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ORIGINAL ARTICLE / ARTÍCULO ORIGINAL

PARASITISM ASSOCIATED WITH LENGTH AND GONADAL MATURITY STAGE OF THE FRESHWATER FISH *METYNNIS LIPPINCOTTIANUS* (CHARACIDAE)

PARASITISMO ASOCIADO A LA LONGITUD Y AL ESTADO DE MADUREZ GONADAL DEL PEZ DE AGUA DULCE *METYNNIS LIPPINCOTTIANUS* (CHARACIDAE)

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Abstract

Parasitism was observed in 72.7% of 44 specimens of *Metynnis lippincottianus* (Cope, 1870) (Characidae) caught in the Upper Paraná River floodplain, Brazil. One species of digenean, *Dadayus pacupeva* Lacerda, Takemoto & Pavanelli, 2003, and four species of nematodes, *Spinoxyuris oxydoras* Peter, 1994, *Contracaecum* sp. Railliet & Henry, 1912 (larval stage), *Procamallanus* (*Spirocamallanus*) *inopinatus* Travassos, Artigas & Pereira, 1928 and *Raphidascaris* (*Sprentascaris*) *mahnerti* Petter & Cassone, 1984 were identified. The prevalence of *D. pacupeva* was correlated with the host's standard length. Correlations between the host's standard length and the abundance of *S. oxydoras*, *P.* (S.) *inopinatus* and *D. pacupeva* were observed. In addition, fish length was correlated with the diversity of parasites. *D. pacupeva* and *S. oxydoras* had their abundances influenced by the host's gonadal maturity stage. According to gonadal maturity stage, the host may or may not have an increased susceptibility to parasites, suggesting a cumulative process causing higher parasite abundance in larger fish and in the mature stage (more time of exposure) than the immature stage (young fish).

Keywords: Brazil - Characidae - digeneans - endoparasites - *Metynnis lippincottianus* - nematodes.

Resumen

Basado en el examen de 44 especímenes de *Metynnis lippincottianus* (Cope, 1870) (Characidae) muestreados en la llanura de inundación del Alto rio Paraná, Brasil, el parasitismo fue observado en 72,7% de los peces. Una especie de digeneo, *Dadayus pacupeva* Lacerda, Takemoto & Pavanelli, 2003, y cuatro especies de nemátodos, Peter, 1994, *Contracaecum* sp. Railliet & Henry, 1912 (forma larval), *Procamallanus* (*Spirocamallanus*) *inopinatus* Travassos, Artigas & Pereira, 1928 y *Raphidascaris* (*Sprentascaris*) *mahnerti* Petter & Cassone, 1984 fueron identificados. La prevalencia de *D. pacupeva* se correlacionó con la longitud estándard del huésped. Se observaron correlaciones entre las longitudes estándard del huésped y la abundancia de *S. oxydoras*, *P.* (*S.*) *inopinatus* y *D. pacupeva*. Además la longitud del pez estubo correlacionada con la diversidad de los parásitos. *D. pacupeva* y *S. oxydoras* tuvieron sus abundancias influenciadas por el estado de madurez gonadal. De acuerdo con el estado de madurez gonadal, el húesped puede o nó tener un aumento de la susceptibilidad a los parásitos, lo que sugiere un proceso acumulativo causando elevada abundancia de parásitos en los peces mayores y en el estado maduro (mayor tiempo de exposición) que en el estado inmaturo (peces jóvenes).

Palabras clave: Brasil - Characidae - digeneos - endoparásitos - *Metynnis lippincottianus* - nemátodos.

INTRODUCTION

A parasitological study was conducted with *Metynnis lippincottianus* (Cope, 1870) (Characidae) from the Upper Paraná River floodplain, collected from March 2006 to December 2007. *M. lippincottianus* is a freshwater fish native to South American basins that lives in waters with temperatures between 20 and 28ºC (Froese & Pauly, 2009). This species has commercial (ornamental fish) and ecological importance, because it belongs to the second trophic level in the local food web (herbivorous); its diet consists of plant pieces and sporadically of arthropods and detritus (Dias *et al.*, 2005). The host's standard length and maturity stage can determine high or low levels of parasitism. Changes in the diet of fish between young and adults allied to accumulative processes result in different levels of parasitism for different fish lengths. The exposure to parasites and the host health are also influenced by gonadal maturity stage (GMS) (Bush *et al.*, 2001). This paper aims to provide information about the accumulative process of parasites influenced by the host's standard length and GMS in *M. lippincottianus*.

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. Fishes were captured using gill nets. The standard length and GMS of each fish were registered, and the internal organs and visceral cavity were analysed under a stereomicroscope. The collected parasites were treated according to Eiras *et al.* (2006) and identified according to Travassos *et al.* (1969); Yamaguti (1971); Moravec (1998) and Lacerda *et al.* (2003). Prevalence and abundance were determined for all identified parasite species. GMS was determined following the scale proposed by Vazzoler (1996).

Data analyses were made using the following statistical tests: Spearman's rank correlation (*rs*) and the Pearson linear correlation (*r*) were used to verify correlations between the host's standard length and the abundance and prevalence of parasites, respectively. Fish were separated into length classes, with angular transformation (arc sine $\sqrt{x}$) of prevalence data prior to using Pearson's linear correlation (*r*). Diversity of the parasite community was evaluated using the Brillouin index, and Spearman's rank correlation was used to correlate the diversity of parasites and the host's length. The Kruskal–Wallis test was used to verify the variation of parasite abundance according to the host's GMS (Zar, 1996). Statistical analysis was applied to parasite 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).

RESULTS

Of the 44 examined hosts, 32 (72.7%) were infected by at least one species of helminth

Table 1. Number of specimens (N), prevalence (P), mean abundance (MA), mean intensity (MI) and amplitude of infection (A) of the parasitic helminthes of *Metynnis lippincottianus* collected in the Upper Paraná River floodplain, Paraná, Brazil.

Parasite	N	P(%)	MA	MI	A
Digenea					
Dadayus pacupeva	3568	61.4	81.09	132.1	1-575
Nematoda					
Spinoxyuris oxydoras	2879	63.6	65.43	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

endoparasite. One digenean, *Dadayus pacupeva* (Lacerda, Takemoto & Pavanelli, 2003) and four nematode species, *Spinoxyuris oxydoras* (Petter, 1994), *Contracaecum* sp. (larval stage; Railliet & Henry, 1912), *Procamallanus* (*Spirocamallanus*) *inopinatus* (Travassos, Artigas & Pereira, 1928) and *Raphidascaris* (*Sprentascaris*) *mahnerti* (Petter & Cassone, 1984) were identified. The number of collected specimens, prevalence, mean abundance, mean intensity and amplitude of infection for each parasite species are presented in Table 1.

The host's standard length varied from 1.4 to 13.4 cm. Significant positive correlation between the host's standard length and the prevalence of *D. pacupeva* and *S. oxydoras* (r = 0.83; p = 0.04 and r = 0.81; p = 0.05, respectively) was observed (Fig. 1).

There was a significant positive correlation between standard length and abundance of the following parasite species: *S. oxydoras*, *P.* (*S.*) *inopinatus* and *D. pacupeva* from the Upper Paraná River floodplain (Fig. 2).

The average infracommunity diversity of the parasites of *M. lippincottianus* in the Upper Paraná River floodplain was 0.3371 (Brillouin index). A positive correlation was found between the diversity of parasites and the host's standard length (rs = 0.68; p < 0.001).

Five GMS were reported: immature, rest, maturing, ripe and semi-spent, according to Vazzoler (1996). There was significant influence of the GMS on parasite abundance only in *D. pacupeva* (H = 24.67; p < 0.001) and *S. oxydoras* (H = 24.50; p < 0.001).

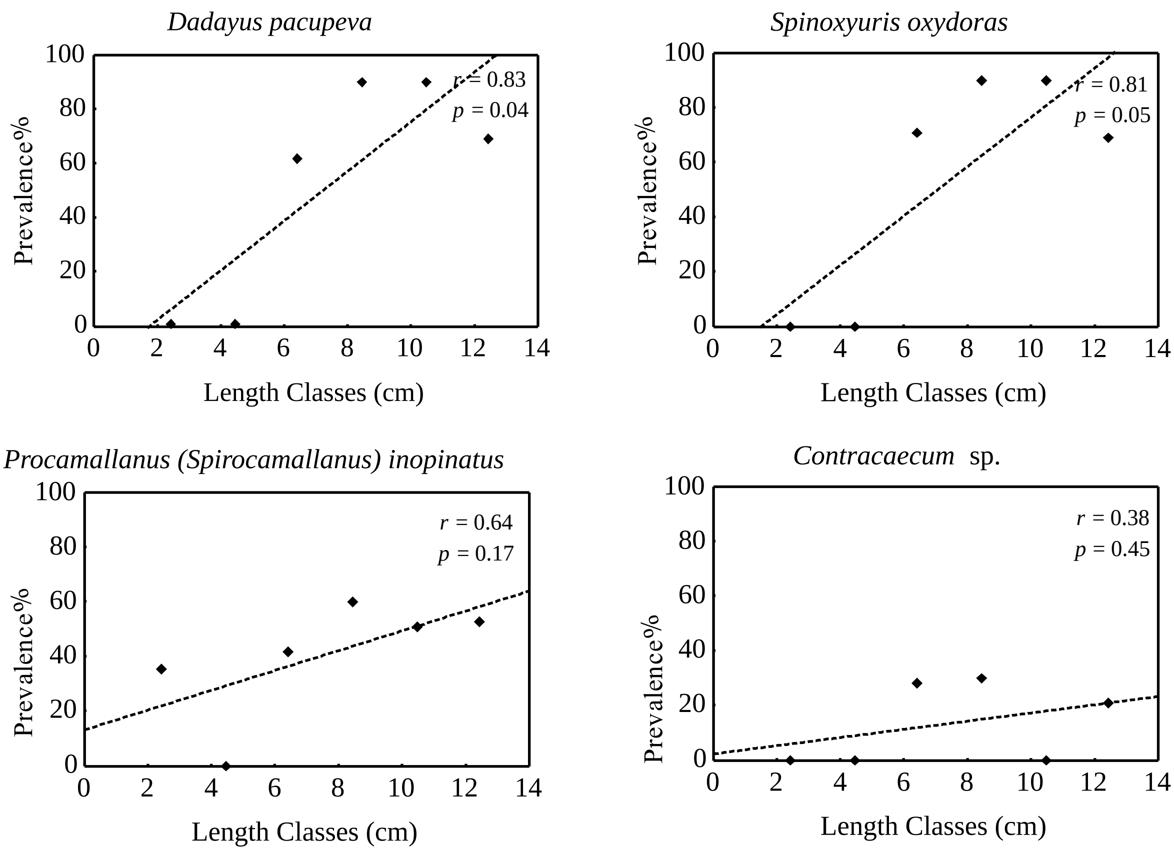

Figure 1. Correlation between the standard length of *Metynnis lippincotianus* and the prevalence of *Dadayus pacupeva*; *Spinoxyuris oxydoras*; *Procamallanus* (*Spirocamallanus*) *inopinatus*; and *Contracaecum* sp. in the Upper Paraná River floodplain, Paraná, Brazil (r = Pearson's linear correlation, p = significance level).

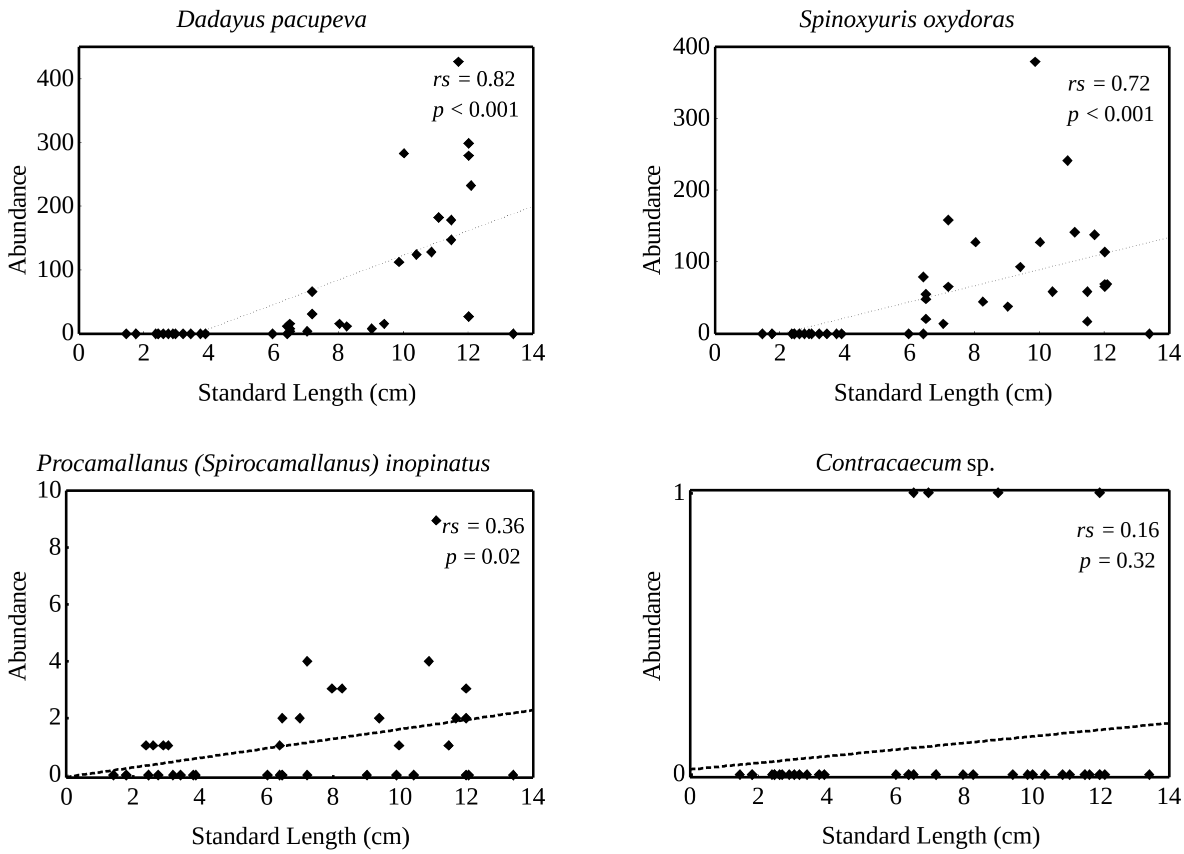

Figure 2. Correlation between standard length of *Metynnis lippincottianus* and abundance of *Dadayus pacupeva*; *Spinoxyuris oxydoras*; *Procamallanus* (*Spirocamallanus*) *inopinatus* and *Contracaecum* sp. in the Upper Paraná River floodplain, Paraná, Brazil (*rs* = Spearman's rank correlation, *p* = significance level).

DISCUSSION

During ontogeny, changes occur in the behaviour and biology of fish (Takemoto *et al.*, 1996). Probably the diet of *M. lippincottianus*, which is mainly composed of vegetation, allowed its infection (ingestion of parasite structures) and the fish became the definitive host of *D. pacupeva*, *S. oxydoras*, *P.* (*S.*) *inopinatus* and *R.* (*S.*) *mahnerti*. However, *Contracaecum* sp. used the fish to reach higher trophic levels (piscivorous fishes and birds), making *M. lippincottianus* act as an intermediate host. The nematodes identified are reported in several fishes due to their low specificity (Moravec, 1998). Some changes in the diet or habitat can make the adults more vulnerable (Dogiel, 1961; Hanek & Fernando, 1978) to the parasite *D. pacupeva*.

Positive correlations between the standard length of the host and prevalence were reported previously in the floodplain with proteocephalid cestodes in *Paulicea luetkeni* (Humboldt, 1821) (=*Zungaro zungaro*) (Takemoto & Pavanelli, 1994), *Proteocephalus microscopicus* (Woodland, 1935), *Proteocephalus macrophallus* (Diesing, 1850) and *Sciadocephalus megalodiscus* Diesing, 1850 in *Cichla monoculus* Kullander & Ferreira, 2006 (=*Cichla kelberi*) (Machado *et al.*, 2000), *Goezeella paranaensis* Pavanelli & Rego, 1989, *Spatulifer maringaensis* Pavanelli & Rego, 1989 and *Mariauxiella piscatorum* Chambrier & Vaucher, 1999 in *Hemisorubim platyrhynchos* (Valenciennes, 1840) (Guidelli *et al.*, 2003) and the nematode *Rondonia rondoni* Travassos, 1920 in *Pterodoras granulosus* (Valenciennes, 1821) (Dias *et al.*, 2004).

A significant positive correlation between the standard length of the host and abundance is expected in parasites that show low damage to the host; thus the fish can increase in size and weight, regardless of parasitism, being capable of harbouring a larger amount of parasites (Poulin, 1998). The relationship between body length of the host and parasitic abundance can be a result of the process of temporal accumulation (Isaac *et al.*, 2000), increase (Zelmer & Arai, 1998) or change (Machado *et al.*, 2000) of ingested food and the dimensions of the sites of infection (internal organs) as a function of growth (Luque *et al.*, 1996). Diet changes in adult fishes can include a large number of items used in the life cycle of parasites, such as intermediate hosts or even aquatic plants containing parasite structures (larvae, eggs), resulting in higher abundance in larger fishes.

Despite being a tropical fish, usually with many parasites (Lizama *et al.*, 2005), the endoparasite diversity was low when compared to that in temperate regions (Hanzelová *et al.*, 2001). A positive correlation was found between the diversity of parasites and the host's standard length. Probably the larger size of the fish indicates more food variation during its ontogeny, and, allied to larger sites of infection, results in higher parasite diversity (Dogiel, 1961). Positive correlations have been found in other hosts of the Upper Paraná River floodplain (e.g. Yamada *et al.*, 2007).

The Gonadal maturity stage can determine higher or lower exposure of the fish to parasitism (migration to places presenting parasites) or even its susceptibility to parasites (due to the lack of food or stress). The immature stage presented the lowest abundances of *D. pacupeva* and *S. oxydoras*, possibly because of the low exposure to parasites or some variation in the feeding of younger fishes (such as food items that are not part of their diet, but will be when they become adults) (Poulin, 1998). This could explain the fact that fish with more advanced GMS have high abundances of *D. pacupeva* and *S. oxydoras*, even though the abundance of specimens at the rest stage are a little higher in maturation. The semi-spent stage, in which the fish were more debilitated (lack of food, high stress and hormonal changes) (Vazzoler, 1996), showed the highest parasitic abundance. Probably the length of time of exposure to parasites (accumulative process) and the food shortages of the semi-spent stage of adult fishes resulted in high abundance.

High values of abundance of *D. pacupeva* and low abundance of *S. oxydoras* in the mature stage may not reflect reality, because at this stage only one specimen of *S. oxydoras* was collected. The study of the gonadosomatic index is used as a tool to increase the knowledge of the reproductive biology of a fish population. Gil de Pertierra & Ostrowski de Nuñez (1990) showed that the reproductive phase of the fish *Rhamdia sapo* (Valenciennes, 1836) coincided with the maximum egg production of the cestode *Proteocephalus jandia* Woodland, 1934, whereas the output of gonadotropin by the fish was in synchrony with the peak of the ovoposition of the parasite. This may explain the greater abundance of *D. pacupeva* and *S. oxydoras* at the end of the reproductive period. The absence of mature specimens and/or in reproduction makes it difficult to confirm these results.

The gonadal maturity stage data partially corroborate the data on the standard length of the host, showing higher abundances of *D. pacupeva* and *S. oxydoras* in hosts with greater standard length. Other studies have demonstrated that increased reproductive effort may result in higher prevalence and intensity of parasitism (e.g. Gustafsson *et al.*, 1994; Oppliger *et al.*, 1996; Sorci *et al.*, 1996). Because both reproduction (Reznick, 1985) and immune responses (Klasing *et al.*, 1991) are costly, reproduction may increase susceptibility to parasites by reducing energy available for immunological defense. Thus, adult fishes (greater abundance of *D. pacupeva* and *S. oxydoras*) that become reproductive reaching the semi-spent stage showed the highest abundances of these parasite species, while the immature (small fishes) showed low abundances.

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