinatus* | 53.3 | 1.9± 0.8 | 1.0±1.1 | 31 | 2.2 | Pyloric caeca | 44.12 | 1.7±0.8 | 0.7±1.0 | 25 | 2.5 | Pyloric caeca |
| *Procamallanus* (*S.*) *inopinatus* | 20.0 | 2.2±0.7 | 0.4±1.5 | 13 | 0.9 | Intestine | 38.24 | 1.8±1.1 | 0.7±1.3 | 24 | 2.4 | Intestine |
| *Rhabdochona acuminata* | 3.33 | 108.0±1.1 | 3.6±19.7 | 108 | 7.7 | Caecum pyloric | 8.82 | 2.7±0.7 | 0.2±0.9 | 8 | 0.8 | Caecum pyloric |
| *Rhabdochona acuminata* | 3.33 | 37.0±2.1 | 1.2±6.8 | 37 | 2.6 | Intestine | 23.53 | 31.0±14.1 | 7.3±19.1 | 248 | 24.7 | Intestine |
| *Contracaecum* sp. (larvae) | 43.3 | 2.6±0.8 | 1.1±2.4 | 34 | 2.4 | Abdominal cavity | 41.18 | 3.1±2.0 | 1.3±3.0 | 44 | 4.4 | Abdominal cavity |
| *Ergasilus* sp. | 6.7 | 1.5±0.6 | 0.1±0.4 | 3 | 0.2 | Gills | 58.82 | 2.8±1.2 | 1.6±2.2 | 55 | 5.5 | Gills |
| Acarina gen. sp | 26.7 | 3.3±1.3 | 0.9±2.2 | 26 | 1.8 | Gills | 17.65 | 3.5±0.8 | 0.6±1.8 | 21 | 2.1 | Gills |

Abbreviations: P, prevalence; MI, mean intensity; MA, mean abundance; TNP, total number of parasites; SI, site of infection. FD: Frequency of dominance, SI: Site of infection, n = Sampling number

*Anacanthorus furculus* and *A. pithophallus*, *R. acuminata*, *Ergasilus* sp. and Acarina gen. sp. exhibited aggregate dispersion, while Digenea gen. sp.1 and Digenea gen. sp.2, *P. spatula*, *P.* (*S.*) *inopinatus* and *Contracaecum* sp. presented random dispersion (Table 2).

The prevalence of *A. furculus* and *A. pithophallus* was similar ($\chi^2$ = 0.008, p = 0.529) for *T. auritus* and *T. angulatus*, however the average abundance (*U* = 327.0, p = 0.014) and average intensity (*U* = 293.5, p = 0.001) were higher in *T. angulatus*. The prevalence ($\chi^2$ = 0.116, p = 0.969), mean abundance (*U* = 500.5, p = 0.898) and mean intensity (*U* = 15.5, p = 0.272) of Digenea gen. sp.1 were similar in both hosts. The prevalence ($\chi^2$ = 0.542, p = 0.627), mean abundance (*U* = 439, p = 0.339) and mean intensity (*U* = 96.0, p = 0.343) of *P.* (*S.*) *inopinatus* were similar in intestine of both hosts. The prevalence ($\chi^2$ = 2.539, p = 0.187), mean abundance (*U* = 413.5, p = 0.194) and mean intensity (*U* = 35.5, p = 0.759) of *P.* (*S.*) *inopinatus* were similar in pyloric caeca of both hosts. In the pyloric caeca, the prevalence ($\chi^2$ = 0.820, p = 0.698) and mean abundance (*U* = 483.5, p = 0.721) of *R. acuminata* were similar in both hosts. In the intestine, the prevalence ($\chi^2$ = 5.379, p = 0.05) of *R. acuminata* was higher in *T. auritus* than in *T. angulatus*, while the mean abundance (*U* = 483.5, p = 0.0.721) was similar for both hosts. The prevalence ($\chi^2$ = 0.597, p = 0.595), mean abundance (*U* = 509.0, p = 0.989) and mean intensity (*U* = 81.0, p = 0.627) of *Contracaecum* sp. were similar in both hosts. The prevalence ($\chi^2$ = 19.219, p = 0.0001) and mean abundance (*U* = 237.5, p = 0.0002) of *Ergasilus* sp. were higher in *T. auritus* than *T. angulatus*. The prevalence ($\chi^2$ = 0.759, p = 0.570), mean abundance (*U* = 466.0, p = 0.553) and mean intensity (*U* = 22.0, p = 0.796) of acari were similar in both hosts.

The component community of *T. angulatus* and *T. auritus* was similar and was composed of a similar presence of ectoparasites and endoparasites (Table 3). In *T. angulatus*, there was a predominance of hosts infected by 2 to 4 parasite species, while in *T. auritus* there was a predominance of hosts infected by 3 to 4 parasite species (Figure 2).

Berger-Parker dominance was greater ($p<0.05$) in *T. angulatus*, while the Brillouin diversity index, equitability and richness of the parasite species were greater ($p<0.001$) in *T. auritus* (Figure 3).

The NMDS did not reveal differences in parasite abundance between *T. angulatus* and *T. auritus*, with a stress value of 0.022 (Figure 4). The similarity of the component communities of the host populations exhibited qualitative similarity, according to the Jaccard index (J = 0.78) and quantitative dissimilarity according to Bray-Curtis index homogeneity (B = 0.69). ANOSIM did not detect any difference between sites but detected a difference between the parasite communities ($R_{\text{Jaccard}}$ = 0.169, p = 0.0001; $R_{\text{Bray-Curtis}}$ = 0.049; p = 0.033). SIMPER showed that the monogeneans (60.1%) and *R. acuminata* (15.2%) contributed most to these differences.

In *T. angulatus*, Brillouin diversity did not reveal a correlation ($r_s$ = -0.235, p = 0.210) with host length, but the richness of the parasite species correlated negatively ($r_s$ = -0.436, 0.016) with host length. In *T. auritus*, Brillouin diversity revealed no correlation ($r_s$ = -0.312, p = 0.072) with host length, but the richness of the parasite species correlated positively ($r_s$ = 0.335, p = 0.053) with host length. In addition, some parasite infracommunities showed a correlation with the length, weight and Kn of the hosts (Table 4).

**Table 2.** Dispersion index (DI), *d*-statistic (*d*) and discrepancy index (D) for infracommunities of parasites in *Triportheus* spp. from lower Jari River, in Brazilian Amazon.

| **Hosts** | ***Triportheus angulatus*** | | | ***Triportheus auritus*** | | |
|---|---|---|---|---|---|---|
| **Parasite species** | **ID** | ***d*** | **D** | **ID** | ***d*** | **D** |
| *Anacanthorus furculus* and *Anacanthorus pithophallus* | 2.270 | 3.289 | 0.343 | 2.100 | 3.587 | 0.351 |
| Digenea gen. sp.1 | 1.410 | 0.858 | 0.806 | 0.990 | -0.102 | 0.765 |
| Digenea gen. sp.2 | - | - | - | 0.850 | -0.673 | 0.800 |
| *Phyllodistomum spatula* | 1.650 | 1.597 | 0.746 | - | - | - |
| *Procamallanus* (*S.*) *inopinatus* | 1.100 | -0.198 | 0.491 | 1.110 | 0.370 | 0.451 |
| *Rhabdochona acuminata* | - | - | - | 2.950 | 5.768 | 0.815 |
| *Contracaecum* sp. | 1.590 | 1.418 | 0.669 | 1.510 | 1.798 | 0.669 |
| *Ergasilus* sp. | - | - | - | 5.290 | 10.500 | 0.438 |
| Acarina gen. sp. | 2.030 | 2.665 | 0.785 | 2.380 | 4.348 | 0.846 |

**Table 3.** Component community of parasites in *Triportheus* spp. from lower Jari River, in Brazilian Amazon.

| **Characteristics** | ***Triportheus angulatus*** | ***Triportheus auritus*** |
|---|---|---|
| Examined fish number | 30 | 34 |
| Body length (cm) | 15.2 ± 2.0 | 14.3± 2.4 |
| Weigth (g) | 68.3 ± 22.2 | 38.3 ± 30.4 |
| Prevalence (%) of parasites | 100 | 100 |
| Total number of parasites | 1408 | 1002 |
| Ectoparasite species | 5 | 5 |
| Percentage of ectoparasites | 79.9 | 64.3 |
| Endoparasite species | 5 | 5 |
| Percentage of endoparasites | 20.1 | 35.7 |
| Endoparasite species (adults) | 5 | 6 |
| Endoparasite species (larvae) | 4 | 3 |

**Table 4.** Spearman correlation coefficient (*rs*) of the abundance of parasites with the total length, body weight and condition factor (Kn) of *Triportheus* spp. from lower Jari River, in Brazilian Amazon.

| **Hosts** | ***Triportheus angulatus*** | | | | | | ***Triportheus auritus*** | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Length** | | **Weight** | | **Kn** | | **Length** | | **Weight** | | **Kn** | |
| **Parasite species** | $r_s$ | $p$ | $r_s$ | $p$ | $r_s$ | $p$ | $r_s$ | $p$ | $r_s$ | $p$ | $r_s$ | $p$ |
| *Anacanthorus furculus* and *Anacanthorus pithophallus* | **-0.349** | **0.050** | -0.21 | 0.241 | 0.336 | 0.069 | **0.328** | **0.050** | **0.340** | **0.048** | 0.003 | 0.984 |
| Digenea gen. sp.1 | -0.161 | 0.395 | **-0.369** | **0.044** | **-0.505** | **0.004** | -0.307 | 0.077 | **-0.375** | **0.029** | -0.126 | 0.476 |
| Digenea gen. sp. 2 | - | - | - | - | - | - | -0.119 | 0.501 | -0.193 | 0.273 | -0.162 | 0.358 |
| *Phyllodistomum spatula* | -0.044 | 0.818 | 0.129 | 0.496 | 0.184 | 0.329 | - | - | - | - | - | - |
| *Procamallanus* (*S.*) *inopinatus* | **-0.387** | **0.034** | -0.221 | 0.240 | 0.315 | 0.089 | **0.448** | 0.**008** | **0.358** | **0.037** | -0.022 | 0.9 |
| *Rhabdochona acuminata* | - | - | - | - | - | - | 0.015 | 0.933 | 0.094 | 0.594 | -0.043 | 0.808 |
| *Contracaecum* sp. | 0.130 | 0.492 | 0.035 | 0.854 | -0.129 | 0.494 | 0.164 | 0.353 | 0.097 | 0.583 | 0.100 | 0.572 |
| *Ergasilus* sp. | - | - | - | - | - | - | **0.374** | **0.029** | 0.301 | 0.083 | -0.045 | 0.799 |
| Acarina gen. sp | -0.334 | 0.071 | **-0.478** | **0.007** | -0.194 | 0.303 | 0.016 | 0.928 | -0.087 | 0.624 | -0.214 | 0.223 |

P= p-values

## Discussion

Parasite communities in sympatric hosts with similar ecology and which are phylogenetically related tend to be structured in a similar manner (Muñoz et al., 2006; Oliveira et al., 2016; Hoshino et al., 2016; Santos-Bustos et al., 2018), especially when the diets of these hosts overlap in the environment. The similar component communities of *T. angulatus* and *T. auritus* parasites from the lower Rio Jari was composed of Monogenea, Digenea, Nematoda, Crustacea and Acarina, with a predominance of *A. furculus* and *A. pithophallus* monogeneans, parasites with simple, direct life cycles (Kohn et al., 2016). ANOSIM revealed that the abundance of parasites was similar in *T. angulatus* and

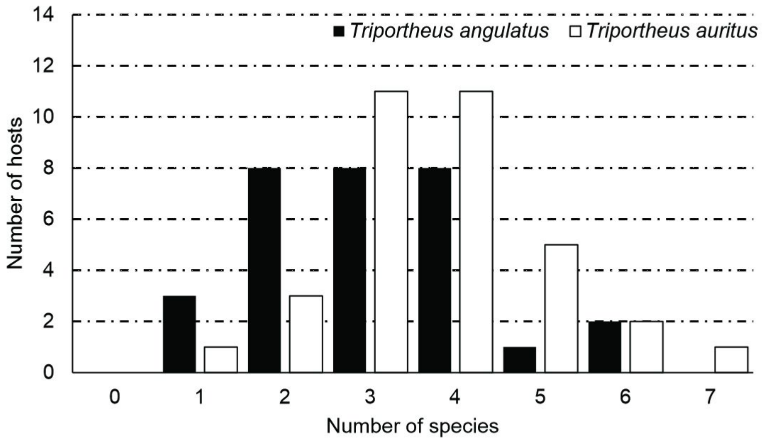

**Figure 2.** Species richness of parasites in *Triportheus angulatus* and *Triportheus auritus* from lower Jari River, in Brazilian Amazon.

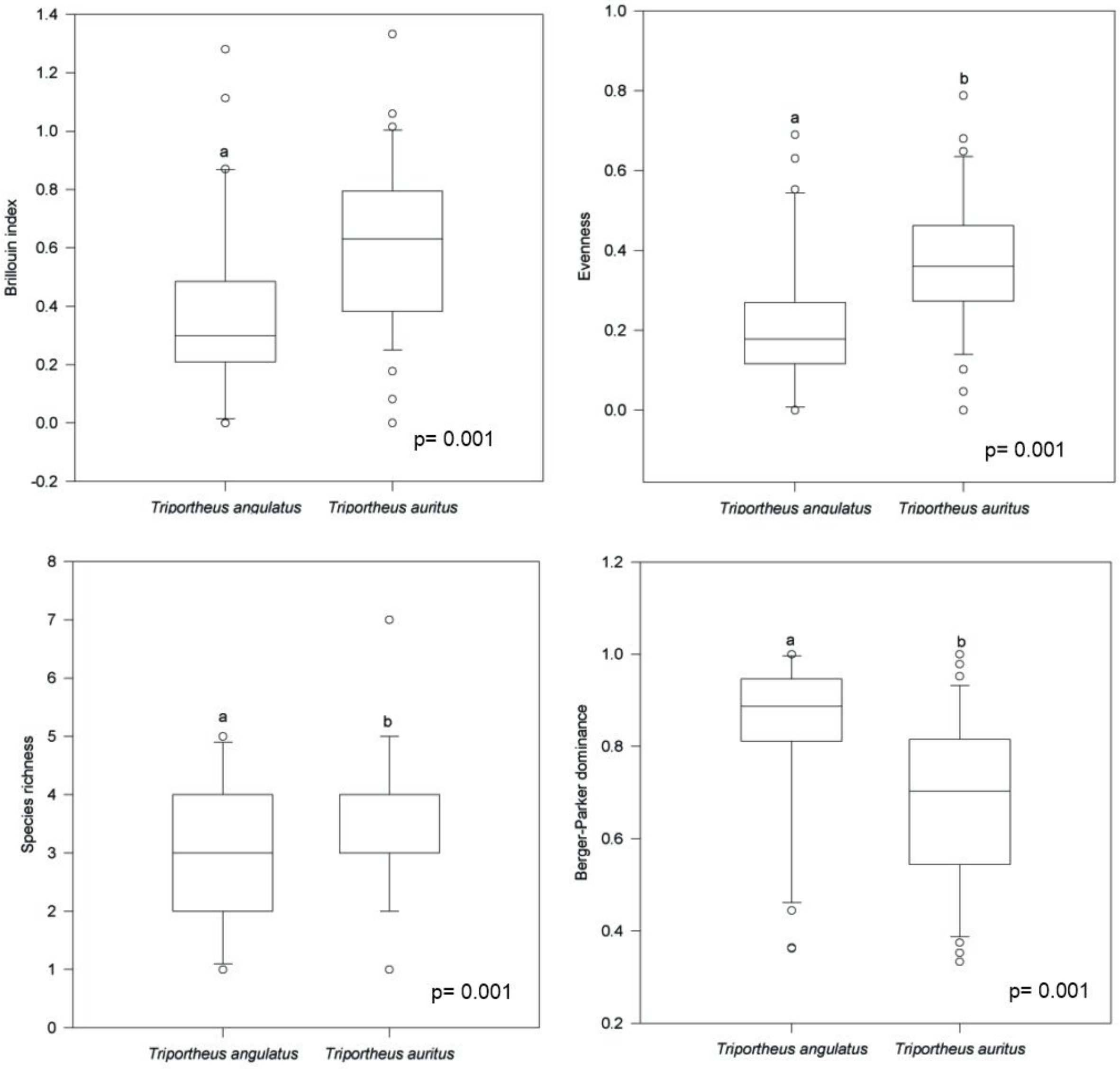

**Figure 3.** Descriptors of diversity for communities of parasites in *Triportheus angulatus* and *Triportheus auritus* from lower Jari River, in Brazilian Amazon (Box plots represent medians, interquartile ranges (25-75%), minimum–maximum ranges and outliers). Different letters indicate differences between descriptor parameters.

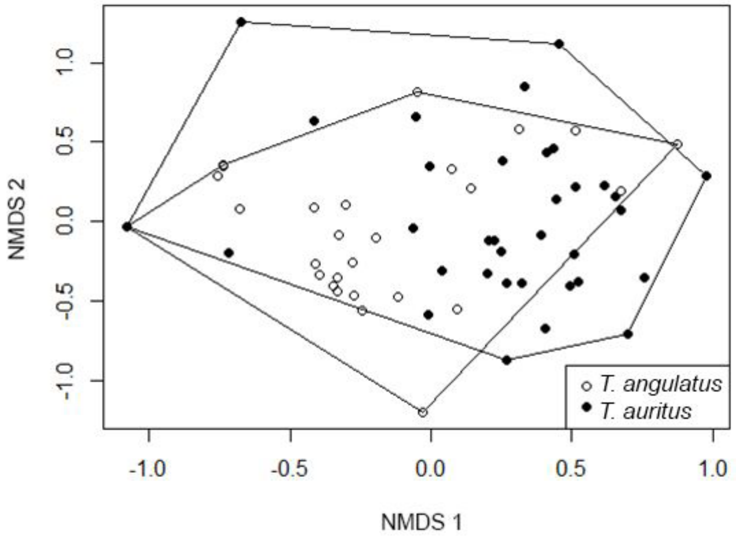

**Figure 4.** Non-metric multidimensional scaling ordination (NMDS) of abundance of parasites in *Triportheus angulatus* and *Triportheus auritus* from lower Jari River, in Brazilian Amazon.

*T. auritus*, as both hosts had a qualitative similarity of 78%. The NMDS analysis revealed a slight difference between the parasite community of *T. angulatus* and *T. auritus*, caused by the abundance of *A. furculus*, *A. pithophallus* and *R. acuminata*. This can occur due to parasite abundance, which can vary depending on the birth rate and mortality, ability to migrate between hosts, competition, or detachment from the host by mechanical action and/or the physiological responses of the host (Anderson & Gordon, 1982; Von Zuben, 1997; Luque et al., 2013).

In wild fish populations, quantitative and qualitative descriptive patterns are found among parasite communities (Magurran, 2004; Oliveira et al., 2016; Hoshino et al., 2016). In *T. angulatus* and *T. auritus* from the lower Rio Jari, we observed that the ecto and endoparasite communities were similar. However, the diversity and richness of parasite species were higher in *T. auritus*. The prevalence of *R. acuminata* was higher in *T. auritus* than in *T. angulatus*. The prevalence and abundance of *Ergasilus* sp. were higher in *T. auritus*. In addition, *P. spatula* occurred only in *T. angulatus*, while *C. marginatum* occurred only in *T. auritus*. Such differences may be related to the different contacts of these hosts with the infectious forms of the parasites in the environment, possibly associated with food, as fish need to explore different locations to feed, thus increasing the possibility of parasitic infection (Luque et al., 2004; Santos-Bustos et al., 2018).

In *T. angulatus* and *T. auritus*, infection by *A. furculus and A. pithophallus, R. acuminata, Ergasilus* sp. and Acarina gen. sp. presented aggregate dispersion. However, Digenea gen. sp.1 and Digenea gen. sp.2, *P. spatula*, *P.* (*S.*) *inopinatus* and *Contracaecum* sp. showed random dispersion. The aggregate dispersion pattern is common in fish populations and is caused by several factors associated with the host and the environment (Rohde et al., 1995; Neves et al., 2013; Oliveira et al., 2016; Hoshino et al., 2016). Random dispersion has generally been attributed to those species of pathogenic parasites which have little opportunity to colonize hosts (Guidelli et al., 2003).

In wild fish populations, the body size of hosts has been identified as a significant predictor of parasite burden (Poulin, 2004; Poulin & Leung, 2011; Paraguassú & Luque, 2007; Baia et al., 2018). Several studies on fish populations have shown that the abundance of parasites increases or decreases according to the age or size of the host fish (Poulin, 2004; Paraguassú & Luque, 2007; Gonçalves et al., 2018; Baia et al., 2018). However, any correlation between the body size of the fish and the burden of the parasites using it as an intermediate host should be positive, as large hosts are unlikely to serve as prey. In *T. angulatus*, the abundance of *A. furculus, Ergasilus* sp., *A. pithophallus and P.* (*S.*) *inopinatus* correlated negatively with the length of the hosts. The abundance of Digenea gen. sp.1 and Acarina gen. sp. correlated negatively with body weight. However, the abundance of *A. furculus*, *A. pithophallus* and *P.* (*S.*) *inopinatus* in *T. auritus* correlated positively with the size of the hosts.

To conclude, we showed that the parasite community of *T. angulatus* and *T. auritus* were characterized by a low abundance of helminths, low species richness, low diversity and evenness, with a predominance of ectoparasite species. There was similarity between the metazoan parasite community of *T. angulatus* and *T. auritus*, but with differences in a few infracommunities, diversity and richness of parasites. Moreover, host size was a factor that influenced the diversity and species richness of parasites. *Triportheus angulatus* and *T. auritus* are intermediate hosts for metacercariae of the digeneas and larvae of *Contracaecum* sp., and definitive hosts for *P.* (*S.*) *inopinatus* and *R. acuminata*. This was the first study on parasites of *T. auritus* and *T. angulatus* from the Jari River.

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