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Ecological aspects of metazoan endoparasites of *Metynnis lippincottianus* (Cope, 1870) (Characidae) from Upper Paraná River floodplain, Brazil

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Summary

We examined 44 specimens of *Metynnis lippincottianus* (Cope, 1870) (Characidae), collected in the Upper Paraná River floodplain, Brazil, from March 2006 to December 2007. Of the total number of fishes, 32 (72.7 %) were infected by at least one species of helminth (endoparasites). One digenean, *Dadayus pacupeva*, and four nematode species, *Spinoxyuris oxydoras*, *Contracaecum* sp. (larval stage), *Procamallanus* (*Spirocamallanus*) *inopinatus* and *Raphidascaris* (*Sprentascaris*) *mahnerti* were identified. *D. pacupeva* and *S. oxydoras* showed the highest values of prevalence, mean intensity and abundance. The typical pattern of overdispersion or aggregation was observed for all endoparasites. Dominance by *D. pacupeva* and *S. oxydoras* was observed in the parasite community. Positive association between *D. pacupeva* and two nematode species (*S. oxydoras* and *P.*(*S.*) *inopinatus*) was observed, including positive and significant covariation between their abundances. These results suggest that species are coexisting without competition. There was no correlation between parasitism and sex for *M. lippincottianus.*

Key words: ecology; metazoan endoparasites; *Metynnis lippincottianus*; nematodes; digenean

Introduction

Brazil has a high fish diversity, and among this fishes an icthyoparasitology study was conducted with *Metynnis lippincottianus* (Cope, 1870) (Characidae), popularly called "peixe CD". According to Froese and Pauly (2008) this species is native of South America (Rodriguez & Lewis, 1997), occurring in several Brazilian basins (Vieira, 2000; Makrakis *et al*., 2007; Silva *et al*., 2007). It has economic importance as food and it is also cultivated as an ornamental fish (Froese & Pauly, 2008). The diet of species of the genus *Metynnis* is composed by vegetal pieces and sporadically by arthropods and detritus (Sazima, 1986; Resende *et al*., 1997; Pereira *et al*., 2004; Dias *et al*., 2005). Intermediate trophic level organisms show, in general, high parasite richness and can act both as intermediate and definitive hosts (Holmes, 1990). Among the main factors influencing the composition of endoparasite communities, the feeding habit is the most important. The food items ingested by the fish can carry parasites (eggs, larval) that will determine the composition of the host parasite community (Poulin, 1998). The host´s sex can be responsible for variation in the parasite fauna due to differences in behaviour, biology, and physiology between male and female fish (Machado *et al.,* 1994; Takemoto *et al*., 1996). This paper aims to provide information on the endoparasites of *M. lippincottianus* from the Upper Paraná River floodplain, Brazil, and the influence of the host´s sex in parasitism.

Material and Methods

Forty-four specimens of *M. lippincottianus* were collected, between March 2006 and December 2007, in the Upper Paraná River floodplain (22°43`S and 53°10`W), Brazil. Fish were captured using gill nets in several sites of the floodplain: the lakes Pau Véio, Garças and Fechada and the Baia River (Fig. 1). The sex of each fish was registered, and the internal organs and visceral cavity were analyzed under stereomicroscope. The collected parasites were treated according to Eiras *et al.* (2006) and identified based on Travassos *et al.* (1969), Yamaguti (1971) and Moravec (1998).

Statistical analysis were applied to parasites species with over 10 % of prevalence and the results were considered significant when $p \leq 0.05$. The ecological terms were suggested by Bush *et al.* (1997).

Data analysis were made using the following ecological indexes and statistical tests: the Dispersion index, tested using "d" statistics in accordance with Ludwig and Rey-

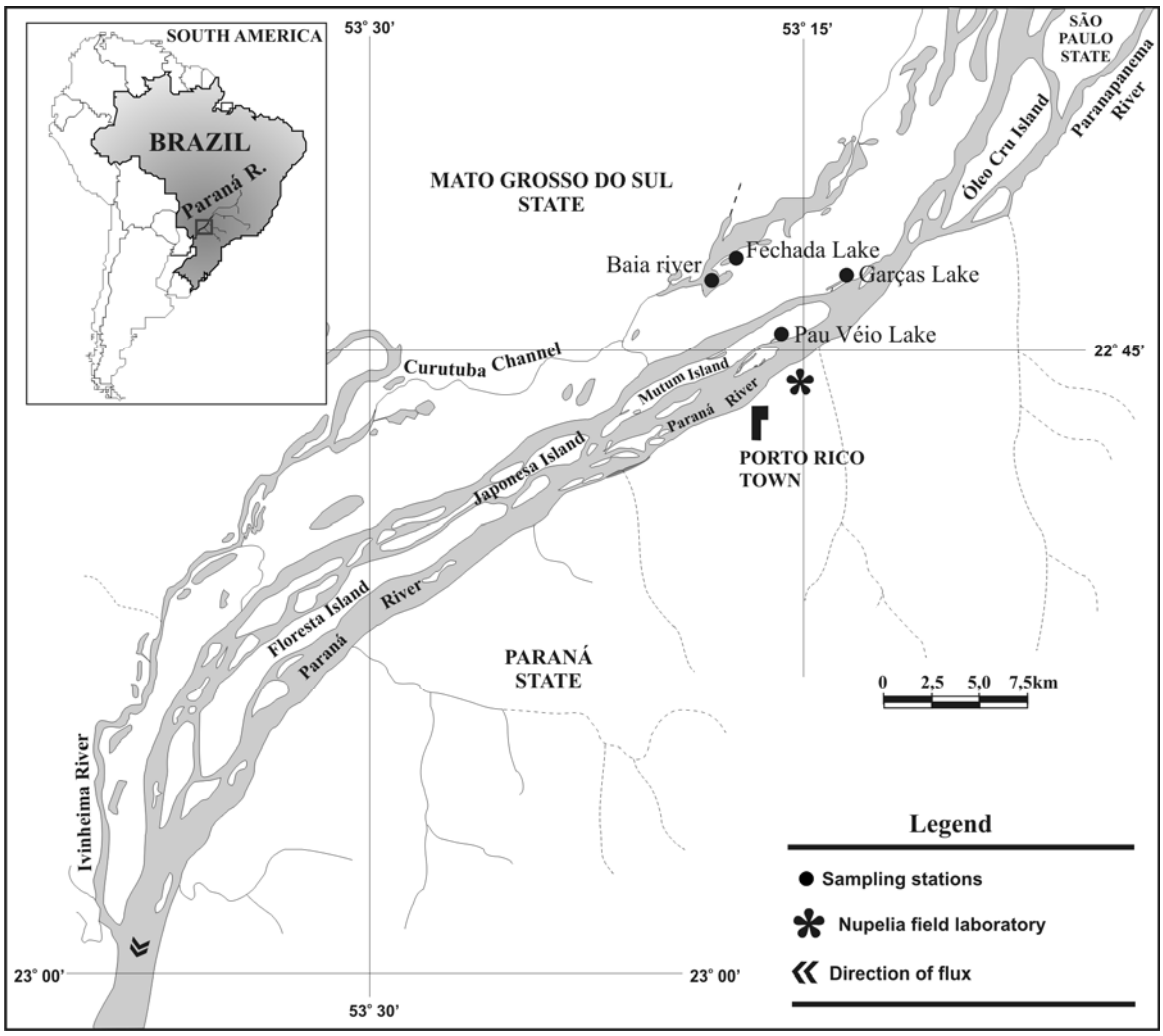

Fig. 1. Sampling stations of *Metynnis lippincottianus* in the Upper Paraná River floodplain, located between the States of Mato Grosso do Sul and Paraná, Brazil

nolds (1988), to verify the dispersion pattern of the species of parasites in the sample of hosts; the degree of overdispersion or aggregation was calculated using Green's index (Ludwig & Reynolds, 1988); Simpson's index (C) to determine dominance trends among the species of parasites, dominance being accepted when C > 0.25 (Stone & Pence, 1978); Chi-square test (χ^2) to determine the occurrence of associations between species of parasites and Spearman's rank correlation (rs) to verify correlations between abundances of the species of parasites that formed associations (Ludwig & Reynolds, 1988); "G" log likelihood test (using the 2 x 2 contingency table) and Mann-Whitney's test (U), used to determine effects of the host`s sex in the prevalence and abundance of each species of parasite, respectively (Zar, 1996). Brillouin's index (H) was used to determine the infracommunity diversity and influence of the host`s sex by using Mann-Whitney's test. Kruskal-Wallis test was used to verify the variation of parasite abundance with the environment where hosts were collected (Ayres *et al*., 2000).

Results and Discussion

Specific composition of the metazoan endoparasites

Five species of helminth endoparasites were found parasitizing *M. lippincottianus*. One digenean, *Dadayus pacupeva* Lacerda, Takemoto and Pavanelli, 2003; and four nematode species, *Spinoxyuris oxydoras* Petter, 1994; *Contracaecum* sp. Railliet and Henry, 1912 (larval stage); *Procamallanus* (*Spirocamallanus*) *inopinatus* Travassos, Artigas and Pereira, 1928 and *Raphidascaris* (*Sprentascaris*) *mahnerti* (Petter and Cassone, 1984) were identified. The host feeding habits determine the endoparasite community of fish (Dogiel, 1961), so probably the parasites found should use aquatic vegetation (main food) to infect *M. lippincottianus*. The fish occupies an initial position in the food web, being consumed by several animals, including man. *Contracaecum* sp. uses the fish as intermediate host to reach higher trophic levels, possibly composed by waterfowls, mammals and piscivorous fishes. Thus, this host, such as other fishes, is important to *Contracaecum* in the completion of its life cycle. The other four parasites use *M.*

lippincottianus as definitive host, reaching their adult form. *Spinoxyuris oxydoras*, *P.* (*S.*) *inopinatus* and *R.* (*S.*) *mahnerti* are generalists nematodes and have being identified parasitizing several hosts (Moravec, 1998).

Structure of the community of metazoan endoparasites

Of the 44 hosts examined, 32 (72.7 %) were infected by at least one species of helminth endoparasite. *Dadayus pacupeva* and *S. oxydoras* showed the highest values of prevalence, mean intensity and abundance. The values for all species are in Table 1.

kind of distribution (Dobson, 1990). Aggregation can be a life strategy of the parasite to maximize its fitness, enabling largest gathering of specimens by reproduction (Holmes, 1990) or due to aggregate distribution of parasites in the environment or to the heterogenic physiology of the hosts (Poulin, 1998).

The parasites *D. pacupeva* and *S.oxydoras* (the most prevalent) showed dominance (C = 0.2967) in the community. Thus these two parasites presented the highest values of prevalence, mean abundance and mean intensity, occurring in more than 60 % of the analyzed fish, and consequently, dominating the parasite community of *M. lippincottianus*. Positive association between *D. pacupeva* and two nematode species (*S. oxydoras* and *P.*(*S.*) *inopinatus*) was observed, as well as positive and significant covariation between their abundances (Table 2). These results suggest that the species are coexisting without competition, probably there is space and food enough in the fish for the development of all species (same ecological requirements) (Guidelli *et al*., 2006; Lizama *et al*., 2006; Karvonen *et al*., 2007).

Table 1. Number of Specimens (N), Prevalence (P), Mean Abundance (MA), Mean Intensity (MI) and Amplitude (A) of the helminth species in *M. lippincottianus* (Cope, 1870) from the Upper Paraná River floodplain, Paraná State, Brazil

Parasite species	**N**	**P(%)**	**MA**	**MI**	**A**
Digenea					
Dadayus pacupeva	3568	61.4	81.1	132.1	1 – 575
Nematoda					
Spinoxyuris oxydoras	2879	63.6	65.4	102.8	1 – 479
Procamallanus (*Spirocamallanus*) *inopinatus*	44	43.2	1.00	2.3	1 – 9
Raphidascaris (*Sprentascaris*) *mahnerti*	1	2.3	0.02	1.0	-
Contracaecum sp. (larval)	8	11.4	0.18	1.6	1 – 4

According to Green's index of aggregation and the Dispersion index the endoparasites *D. pacupeva* (GI = 0.0585; DI = 209.9; d = 124.1), *S. oxydoras* (GI = 0.0514; DI = 148.9; d = 104.8), *P.* (*S.*) *inopinatus* (GI = 0.0438; DI = 2.9; d = 6.5) and *Contracaecum* sp. (GI = 0.1960; DI = 2.3; d = 5.0) showed the typical pattern of overdispersion or aggregation of the parasite population. Several fish species of the Upper Paraná River floodplain (Machado *et al*., 1996; Machado *et al*., 2000; Guidelli *et al*., 2003; Lacerda, 2007) showed this overdispersion pattern in their parasite community, usually parasites less pathogenic show this

Table 2. Association of endoparasite species of *Metynnis lippincottianus* (Cope, 1870) collected in the Upper Paraná River floodplain, Paraná State, Brazil. (χ^2 = Chi-square for associations of pairs of species, rs = Spearman's rank correlation of species abundance of each pair)

Parasite species	**1**	**2**	**3** **"rs"**	**4**
Dadayus pacupeva **(1)**	#	0.87*	0.30*	0.15
Spinoxyuris oxydoras **(2)**	(+) 35.97*	#	0.37*	-0.001
Procamallanus (*Spirocamallanus*) *inopinatus* **(3)**	(+) 4.03*	(+) 3.04	#	-0.02
Contracaecum sp. (larval) **(4)**	(+) 1.95	(+) 1.69	(-) 0.05	#
*significant values		χ^2		

Table 3. Values of the "G" log likelihood test and Mann-Whitney's test (U), used to determine effects of the host`s sex on the prevalence and abundance of each species of parasite in *Metynnis lippincotianus* from the Upper Paraná River floodplain, Paraná State, Brazil, respectively (Z(U)=normal approximation, p= significance level)

Parasite species	**G**	**P**	**Z(U)**	**P**
Dadayus pacupeva	0.015	0.902	0.589	0.556
Spinoxyuris oxydoras	0.089	0.766	0.206	0.837
Procamallanus (*Spirocamallanus*) *inopinatus*	-	-	1.768	0.077
Contracaecum sp. (larval)	0.24	0.623	0.295	0.768

Host's sex influence

Among the analyzed fish specimens, four were male and three (75 %) of them were parasitized by at least one species of parasite. Twenty-one out of 27 analyzed female were parasitized by at least one species of parasite, resulting in prevalence of 77.8 %. Thirteen out of 44 hosts collected could not have their sex determined. According to the values obtained from the "G" log likelihood test and Mann-Whitney's test, the host`s sex did not influence the prevalence and abundance of parasite infection, respectively (Table 3). Although the sex of the host may be an important factor influencing the levels of parasitism in the fish, due to behavioural and physiological (hormones, mucus) differences (Paling, 1965; Esch *et al*., 1988; Moser & Hsieh, 1992), it did not happen in *M. lippincottianus*. Possibly similar diets and reproductive strategies (without parental care or lack of migration) between males and females (Hahn *et al.*, 2004; Suzuki *et al.*, 2004) resulted in the same parasitism levels. Previous studies with the fishes *Pseudoplatystoma corruscans* (Machado *et al*., 1994), *Paulicea luetkeni* (=*Zungaro zungaro*) (Takemoto & Pavanelli, 1994) and *Prochilodus lineatus* (Lizama *et al*., 2005) in the Upper Paraná River floodplain, did not show influence of the host`s sex on parasitism, such as the present work. The independence of prevalence and abundance in relation to the sex of *M. lippincottianus* can constitute evidence that the diet and distribution in the environment (ecological relationships) are similar between males and females.

There were no statistical significant differences (Z(U) = 0.47 and p = 0.6374) of the endoparasite diversity between males and females, mean Brilouin index 0.4318 and 0.4130, respectively. Probably this fact is due to the behaviour and other features (ecological relationships) similar in males and females, discussed previously. As the fish were collected using gillnets, we could not have an equal division between the sexes, resulting in larger number of females and few males (only four). Perhaps this sampling problem might have influenced the results.

Influence of the environments on the abundance of parasites in the Upper Paraná River floodplain

Dadayus pacupeva (H = 23.623; p < 0.0001) and *S. oxydoras* (H = 22.449; p = 0.0001) showed significant statistical differences in abundance according to the collection site, but not for *P.*(*S.*) *inopinatus* and *Contracaecum* sp. *Dadayus pacupeva* was not found in the Pau Véio Lake and had the highest mean abundance in the Baia River (Mean Abundance = 185.86). *Spinoxyuris oxydoras* was not found in the Pau Véio Lake and the highest abundance in the Fechada Lake (Mean Abundance = 102.000 (Fig. 2). Probably limnological characteristics (Pavanelli *et al.,* 1997) or absence of intermediate hosts or vegetation (used as food) (Pereira *et al*., 2004; Dias *et al*., 2005) resulted in

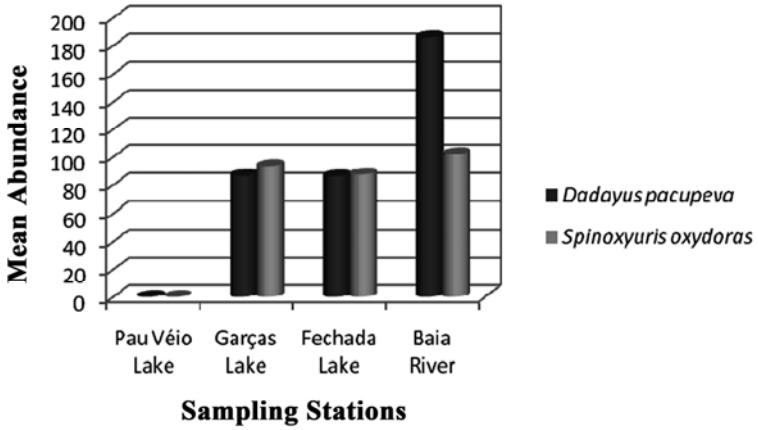

Fig. 2. Mean Abundance of *Dadayus pacupeva* and *S. oxydoras* collected in Pau Véio Lake, Garças Lake, Fechada Lake and Baia River, environments of Upper Paraná River floodplain

the absence of these parasites in the Pau Véio Lake. On the other hand, there must be favourable factors allowing the life cycle of the digenean (intermediate hosts) and nematodes (vegetation) (Sazima, 1986; Resende *et al*., 1997) in the Baia River and the Fechada Lake, respectively. Probably the absence of correlation between *P.(S.) inopinatus* and *Contracaecum* sp. is because their possible intermediate hosts, chironomids and microcrustaceans, respectively, are present in all studied sites.

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