Ecological aspects of endoparasite fauna of *Acestrorhynchus lacustris* (Lütken, 1875) (Characiformes, Acestrorhynchidae) on the Upper Paraná River floodplain, Brazil

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ABSTRACT. Fifty-one specimens of *Acestrorhynchus lacustris* (Lütken, 1875) collected on the Upper Paraná River floodplain were analyzed from February 2000 to November 2001. Of these, 35 (68.6%) were parasitized by at least one species of endohelminth. Eight species of endoparasites were found: five nematodes (*Contracaecum* Type 1 larvae of Moravec, Kohn and Fernades, 1993, *Contracaecum* Type 2 larvae of Moravec, Kohn and Fernades, 1993, *Contracaecum* sp., *Eustrongylides* sp. and *Procamallanus* sp.), two digeneans (*Clinostomum* sp. and *Rhipidocotyle gibsoni* Kohn and Fernandes, 1994) and one acanthocephalan (*Quadrigyrus torquatus* Van Cleave, 1920). *Contracaecum* sp. and *Q. torquatus* were positively associated and also had positively correlated abundances. There was significant difference in the prevalence and abudance of infection of *Q. torquatus* between hosts sexes. This parasite also presented negative correlation between its intensity and host standard length. There are significant positive correlation between the prevalence of *Contracaecum* Type 1 and host standard length.

Key words: *Acestrorhynchus lacustris*, endoparasites, ecology, Paraná River.

RESUMO. Aspectos ecológicos da fauna endoparasitária de *Acestrorhynchus lacustris* (Lütken, 1875) (Characiformes, Acestrorhynchidae) da planície de inundação do alto rio Paraná, Brasil. Foram analisados 51 espécimes de *Acestrorhynchus lacustris* (Lütken, 1875) coletados na planície de inundação do alto rio Paraná, entre fevereiro de 2000 a novembro de 2001. Desses, 35 (68,6%) estavam parasitados por pelo menos uma espécie de endohelminto. Foram encontradas oito espécies de endoparasitas: cinco nematóides (*Contracaecum* Tipo 1 larva de Moravec, Kohn e Fernades, 1993, *Contracaecum* Tipo 2 larva de Moravec, Kohn e Fernades, 1993, *Contracaecum* sp., *Eustrongylides* sp., *Procamallanus* sp.), dois digenéticos (*Clinostomum* sp., *Rhipidocotyle gibsoni* Kohn e Fernandes, 1994) e um acantocéfalo (*Quadrigyrus torquatus* Van Cleave, 1920). *Contracaecum* sp. e *Q. torquatus* mostraram-se positivamente associadas e tiveram suas abundâncias positivamente correlacionadas. Houve diferença significativa na prevalência e intensidade média de infecção de *Q. torquatus* entre os sexos dos hospedeiros. Este parasita também apresentou correlação negativa entre sua intensidade e comprimento padrão do hospedeiro. Houve correlação positiva significativa entre a prevalência de *Contracaecum* Tipo 1 e o comprimento padrão dos hospedeiros.

Palavras-chave: *Acestrorhynchus lacustris*, endoparasitas, ecologia, rio Paraná.

Introduction

Acestrorhynchus lacustris (Lütken, 1875) is commonly known as "peixe-cachorro". It is a carnivorous fish of the family Acestrorhynchidae which occurs in South America. In Brazil, it occurs mainly in the basins of the rivers São Francisco and Paraná. On the Upper Paraná River floodplain, this species is characteristic of lakes and feeds in lentic waters. The predominant items in its diet are foragers species such as *Astyanax altiparanae*, *Moenkhausia intermedia* and *Steindachnerina insculpta* (Hahn *et al*., 1997).

According to Dogiel (1970), the factor that influences parasite fauna is the feeding habit of the host. Piscivorous species such as *A. lacustris* can be parasitized by all endoparasite groups because their diets include fishes that feed on invertebrates. Therefore, *A. lacustris* can be the

intermediate and definitive host of parasites that are transferred along the food web.

Of the studies carried out in the Paraná Basin related to the ecology of fish parasites, (Takemoto and Pavanelli, 1994, 2000; Machado *et al*., 1994, 1995, 1996, 2000; Pavanelli and Takemoto, 2000; Guidelli *et al*., 2003), none deals with *A. lacustris*. Studies about the endoparasites of *A. lacustris* in the Paraná River are related to taxonomy. For example, Pavanelli *et al*. (1997) recorded the occurrence of digeneans and nematodes in this fish species in the Upper Paraná River and Kohn and Fernandes (1994) described a new species of digenean parasitizing this fish in the Paraná River. Araújo Costa *et al*. (1991) described a species of nematode parasitizing *A. lacustris* from Três Marias Reservoir (Minas Gerais State). The aim of this paper is the study of the endoparasites of *A. lacustris*, as well as the study of some aspects of the host-parasite relationship.

Material and methods

Fifty-one specimens of *Acestrorhynchus lacustris* "peixe-cachorro" were collected in marginal lakes in the Upper Paraná River floodplain, Brazil (22º43'S and 53º10'W) from February 2000 to November 2001. After capture, the weight, standard length and sex of the fishes were observed. The parasites were collected, prepared and mounted according to Eiras *et al*. (2000).

The endoparasites were identified according to Yamaguti (1963), Thatcher (1993), Kohn and Fernandez (1994) and Moravec (1998).

The chi-square test with Yate's correction was used to determine possible associations between pairs of co-occurring species. The Spearman's rank correlation (rs) was used to verify the correlation between the abundance of the pair of species and to verify the correlation between the standard length of the hosts and the abundance of the parasites. The Pearson's linear correlation (r) was used to determine the correlation between prevalence and host standard length, with previous angular transformation of prevalence (arc sen $\sqrt{\chi}$) (Zar, 1996).

The Mann-Whitney "U" test, with normal approximation (Z), was used to evaluate the effect of host sex on infection intensity for each parasite species. The log-likelihood "G" test, with contingency table 2X2, was used to estimate the effect of host sex on the prevalence of each species of parasite.

The above mentioned tests were only applied to parasite species with prevalence higher than 10%. Only the chi-square test was applied to every species, even those with prevalence lower than 10%. The results were considered significant when $p \leq 0.05$. Terminology related to parasite ecology was based on Bush *et al*. (1997).

Results

Of the total number of fish collected, 35 were parasitized by at least one species of endoparasite, representing 68.6% of parasitism. Seven hundred ninety-eight parasites were collected, which represented a mean of 22.8 parasites by fish.

Eight species of endoparasites were collected: five nematodes (*Contracaecum* Type 1 larvae of Moravec, Kohn and Fernandes, 1993, *Contracaecum* Type 2 larvae of Moravec, Kohn and Fernandes, 1993, *Contracaecum* sp., *Eustrongylides* sp. and *Procamallanus* sp.), two digeneans (*Clinostomum* sp. and *Rhipidocotyle gibsoni* Kohn and Fernandes, 1994) and one acanthocephalan (*Quadrigyrus torquatus* Van Cleave, 1920).

Of the parasites collected, 75% were in the larval stage of development (*Clinostomum* sp., *Contracaecum* Type 1, *Contracaecum* Type 2, *Contracaecum* sp., *Eustrongylides* sp. and *Q. torquatus*) and 25% were adults (*R. gibsoni* and *Procamallanus* sp.). The highest values of prevalence and mean intensity were verified for *Contracaecum* sp., *Contracaecum* type 1, *Q. torquatus* and *R. gibsoni* (Table 1).

Table 1. Mean intensity and prevalence of infection of the endohelminths of *Acestrorhynchus lacustris*, collected from February 2000 to November 2001, in the floodplain of the Upper Paraná river, Brazil.

Parasite	Mean Intensity	Prevalence (%)
Clinostomum sp.	11	3.9
Rhipidocotyle gibsoni	3.6	17.6
Contracaecum Type 1	3.7	13.7
Contracaecum Type 2	1	1.9
Contracaecum sp.	19	41.1
Eustrongylides sp.	2.5	3.9
Procamallanus sp.	1	1.9
Quadrigyrus torquatus	16.3	37.2

The chi-square test indicated that, among the 28 possible associations, only the pair *Contracaecum* sp. - *Q. torquatus* had positive association ($\chi^2 = 4.201$ and $p < 0.05$). The abundance of these species was positively correlated ($rs = 0.2834$ and $p = 0.048$). Significant negative association between the pairs *Contracaecum* Type 2-*Procamallanus* sp, *Clinostomun* sp.-*Procamallanus* sp. and *Eustrongylides* sp.-*Procamallanus* sp. was observed; however, these

species occur in low prevalence, which may have influenced the results.

Of the total number of fish analyzed, 27 were males; with 20 parasitized by at least one species, presenting prevalence and mean intensity of 74% and 29.5, respectively. Twenty-four females were collected, with 15 parasitized by at least one species, representing prevalence of 62.5% and mean intensity of 11.8.

For both sexes, prevalence and mean intensity were similar to *R. gibsoni*, *Contracaecum* Type 1 and *Contracaecum* sp. (Table 2).

Table 2. Mean intensity (MI) and prevalence (P%) of infection of the endohelmints in males and females of *Acestrorhynchus lacustris*, collected from February 2000 to November 2001, in the floodplain of the Upper Paraná river, Brazil.

Parasite	Females		Males	
	MI	P (%)	MI	P (%)
Contracaecum Type 1	4.50	16.66	2.66	11.11
Contracaecum sp.	11.81	45.83	27	37.03
Quadrigyrus torquatus	5.25	16.66	19.26	55.55
Rhipidocotyle gibsoni	2.25	16.66	4.80	18.51

According to the "G" test, sex influenced prevalence only for *Q. torquatus*, with males being more parasitized. Based on the values of the "U" test, it was possible to observe that, for *Q. torquatus*, there was also significant difference in the abundance of the parasites between males and females, with males possessing higher abundance (Table 3).

Table 3. Results of the log-likelihood test (G) to compare prevalence of endohelminths between males and females and of the Mann-Whitney *U*,-test to compare abundance of endohelminths between males and females of *Acestrorhynchus lacustris*, collected from February 2000 to November 2001, in the floodplain of the Upper Paraná river, Brazil. (P = level of significance).

Parasite	G	P	U	P
Contracaecum Type 1	0.330	0.50 < P <0.75	306	0.7307
Contracaecum sp.	0.405	0.50 < P <0.75	300.5	0.6602
Q. torquatus	8.627⋆	0.001< P <0.005	192⋆	0.0115
R. gibsoni	0.030	0.75 < P < 0.90	319	0.9297

⋆ Value with significance levels of P≤ 0.05

The standard length of the fish collected varied from 13.5 to 22.5cm in females and from 10.0 to 17.1cm in males.

According to the Spearman's rank correlation "rs", only *Q. torquatus* showed significant negative correlation between host standard length and parasite abundance. The Pearson's linear correlation "r" showed that only prevalence of *Contracaecum* Type 1 had positive correlation with host standard length (Table 4).

Table 4. Values of Pearson's correlation coefficients (r) and Spearman's rank correlation coefficients (rs), to evaluate the relationship between prevalence and abundance, respectively, of the endohelminth fauna with standart length of *Acestrorhynchus, lacustris* collected from February 2000 to November 2001, in the floodplain of the Upper Paraná river, Brazil. (P = level of significance).

Parasite	r	P	"rs"	P
Contracaecum Type 1	0.808	0.02< P <0.05⋆	0.2515	0.0781
Contracaecum sp.	0.701	0.05< P <0.10	0.1085	0.4533
Quadrigyrus torquatus	-0.042	P >0.50	-0.3098⋆	0.0286
Rhipidocotyle gibsoni	0.393	0.20 <P <0.50	0.1074	0.4580

⋆Value with significance levels of P≤ 0.05

Discussion

Feeding habits of fish are the most important factors explaining species composition in endoparasite infracommunities, since the majority is acquired by feeding. However, the environment where the main volume of food is acquired is as important as the diet (Dogiel, 1970). The diet items of *Acestrorhynchus lacustris* are of autochthonous origin. This species is essentially piscivorous, feeding on foragers species such as *Astyanax altiparanae*, which acts as intermediate or paratenic hosts in the life cycle of species such as *Contracaecum* sp. and *Q. torquatus* (Lizama, personal communication).

Acestrorhynchus lacustris is piscivorous, but is also an opportunist. In studies of the stomach contents of *A. lacustris*, Hahn *et al*. (2000) found 17 species of fish prey, which suggests changes in the composition of its diet in accordance with the prey that is available in the environment. This behavior must, therefore, influence the levels of parasitism and species composition, which increase or decrease according to the availability of intermediate or paratenic hosts in the environment.

The parasite fauna of *A. lacustris* was composed of autogenic species (those that mature in aquatic vertebrates) such as the digenean *R. gibsoni* and alogenic species (those that mature outside the water, in terrestrial vertebrates) such as *Contracaecum* larvae. Seventy-five percent of the species found were larvae, showing that this fish occupies an intermediate position in the food web and can be used as a paratenic or intermediate host by some species in the completion of their life cycle.

Factors such as disputes for space and food can interfere in the parasite community, provoking competition or association between the species (Holmes, 1990). In this study, only *Contracaecum* sp. and *Q. torquatus* presented positive association and abundances correlated. Guidelli *et al*. (2003) observed the same for the endoparasites of another piscivorous species from the region. The use of the

same paratenic and intermediate hosts by *Contracaecum* sp. and *Q. torquatus* may be responsible for this association, since recent studies have shown the presence of these species in *A. altiparanae*, a predominant item in the diet of *A. lacustris.* (Lizama, personal communication).

According to Esch *et al*. (1988), host sex is an influential and determinant factor in the levels of parasitism. This can occur due to differences in diet, behavior and physiology between males and females.

In the present research, was observed that the prevalence and the abundance of *Q. torquatus* were influenced by host sex, and the males were more parasitized. This difference may be explained by physiological differences between males and females, mainly during reproduction (Fernandez, 1985). The infrapopulations of parasites apparently obtains more success in male hosts, henceforth the females were parasitized, the abundance was less. Zamam and Seng (1989) postulated that male hormones may favour the increase and the survival of the parasites, while female hormones may disfavour the infection. This would justify the results obtained in the present work. Other studies that consider differences in the levels of parasitism between males and females (Etchegoin and Sardella, 1990; Moser and Hsieh, 1992) also suggest the influence of hormones on the parasite fauna.

Fish growth induces many alterations in the behavior and biology that directly influence its feeding habits. These alterations have considerable influence on its parasite fauna, mainly endoparasites that are recruited due to the ingestion of intermediate hosts. In fishes with standard lengths shorter than 13 cm no parasite was found; therefore, host size may be a limiting factor in the infection.

Positive correlation between the host standard length and the prevalence of *Contracaecum* Type 1 was observed. Parasite acquisition only occurs when the fish has sufficient size to eat the intermediate host as prey (Zelmer and Arai, 1998). Hahn *et al.* (2000) describe that the size of the prey eaten by *A. lacustris* increases with the growth of the fish. Therefore, high prevalence in the larger fish suggests that the fish begins feeding on the intermediate host from a specific size and that this correlation may also occur in the intermediate host, i.e. larger prey may also be more parasitized. The presence of a higher infrapopulation in larger fish is a common characteristic in the host-parasite system (Dogiel, 1970).

According to Zelmer and Arai (1998), the increase in the infrapopulations of parasites happens by simple accumulation, resulting from the increase in the age of the fish and, as fish size is an expression of age (Dogiel, 1970), it is expected that larger fish have a higher infrapopulation. Furthermore, in large fish the available space for parasites is greater. Diverse studies describe a positive correlation between host standard length and parasitism level (Machado *et al*., 1994, 1996; Takemoto and Pavanelli, 1994).

Quadrigyrus torquatus shows a negative correlation between parasite abundance and host standard length, i. e. abundance decreased with the increase in fish size. This shows the possibility of older fish developing an immune response which would stop parasite accumulation. Moreover, the prevalence and the abundance of *Q. torquatus* may be lower in the prey that the larger fish capture.

Aknowledgments

We would like to thank Nupélia (Núcleo de Pesquisas em Limnologia, Ictiologia e Aquicultura) for the use of their facilities in carrying out this research.

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Received on August 13, 2003.
Accepted on November 19, 2003