ECOLOGICAL ASPECTS OF METAZOAN PARASITES OF *Astyanax altiparanae* GARUTTI & BRITSKI, 2000 (CHARACIDAE) OF THE UPPER PARANÁ RIVER FLOODPLAIN, BRAZIL*

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ABSTRACT

One hundred and ninety specimens of *Astyanax altiparanae* Garutti & Britski, 2000 were collected in the upper Paraná River floodplain, Brazil, between February 2000 and November 2001, with the aim to identify the parasite fauna and to observe the ecological aspects of metazoan parasites of *A. altiparanae*. A total of 3908 parasite specimens of 23 species were collected. The metacercaria *Ascocotyle (Ascocotyle) tenuicollis* Price, 1935 was the most abundant and the acanthocephalan *Quadrigyrus* sp. was the most prevalent. According to degree of importance, all species were classified as satellites. The community of metazoan parasites of *A. altiparanae* showed a typical overdispersion pattern. The diversity mean was H=0.1492 ± 0.2406. *Ascocotyle (A.) tenuicollis* had a significant correlation between standard length and parasitism abundance and prevalence. The monogenean *Amphitecium* sp. had a significant correlation only between parasitism prevalence and host length classes. No significant differences in abundance and prevalence of parasitism, by sex, were observed.

Key words: parasite-hosts relation; *Astyanax altiparanae*; floodplain; Paraná River; Brazil.

ASPECTOS ECOLÓGICOS DOS METAZOÁRIOS PARASITOS DE *Astyanax altiparanae* GARUTTI & BRITSKI, 2000 (CHARACIDAE) DA PLANÍCIE DE INUNDAÇÃO DO ALTO RIO PARANÁ, BRASIL

RESUMO

Cento e noventa exemplares de *Astyanax altiparanae* Garutti & Britski, 2000 foram coletados na planície de inundação do alto rio Paraná, Brasil, entre fevereiro de 2000 a novembro de 2001, com o objetivo de identificar a fauna parasitária e observar os aspectos ecológicos dos metazoários parasitos de *A. altiparanae*. Um total de 3.908 espécimes de parasitos pertencentes a 23 espécies foram coletados. A metacercária *Ascocotyle (Ascocotyle) tenuicollis* Price, 1935 foi a mais abundante e o acantocéfalo *Quadrigyrus* sp. foi a espécie mais prevalente. De acordo com o grau de importância, todas as espécies foram consideradas satélites. A comunidade de metazoários parasitos de *A. altiparanae* apresentou padrão típico de distribuição agregada. A diversidade média foi de H=0,1492 ± 0,2406. *A. (A.) tenuicollis* apresentou correlação significativa entre o comprimento padrão e a abundância e prevalência de parasitismo. *Amphitecium* sp. apresentou correlação significativa somente entre a prevalência de parasitismo e as classes de comprimento. Não foram observadas diferenças significativas na abundância e prevalência dos parasitos de acordo com o sexo hospedeiros.

Palavras-chave: relação parasito-hospedeiro, estrutura dos parasitos, tambiú.

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INTRODUCTION

Tambiú, *Astyanax altiparanae* Garutti & Britski, (2000) was, for a long time, identified as *Astyanax bimaculatus* (Linnaeus, 1758) in the upper Paraná River floodplain, Brazil. It is a small-sized species (less than 20 cm in length) found in all environments, but more abundant in rivers and channels (AGOSTINHO *et al.*, 1997). According to Hahn (*personal communications*) this species is a trophic generalist, feeding both on higher plants and on insects, zooplankton, scales, and decomposing fish parts (CASSEMIRO *et al.*, 2002; LUIZ *et al.*, 1998; CASTRO and CASATTI, 1997; AGOSTINHO *et al.*, 1997; HAHN *et al.*, 1998). It is considered a forage species, serving as food for large-sized fish species, in addition to piscivorous mammals, reptiles, and birds that inhabit the floodplains of rivers in general (HAHN *et al.*, 1997).

Studying the community of parasite metazoans in this fish is highly important, since tambiú is an intermediate host to several species of parasites that complete their cycles in its natural predators. Knowing ecological aspects between these hosts may help elucidate the life cycles of many parasite species.

MATERIAL AND METHODS

One hundred and ninety specimens of *Astyanax altiparanae* were colected from 2000 to November 2001 in the upper Paraná River floodplain (Figure 1). Fish captures were performed using standard trawl nets and gill nets. Total weight, standard length, and sex for each fish were recorded. Parasites were collected under the stereoscopic microscope (EIRAS *et al.*, 2000).

The parasite metazoans were identified according to COLEMAN (1993), OSTROWSKI DE NUÑEZ (1993), THATCHER (1991, 1993) and MORAVEC (1998).

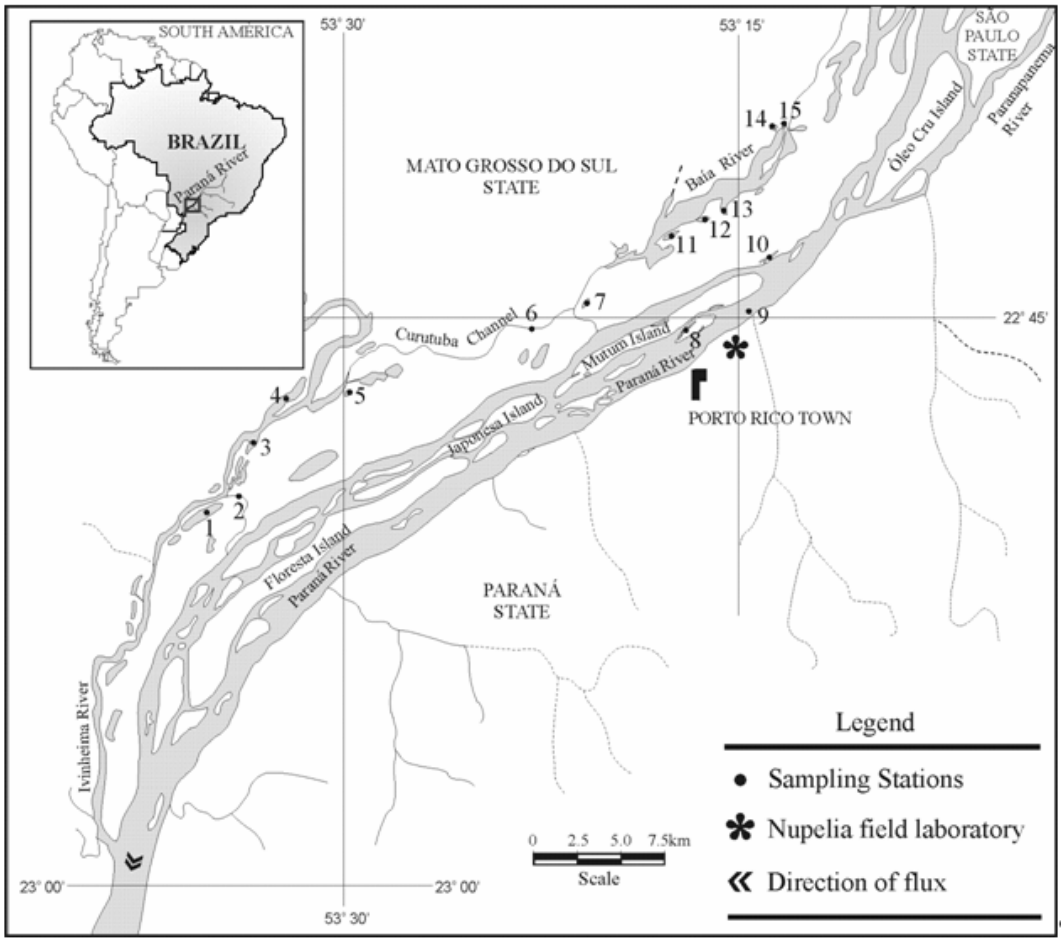

Figure 1. Upper Paraná River floodplain. *Astyanax altiparanae* collection points. 1. Ventura Lagoon, 2. Ipoitã Channel, 3. Capivara Lagoon, 4. Finado Raimundo Lagoon, 5. Jacaré Lagoon, 6. Corutuba Channel, 7. Traíra Lagoon, 8. Leopoldo Inlet, 9. Paraná River, 10. Garças Lagoon, 11. Fechada Lagoon, 12. Pousada das Garças Lagoon, 13. Dos Porcos Lagoon, 14 Maria Luiza Lagoon, 15. Gavião Lagoon

Dispersion index and Green's index (GI) were calculated to verify the dispersion and aggregation pattern of parasite species. Dispersion index was tested via the statistic *d* (LUDWIG and REYNOLDS, 1988). Parasite diversity for each metazoan infracommunity was calculated by Brillouin index (H). Caswell and Hanski's importance value (BUSH and HOLMES, 1986), was used to verify the degree of importance of each species in the parasite metazoan community (Central, Secondary, and Satellite).

The following statistical tests were used: Spearman's "rs" rank correlation coefficient to determine possible host length correlations with parasitism abundance and parasite diversity. Pearson's "r" coefficient of correlation was used to determine possible correlations between standard length and prevalence, with angular transformation of prevalence values; Mann-Whitney's "U" Test with "Z" normal approximation, to determine host sex effect on infection/infestation abundance of each parasite species; Log-Likelihood "G" Test, using a 2×2 contingency table to determine the host sex effect on prevalence (ZAR, 1996).

The tests were applied to species that showed prevalence higher than 10% [16]. A statistical significance level $p \leq 0.05$ was adopted.

The terminology related to parasite ecology was based on BUSH *et al.* (1997).

RESULTS

Parasite community structure

A total of 3908 parasite specimens were collected, belonging to 23 species. The endoparasites corresponded to 97.42% over the total parasite metazoan fauna. The metacercaria *A. (A.) tenuicollis* was the most abundant species and the acanthocephalan *Quadrigyrus* sp. was the most prevalent. According to their degree of importance, all were considered satellite species (Table 1).

Table 1. Prevalence (P %), Mean Intensity (MI), Mean Abundance (MA), and Amplitude of Intensity (AI), and Classification of species (CLAS), according to their degree of importance for the community, and infection/infestation site of the parasite fauna of *Astyanax altiparanae* of the upper Paraná river floodplain

Parasite	P	MI	MA	AI	CLAS	Infection/infestation site
Monogenea						
Urocleidoides sp.	1.05	2.00	0.02	1-3	Sa	Gills
Amphitecium sp.	10.53	1.45	0.15	1-7	Sa	Gills
Notozothecium sp.1	5.79	2.36	0.14	1-5	Sa	Gills
Notozothecium sp.2	2.10	1.5	0.67	1-2	Sa	Nasal cavity
Digenea (metacercariae)						
Clinostomum sp.	0.52	1.00	0.01	1	Sa	Eyes
Herpetodiplostomum sp.	5.26	3.80	0.20	1-15	Sa	Eyes
Tylodelphys sp.	3.16	2.00	0.06	1	Sa	Eyes
Ascocotyle (A.) tenuicollis	12.10	148.04	18.70	20-387	Sa	Heart
Antorchis sp.	1.05	2.00	0.05	1-2	Sa	Mesentery
Bucephalidae sp.1	1.05	3.00	0.03	1-5	Sa	Mesentery
Bucephalidae sp.2	1.05	2.00	0.02	2	Sa	Mesentery
Metacercaria sp.1	0.52	1.00	0.01	1	Sa	Eyes
Metacercaria sp.2	0.52	1.00	0.01	1	Sa	Gonads
Cestoda						
Larvae	2.10	14.50	0.30	1-40	Sa	Mesentery
Nematoda (larvae)						
Spiroxys sp.	0.52	1.00	0.01	1	Sa	Mesentery
Procamallanus sp.	2.63	1.25	0.03	1-2	Sa	Mesentery
Contracaecum sp.	2.63	2.00	0.02		Sa	Mesentery
Unidentified larvae	1.05	1.50	0.02	3	Sa	Mesentery
Acanthocephala						
Quadrigyrus sp.	26.31	2.08	0.54	1-7	Sa	Intestine; Mesentery
Copepoda						
Brasergasilus sp.	1.05	5.50	0.06	2-10	Sa	Nasal cavity
Ergasilus sp.	1.58	2.67	0.04	1-6	Sa	Gills
Vaigamus sp.	0.53	1.00	0.01	1	Sa	Gills
Acusicola sp.	1.05	2.00	0.08	4-6	Sa	Gills

The *A. altiparanae* parasite metazoan community showed a typical agregated distribution pattern. According to Green's index all species presented low agregation (Table 2).

The *A. altiparanae* parasite metazoan community showed a lowed mean diversity of H=0.1492±0.2406. Host standard length was not correlated with diversity (rs = 0.0595; p = 0.5424). With regard to species richness in the community, there was a predominance of non-parasitized hosts, followed by hosts with one species of parasite. The number of hosts with four parasites was smaller than expected. Tambiú harbors a maximum of five parasite species per host (Figure 2).

Standard length

Among the three most prevalent parasite species of *A. altiparanae*, digenetic *A. (A.) tenuicollis* presented a significant correlation between host standard length and abundance, and between standard length and parasitism prevalence (Table 3). The species *Amphitecium* sp. showed a significant correlation only between parasitism prevalence and host length classes.

Sex

Of all fish examined, 111 were females (58.42%); 75 were males (39.47%); and 4 (2.10%) were indeterminate. Of the 111 females, 63 (56.76%) were parasitized and of the 75 males, 41 (54.67%) were parasitized by one or more species of parasites. All four specimens where sex was indeterminate were negative for parasitism.

No significant differences were observed between males and females with parasitism prevalence, or with regard to abundance

Table 2. Dispersion index (DI) results, *d* statistic, and Green's aggregation index (GI) estimated for the most important parasite species on *Astyanax altiparanae* of the upper Paraná river floodplain

Parasite	DI	*d*	GI
Monogenea			
Amphitecium sp.	2.516	11.421*	0.054
Digenea			
Ascocotyle (A.) tenuicollis	183.285	243.152*	0.051
Acanthocephala			
Quadrigyrus sp.	2.495	11.299*	0.014

**Significant values*

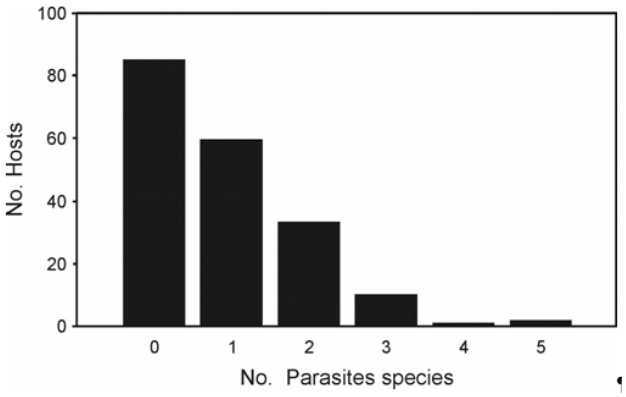

Figure 2. *Astyanax altiparanae* parasite metazoan community richness of the upper Paraná river floodplain (N= 190 hosts)

Table 3. Statistical analysis results for Spearman's "rs" rank correlation coefficient between standard length and parasitism abundance, and for "r" correlation coefficient between length and parasitism prevalence of *Astyanax altiparanae* of the upper Paraná river floodplain

Parasite	rs	p	r	p
Monogenea				
Amphitecium sp.	0.061	0.406	0.877	0.009*
Digenea				
Ascocotyle (A.) tenuicollis	0.166	0.022*	0.806	0.028*
Acanthocephala				
Quadrigyrus sp.	0.125	0.088	0.090	0.848

** Significant values*

DISCUSSION

Parasite community structure

The *Astyanax altiparanae* parasite metazoan community, consisting almost entirely of endoparasites, is probably related to the environment where it occurs and to the feeding habit of the fish. According to Hahn (*pers. com.*) this species is a trophic generalist, feeding both on higher plants and on insects, zooplankton, scales, and decomposing fish parts parts (CASSEMIRO *et al.*, 2002; LUIZ *et al.*, 1998; CASTRO and CASATTI, 1997; AGOSTINHO *et al.*, 1997; HAHN *et al.*, 1998), thus encouraging a number of parasite transmission forms.

Being a forage species that provides food to several species of piscivorous fish in the high Paraná River floodplain, tambiú plays an important role both in the trophic web and as a means for parasite metazoan species to reach their final hosts. The fact that all endoparasites were at the larval stage, such as *Quadrigyrus* sp., which was found in tambiú while the adult stage is found in *Phalacrocorax brasilianus* (Dias, 2002), reinforces the forage characteristic of the species.

The exclusive presence of satellite species (prevalence lower than 33%) demonstrates that dominance of a particular parasite species does not occur, although a high number of species was found (23 species collected).

The overdispersed distribution pattern of parasites in the sample is typical of parasitism, as demonstrated in LUQUE *et al.* (1996) and ALVES *et al.* (1996) for marine environments and also for freshwater fish parasites as previously recorded in the high Paraná River floodplain for *Cichla monoculus* (MACHADO *et al.*, 2000), *Pimelodus maculatus* (BRASIL-SATO, 1999), and *Hemisorubim platyrhynchos* (GUIDELLI, 2003).

Parasite richness refers to the number of parasite species present in the community. In *A. altiparanae*, most hosts were parasitized by a single parasite metazoan species. HOLMES (1990) points out that parasite richness is higher in fish of intermediate trophic levels, since they harbor parasites at adult stages and are also infected by several larval forms, whose final hosts in this case are fish. In tambiú, the adult forms found were exclusively ectoparasites, since endoparasites were all in the larval stage. Larval forms can also be acquired by active penetration, by the swimming of some species, by ingestion of eggs and/or larvae attached to the littoral substrate, or by direct ingestion of some larval forms of these metazoans.

There was no competition between the most prevalent parasite species, since they inhabit different sites: *Amphitecium* sp. is a monogenetic species that dwells in gills; *A. (A.) tenuicollis* is a metacercaria that lives in the heart, and *Quadrigyrus* sp. is found in the intestine and mesentery.

Standard length

The standard length of *A. altiparanae* showed a significant correlation with prevalence for the monogenetic species *Amphitecium* sp. This pattern is typical of ectoparasites, and may occur due to a cumulative effect (RHODE, 1993). The increase in number of parasitized fish may be reflected by the life strategy of this host, which lives in schools. The metacercaria *A. (A.) tenuicollis* showed significant correlation with both parasitism abundance and prevalence. The cumulative effect may also explain this correlation, since metacercariae are found in the bulbus arteriosus of the heart, where they remain encapsulated until the fish is used as food by its predator and possible final host, thus completing its cycle. Was observed that infection by this metacercaria was restricted to the month of August 2000.

Sex

ESCH *et al.* (1988) pointed out that host sex is one of the factors that influence parasitism levels. For some fish species, specimens become more susceptible in seasons comprising the reproductive period, due to physiological and behavioral changes, as is the case with *Cichla monoculus* (MACHADO *et al.*, 2000). However, studies have been conducted in which a relationship between parasitism levels and host sex in species of the high Paraná River floodplain could not be found, such as those by TAKEMOTO and PAVANELLI (1994) and MACHADO *et al.* (1994). Because no significant differences were observed between parasitism levels as a function of sex in these studies, as well as in *A. altiparanae*, it is therefore possible to suggest that ecological relations (habitat, behavior, diet) between male and female hosts are similar. FERRARI-HOEINGHAUS *et al.* (2006) too don't find difference of prevalence of parasitism according to host sex.

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