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The influence of parasitism on the relative condition factor (Kn) of *Metynnis lippincottianus* (Characidae) from two aquatic environments: the upper Parana river floodplain and Corvo and Guairacá rivers, Brazil

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ABSTRACT. The study analyzed 84 specimens of *Metynnis lippincottianus* (Cope, 1870) (Characidae) from two environments with different degrees of impact due to a hydroeletric plant; 44 hosts from the upper Parana river floodplain (low degree of impact) and 40 from Paranapanema tributaries (Corvo and Guairacá rivers, high degree of impact). The prevalence found, among the total collected fishes, was 77.4%. One digenetic species, *Dadayus pacupeva*, and four nematodes, *Spinoxyuris oxydoras*, *Contracaecum* sp. (larval stage), *Procamallanus (Spirocamallanus) inopinatus* and *Raphidascaris (Sprentascaris) mahnerti* were identified. In the floodplain, the fishes parasitized by *D. pacupeva* and *S. oxydoras* presented better relative condition factor (Kn) than non-parasitized species. Positive correlation between Kn and abundance of these parasites was found in the same area. In the tributaries, the Kn did not differ significantly between parasitized an non-parasitized fishes, not even correlation with abundance of any parasite found.

Key words: ecology, parasites, nematode, digenetic, hydroelectric plants.

RESUMO. Influência do parasitismo sobre o fator de condição relativo (Kn) de *Metynnis lippincottianus* em dois ecossistemas aquáticos: planície de inundação do alto rio Paraná e rios Corvo e Guairacá, Brasil. Foram coletados 84 espécimes de *Metynnis lippincottianus*, peixe caracídeo, em dois ecossistemas com diferentes níveis de impacto, resultante da construção de usinas hidroelétricas; 44 hospedeiros na planície de inundação do alto rio Paraná (baixo impacto) e 40 nos tributários do rio Paranapanema (rios Corvo e Guairacá) com alto impacto. Foi encontrada prevalência parasitária de 77,4% no total de peixes coletados. Uma espécie de digenético: *Dadayus pacupeva* e quatro de nematoides: *Spinoxyuris oxydoras*, *Contracaecum* sp. (estágio larval), *Procamallanus (Spirocamallanus) inopinatus* e *Raphidascaris (Sprentascaris) mahnerti* foram identificadas. Na região da planície, os peixes parasitados por *D. pacupeva* e *S. oxydoras* apresentaram melhor fator de condição relativo (Kn) quando comparado aos não-parasitados. Verificou-se correlação positiva entre o Kn e a abundância dos parasitos citados anteriormente na mesma região. Nos tributários, não houve diferença estatisticamente significativa entre o Kn dos peixes parasitados e não-parasitados, nem correlação do mesmo com a abundância de nenhum parasito encontrado.

Palavras-chave: ecologia, parasitas, nematóides, digenéticos, hidrelétricas

Introduction

Ichthyology studies become necessary due to high fish diversity found in our country, the result of a rich river system. The present work was conducted with a fish species, *Metynnis lippincottianus* (Cope, 1870) (Characidae), commonly know as 'pacu CD'. This freshwater fish is native to South America (REIS et al., 2003; LASSO et al., 2004; BOGOTÁ-GREGORY; MALDONADO-OCAMPO, 2006), living in several Brazilian basins (VIEIRA, 2000; MAKRAKIS et al., 2007; SILVA et al., 2007). Its diet is composed of vegetal sources (benthonic and phytoplanktonic algae) and occasionally by arthropods and debris (SAZIMA, 1986; RESENDE et al., 1997; PEREIRA et al., 2004; DIAS et al., 2004). *M. lippincottianus* shows commercial importance, used in aquaculture (ornamental fish), and ecological importance by occupying the second trophic level in the food web. It is known that the feeding habits of fishes have

direct influence on the diversity of parasites that infect the host, as food items can act as disseminators of several parasites species (DOGIEL, 1961; GUIDELLI et al., 2003).

The increase in energy consumption in our country resulted in the installation of several hydroelectric plants, forming reservoirs, changing limnological traits of aquatic ecosystems (lack of natural/seasonal variation in water levels) (JOBIN, 1999). Studies concerning the impact of constructions on fish parasites are scarce, so the present study is proposed to analyze them using the relative conditional factor (Kn) comparing the parasite community of *M. lippincottianus* in two places, with low (the floodplain) and high (tributaries of the Paranapanema river, rivers Corvo and Guairacá) impact due to the installation of hydroelectric plants. When correlated with parasite abundance, Kn is an important tool for studying host-parasite interactions (LIZAMA et al., 2006), because it serves as a quantitative indicator of fish welfare (VAZZOLER, 1996). Many studies with fish parasites focus only on taxonomy and pathology; this work, however, is proposed to study the ecological relationships involved in parasitism.

The knowledge of the ecological relationships (parasitism) helps in the control of these diseases in an intensive farming system (commercial aquaculture), assisting in the planning of control measures (GUIDELLI et al., 2006).

Material and methods

The locations chosen for the collections represent respectively a habitat that has suffered the indirect impacts of the construction of hydroelectric plants, and there are still seasonal flooding and drought (the upper Paraná river floodplain), in contrast to an environment heavily impacted by human action (tributaries Corvo and Guairacá). This impact was mainly caused by the formation of the Rosana reservoir (formed in 1987), for electricity production, which increased the water level and flood the tributaries, changing the limnological dynamics of previously small watercourses, making water level constant.

The upper Paraná river floodplain is located near Porto Rico, State of Paraná (22°43'S and 53°10'W). Collections were made in several environments of the floodplain, such as canals, rivers and lakes (open and closed). Corvo and Guairacá rivers belongs to the lower Paranapanema river and are directly influenced by the reservoir of the Rosana hydroelectric plant (22º36'S; 52º52'W) (CESP, 1998). The two tributaries were considered, for analysis, as a single sampling unit.

The collection of hosts from the upper Paraná river floodplain took place from March 2006 to December 2007. The collections in Corvo and Guairaca began in April 2006 until August 2006. Fish captures were performed using gill nets, with different mesh sizes, exposed for a period of 24 hours with collections every 8 hours. Procedures for necropsy of the hosts, collection, preservation and preparation of endoparasites were according to Eiras et al. (2006). The relative condition factor (Kn) was calculated according to Le Cren (1951).

The Mann-Whitney non-parametric test was used to verify possible differences between the relative condition factor (Kn) of parasitized and not parasitized fish (SIEGEL, 1975). The relationship between Kn and abundance of each parasite species was verified by Spearman's rank correlation coefficient 'rs'. Statistical tests were applied only to the species that showed prevalence higher than 10% (BUSH et al., 1997). The level of statistical significance adopted was $p \leq 0.05$.

Results and discussion

Forty-four specimens of *M. lippincottianus* were collected in the upper Paraná river floodplain, showing parasite prevalence of 72.7%. The following parasites were found; *Procamallanus (Spirocamallanus) inopinatus* Travassos, Artigas and Pereira, 1928, *Contracaecum* sp. Railliet and Henry, 1912, *Dadayus pacupeva* Lacerda, Takemoto and Pavanelli, 2003, *Raphidascaris (Sprentascaris) mahnerti* Petter and Cassone, 1984 and *Spinoxyuris oxydoras* Peter, 1994. Using the Mann-Whitney U Test, no differences verified between relative condition factor (Kn) of not parasitized and parasitized fishes by *P. (S.) inopinatus* and *Contracaecum* sp. However, they differed significantly for *D. pacupeva* and *S. oxydoras*, where the highest Kn values was found in parasitized fishes (Table 1).

Table 1. Mann-Whitney U Test checking for differences in the relative condition factor (Kn) of parasitized and non parasitized hosts and Spearman's rank correlation coefficient 'rs' comparing the relative condition factor with parasite abundance in the upper Paraná river floodplain.

Parasite	Z(U)	p	'rs'	p
Dadayus pacupeva	2.634	0.0084*	0.5794	0.0001*
Spinoxyuris oxydoras	3.1407	0.0017*	0.4357	0.0055*
Procamallanus (Spirocamallanus) inopinatus	1.2082	0.227	0.1641	0.318
Contracaecum sp. (larva)	0.3162	0.7518	0.0513	0.7564

*significance.

Dadayus pacupeva and *S. oxydoras* from the upper Paraná river floodplain showed positive and significant correlation between their abundances and Kn (Table 1) (Figure 1). However, *P.(S.) inopinatus* and *Contracaecum* sp. showed no significant correlation, but the hosts

gained weight and grew independently of parasitism to these two species of nematodes.

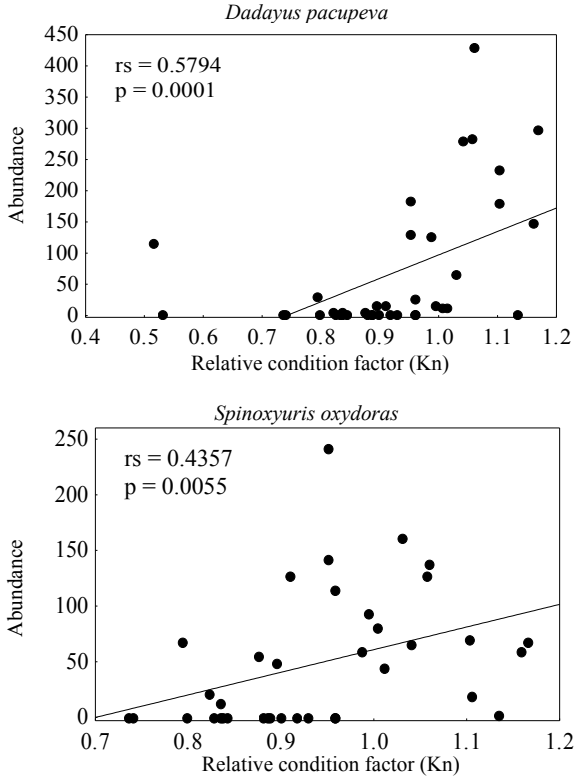

Figure 1. Relationship between the abundance of parasites *D. pacupeva* and *S. oxydoras* with the relative condition factor (Kn) of *M. lippincottianus* in the upper Paraná river floodplain (rs = Spearman's rank correlation coefficient, p = significance level).

Whereas parasites are pathogenic to the host, it is expected to find a negative correlation between the relative condition factor and abundance/prevalence of parasites. However, many times hosts can contain high parasite levels without affecting the relative condition factor (DIAS et al., 2004). Lizama et al. (2006) observed a positive relationship between Kn and abundance of some parasites species in *Prochilodus lineatus*, suggesting that fishes with better Kn withstand higher parasites levels. This correlation may be explained by greater food quantity (abundance) in the digestive tract for the parasites, more physical space available and greater intake of food that may contain infective forms in fishes with higher Kn. The positive correlation in *M. lippincottianus* to parasites *D. pacupeva* and *S. oxydoras* is probably due to the same ones not make a lot of damage (low levels) in the host, since not influenced the Kn negatively, allied with better ability of fishes with higher Kn to contain parasites.

Previous studies conducted in the floodplain, to host *Satanoperca pappaterra*, also reported positive correlation between the Kn and parasitism by monogenetic *Sciadicleithrum* sp. (YAMADA et al., 2008).

Forty specimens of *M. lippincottianus* were collected in the Paranapanema tributaries (Corvo and Guairacá rivers), showing parasite prevalence of 82.5%. The parasites found were: *Contracaecum* sp. (larvae), *D. pacupeva* and *S. oxydoras*. No statistically significant difference was found in the relative condition factor (Kn) between hosts not parasitized and parasitized by *D. pacupeva* and *S. oxydoras*. Additionally, no significant correlation was found between Kn and abundance of parasites found (Table 2). Thus, *M. lippincottianus* is growing and gaining weight independent of parasitism (prevalence and abundance). Perhaps this occurs because food availability in the tributaries is different from the floodplain, where maybe there is a scarce presence of intermediate hosts or unfavorable conditions to ingestion of infective forms. Another factor that makes possible lack of correlation is low parasite pathogenicity, which did not influence the Kn/parasitism correlation, as would happen if they were high virulence parasites (POULIN, 1998).

Table 2. Mann-Whitney U Test to verify differences between the host's relative condition factor (Kn) ad the occurrence of parasitism. Spearman's rank correlation coefficient 'rs' to correlate relative condition factor with abundance of parasites species in *Metynnis lippincottianus* from the Paranapanema tributaries. (Z(U) = normal approximation, p = significance level).

Specie	Z(U)	p	'rs'	p
Dadayus pacupeva	0.4734	0.6359	-0.1348	0.4070
Spinoxyuris oxydoras	0.4805	0.6308	-0.0156	0.9239

Conclusion

Using the relative condition factor (Kn), it was possible to note the low pathogenicity of parasites *D. pacupeva* and *S. oxydoras* on host *Metynnis lippincottianus*, thus, both were classified as low virulence parasites. It was possible observe that low pathogen parasites can occur in high abundance in the host, without negatively influencing its Kn, and can even show positive correlations between them.

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