ACTA
AMAZONICA

Seasonality of nematode larvae in *Iguanodectes spilurus* (Characidae) an ornamental fish from northeastern Para, Brazil

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ABSTRACT

The current study presents a parasitological survey of larval nematodes from freshwater ornamental fish *Iguanodectes spilurus* caught in the watercourse of the Caete River, in the northeast region of the State of Para, Brazil. A total of 176 specimens, 1.36±0.75 g weight and 5.53±0.98 cm total length, were analyzed. Nematode larvae were identified as *Capillaria* sp., *Procamallanus* sp. and Anisakidae, with prevalence of 70.45% and infection intensity ranging from 1.81 to 4.70 larvae. The highest prevalence 57.38% occurred in the liver, but no seasonality was observed, indicating high infection throughout the year. Seasonality was observed in fish parasitized in the stomach, intestine and caecum, with prevalence and mean intensity of 17.61% and 2.32 parasites, 12.5% and 1.81 parasites, 10.79% and 2.21 parasites, respectively. The highest degree of infection was observed in the rainy season, probably due to increased availability of intermediate hosts or food.

KEYWORDS: Characidae, Parasitology, Seasonality, River.

Sazonalidade de larvas de nematóide em *Iguanodectes spilurus* (Characidae) um peixe ornamental no nordeste do Pará, Brasil

RESUMO

O presente estudo apresenta um levantamento parasitológico de larvas de nematóides de *Iguanodectes spilurus* capturados no fluxo do Rio Caeté, nordeste do Pará, Brasil. Um total de 176 espécimes com médias de 1,36 ± 0,75 g de peso e 5,53 ± 0,98 cm de comprimento total foram analisados. Foram identificados em 124 peixes os nematóides *Capillaria* sp., *Procamallanus* sp. e da família Anisakidae, apresentaram uma prevalência de 70,45% e intensidade de infecção de 1,81 a 4,70 larvas. A maior prevalência foi de 57,38% no fígado, mas não foi observada sazonalidade, indicando alta potência de infecção ao longo do ano. A sazonalidade foi observada em peixes parasitados no intestino, estômago e ceco com prevalência e intensidade média de 17,61% e 2,32 parasitas, 12,5% e 1,81 parasitas, 10,79% e 2,21 parasitas, respectivamente. A maior infecção foi encontrada na estação chuvosa, provavelmente devido ao aumento da disponibilidade de hospedeiros intermediários ou de alimentos.

PALAVRAS-CHAVE: Characidae, Parasitologia, Sazonalidade, Rio.

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INTRODUCTION

The freshwater fish *Iguanodectes spilurus* (Günther, 1864) (Characidae), commonly found in Brazil and known as "piaba comprida", is of great ecological importance in aquatic ecosystems serving as a foraging fish species in the food chain and as ornamental fish (Vari 1977).

However, no records have been found on its biology and parasitic fauna. Climatic and aquatic alterations may interfere in the balance host/parasite/environment (Moraes and Martins 2004). The parasitic fauna of native freshwater fish is strongly related to nematodes, which, in turn, may be found as encysted larvae in the internal organs (Eiras *et al.* 2006). The effects of nematode larvae infection on fish might be related to the life cycle, degree of infection, site of infection, nutritional condition and immune response (Eiras *et al.* 1998).

The presence of nematode larvae in the visceral cavity and their migration to other organs such as the liver, muscle and mesentery originate cysts, which in some cases can provoke morphological alterations in the organs (Rodrigues *et al.* 2002).

This study evaluated the parasitic infection by nematode larvae in *I. spilurus* from northeastern Pará state, Brazil, and their relation with the dry and rainy seasons and condition factor.

MATERIALS AND METHODS

A total of 176 specimens of *I. spilurus* were caught monthly for parasitological assessment with the use of net and sieve in the Chumucui stream (01º12'38.3"S, 046º47'31.7"W), a tributary to the Caete River, municipality of Bragança, northeastern Pará state, Brazil, from June 2006 to June 2007.

The water quality was measured at 30 cm depth as follows: pH, by portable pHmeter (Quimis Q-400 BC/BD; Quimis, Sao Paulo, Brazil), dissolved oxygen and temperature, by oxymeter (Lutron DO-5510; Lutron, Taipei, Taiwan). Accumulated rainfall in each month was obtained from the data provided by the National Institute of Meteorology - INMET to determine the dry and rainy periods according to Schaeffer-Novelli and Cintrón (1986).

The fish were transferred alive to the Ichthyoparasitology and Aquaculture Laboratory at the Federal University of Para. They were euthanized in benzocaine solution (0.1 g L^{-1}) and then measured and weighed for posterior parasitological analysis (Eiras *et al.* 2006). Nematode identification was performed according to Travassos *et al.* (1928), Thatcher (2006) and Eiras *et al.* (2006), and prevalence and mean intensity of infection were calculated according to Bush *et al.* (1997).

Based on the length and weight data, the allometric condition factor was calculated according to the formula: $Ka = W/L^b$, where W = weight (g); L = total length (cm) and b = angular coefficient of relation weight/length, estimated by the equation $y = ax+b$, as recommended by Le Cren (1951).

Values of weight and total and standard length were submitted to the *T test* in relation to the dry and rainy seasons. The data from prevalence and mean intensity in each organ were correlated to weight, total and standard length and condition factor, as well as to pH, dissolved oxygen and temperature, by the Pearson´s correlation matrix. Statistical tests were performed in the Biostat 4.0 software.

RESULTS

No significant difference between the mean values of weight, total length and standard length with the condition factor was found (Table 1). The dry period (rainfall< 100mm³) corresponded to August 2006 - January 2007, while the rainy period (rainfall>100mm³) corresponded to June - July 2006 and February - June 2007.

Measures of dissolved oxygen in water (5.36 ± 1.00 mg L^{-1}, ranged from 3.9 to 6.8 mg L^{-1}) were not considered inadequate to the survival of *I. spilurus*. During the dry season (August through December 2006, and January 2007), increased pH was observed (pH = 7.81 ± 0.55) compared to the rainy season (pH = 6.96 ± 0.32).

No correlation between pH, oxygen and temperature with parasitological indexes (prevalence and mean intensity of infection) was observed (Tables 2 and 3). Significant increase ($P<0.01$) in the weight and length of fish was observed in the rainy period (Figure 1).

Nematode larvae were identified as *Procamallanus* sp. (Camallanidae) L_3, *Capillaria* sp. (Capillariidae), and anisakid

Table 1. Monthly mean values and standard deviation of weight, total length (TL), standard length (SL) and condition factor of *Iguanodectes spirulus* from northeastern Pará state, Brazil.

Months	Weight (g)	TL (cm)	SL (cm)	Condition factor
Jun/06	1.96 ± 0.91	6.04 ± 0.86	5.29 ± 0.80	$6.91x10^{-4} \pm 1.58x10^{-4}$
Jul/06	0.95 ± 0.30	5.46 ± 0.70	4.95 ± 0.71	$5.75x10^{-4} \pm 2.28x10^{-4}$
Aug/06	0.92 ± 0.44	5.04 ± 0.69	4.49 ± 0.71	$7.49x10^{-4} \pm 2.49x10^{-4}$
Sep/06	0.83 ± 0.27	4.59 ± 0.49	4.14 ± 0.41	$1.03x10^{-4} \pm 2.50x10^{-4}$
Oct/06	1.00 ± 0,35	4.88 ± 0.58	4.36 ± 0.54	$9.25x10^{-4} \pm 1.81x10^{-4}$
Nov/06	1.05 ± 0,42	5.27 ± 0.89	4.76 ± 0.87	$7.42x10^{-4} \pm 3.07x10^{-4}$
Dec/06	1.15 ± 0.00	5.00 ± 0.00	4.50 ± 0.00	$9.67x10^{-4} \pm 0.00$
Jan/07	1.80 ± 1.24	6.1 ± 1.50	5.40 ± 1.35	$6.49x10^{-4} \pm 3.64x10^{-4}$
Feb/07	2.34 ± 0.71	6.62 ± 0.67	5.53 ± 1.53	$5.73x10^{-4} \pm 1.33x10^{-4}$
Mar/07	2.35 ± 0.21	6.75 ± 0.35	5.75 ± 0.35	$5.31x10^{-4} \pm 7.41x10^{-5}$
Apr/07	1.83 ± 1.05	6.46 ± 1.16	5.46 ± 1.00	$4.64x10^{-4} \pm 8.81x10^{-5}$
May/07	1.32 ± 0.71	5.5 ± 0.92	4.48 ± 1.63	$7.24x10^{-4} \pm 2.69x10^{-4}$
Jun/07	1.75 ± 0.57	6.21 ± 0.82	5.50±0.57	$5.90x10^{-4} \pm 2.14x10^{-4}$

Table 2. Mean values of Pearson's correlation matrix between pH, dissolved oxygen (DO), water temperature and rainfall, with prevalence and mean intensity of infection in the internal organs of *Iguanodectes spilurus* from northeastern Pará state, Brazil, between June 2006 and June 2007.

Site of infection	pH	DO	Temperature	Rainfall
	Prevalence			
Stomach	-0.63	0.048	-0.24	0.32
Anterior intestine	0.16	0.10	-0.47	-0.08
Medium intestine	-0.59	0,13	-0.36	-0.03
Posterior intestine	-0.31	0.09	-0.26	-0.17
Liver	-0.59	0.13	-0.36	-0.15
Caecum	-0.68	0.04	-0.25	0.62
	Mean intensity of infection			
Stomach	-0.52	0.30	-0.05	0.29
Anterior intestine	0.01	0.10	-0.46	-0.17
Medium intestine	0.02	-0.06	-0.14	-0.16
Posterior intestine	-0.09	0.35	-0.42	0.08
Liver	0.07	0.29	0.21	-0.42
Caecum	-0.64	0.02	-0.26	0.41

Table 3 - Mean values of Pearson's correlation matrix between mean weight (W), total length (TL), standard length (SL) and condition factor (Kn), with prevalence and mean intensity of infection in the internal organs of Iguanodectes spilurus from northeastern Pará state, Brazil, from June 2006 to June 2007.

Site of infection	Prevalence				Mean intensity of infection			
	W	TL	SL	Kn	W	TL	SL	Kn
Stomach	0.12	0.17	-0.03	-0.2974	0.01	0.15	0.07	-0.3389
Anterior intestine	0.25	-0.28	-0.36	0.1994	-0.12	-0.26	-0.28	0.4237
Medium intestine	0.21	0.15	0.14	0.0596	-0.35	-0.31	-0.30	0.2468
Posterior intestine	0.21	0.32	0.14	-0.4105	0.12	0.17	0.15	-0.2544
Liver	0.02	-0.07	-0.09	0.2398	-0.22	-0.14	0.07	0.0617
Caecum	0.34	0.44	0.26	-0.5011	0.17	0.22	0.01	-0.2492

(Anisakidae) in the stomach, intestine and liver of fish. From a total of 176 specimens examined, 124 (70.4%) were parasitized by larval nematodes. The highest prevalence per site of infection was found in the liver, with 57.4% prevalence and 4.7±2.1 mean intensity of encysted larvae (Table 4). The highest total prevalence (P<0.01) was observed in the rainy period (Figure 2).

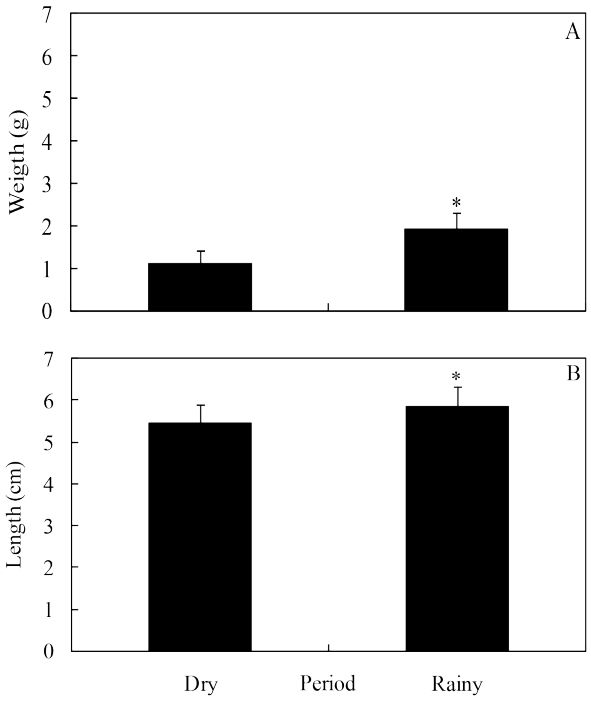

Figure 1 - Mean values and standard deviation of biometric data of *Iguanodectes spilurus* in the dry and rainy periods. A: weight. B: total length. * p<0.01.

Table 4. Parasitological assessment in *Iguanodectes spilurus* from northeastern Pará state, Brazil, between June 2006 and June 2007. Data based on 176 examined fish.

Site of infection	Parasitized fish	Total number of parasites	Prevalence (%)	Mean intensity of infection
Stomach	31	72	17.61	2.32 ± 1.47
Anterior intestine	35	65	19.80	1.85 ± 0.93
Medium intestine	30	62	17.04	2.06 ± 0.89
Posterior intestine	22	40	12.50	1.81 ± 1.03
Liver	101	475	57.38	4.70 ± 2.13
Caecum	19	42	10.79	2.21 ± 1.22

DISCUSSION

Low water quality, such as water with low dissolved oxygen contents, decreases fish resistance and may provoke parasitic and bacterial infections (Martins, 2004). Consequently, the low variation in aquatic parameters did not influence the parasitic infection in *I. spilurus*. This fish can be found living in waters of varied dissolved oxygen (from 4.93 to 7.12 mg L^{-1}) concentrations, as reported by Anjos (2005) in the Central Amazon.

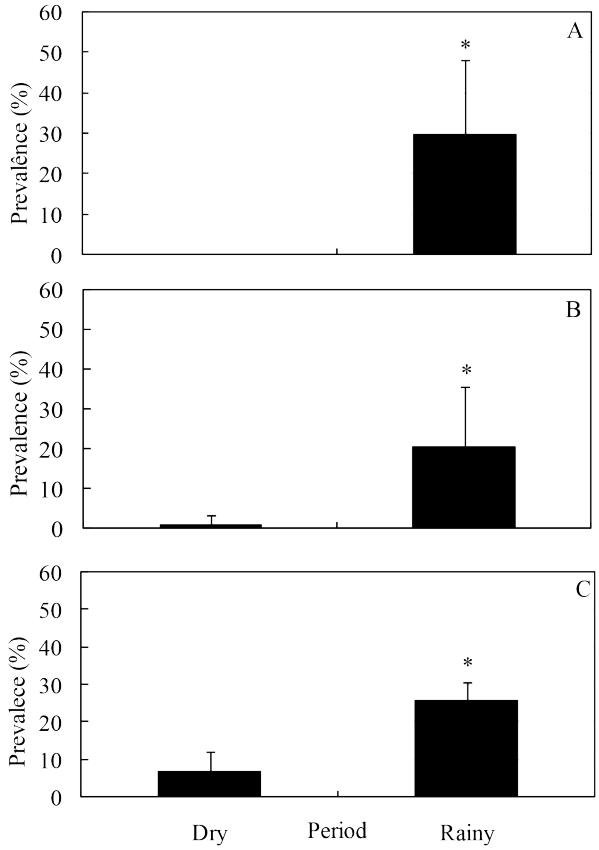

Figure 2 - Mean values and standard deviation of prevalence (%) of nematode larvae in the caecum (A), stomach (B) and posterior intestine (C) in *Iguanodectes spilurus* in the dry and rainy periods. * $p<0.01$

Decreased levels of pH were found in February, April and May 2007 (rainy season), which can be associated to organic matter decomposition. In July 2006, high values of pH (9.14) and dissolved oxygen (6.8 mg L^{-1}) were observed, they were possibly related to an adverse condition. In fact, this condition could be associated to a transition period between the rainy and dry seasons. Water quality, such as pH and oxygen contents and temperature, did not influence the parasitological data for *I. spilurus.*

In this study, *Iguanodectes spilurus* harbored nematodes in larval stage such as found by Fischer *et al.* (2004) in the Amazonian fish tambaqui, *Colossoma macropomum*. Encysted nematodes represent a strategy against the defense of hosts, contributing to parasite survival and dissemination. The importance of nematode larvae as biological indicators and the distinction of host populations in aquatic ecosystems were evaluated by Mackenzie (1983), for example, anisakid worms. Similarly, Rodrigues *et al.* (2002) observed 15.3% prevalence of nematodes in the liver of dourado, *Salminus maxillosus*, which caused histological alterations such as inflammatory reaction of the host.

Increased weight and length of fish during the rainy season may be related to increased food ingestion, facilitated by the stream overflow, with large amounts of organic matter (Abelha *et al.* 2001). According to Claro Jr. *et al.* (2004), the diet composition of Amazonian fish varies as a consequence of the overflow of rivers. During the flood period in the Amazon, a diversification of habitats such as nutrient intake and ichthyofauna alterations was observed in *Triportheus angulatus* by Yamamoto *et al.* (2004). The highest prevalence rate and mean intensity of infection in the stomach, posterior intestine and caecum were observed in the rainy season. According to the findings by Tavares and Luque (2001), in parasitized common snook *Centropomus undecimalis*, the increased number of parasites was closely related to the feeding habitat and not to the parasitic accumulation process. Isaac *et al.* (2004) commented that the endoparasitic fauna of knife fish *Gymnotus* spp. was strongly associated to feeding, mainly composed by crustaceans and insects. Alike the present study, Martins *et al.* (2003a) found the highest mean intensity of infection by nematode *Ichthyouris voltagrandensis* in characid fish from a reservoir in the State of Minas Gerais in rainy season.

In traira, *Hoplias malabaricus*, caught in the Cuiaba River, *Contracaecum* sp. and *Eustrongylides* sp. larvae occurred mostly in the muscles and viscera at prevalence rates of 73 and 33%, respectively (Barros *et al.* 2007). The authors argued that infection was favored by the ingestion of intermediate hosts as a result of the flooding on that region. In contrast, no difference was reported either in parasitism or in seasonality of *Procamallanus* (*Spirocamallanus*) *pintoi,* from peppered corydoras, *Corydoras paleatus*, in the State of Parana, Southern Brazil (Ito *et al.* 2005). In the present study, although larger fish were collected in the rainy season, no significant correlation was observed between the weight and length of hosts and parasitism, similarly to that found by Tavares *et al.* (2001).

The occurrence of *Procamallanus* L_3 larvae in *I. spilurus* suggests that the feeding habitat of this fish may be composed of copepods, as verified by Martins *et al.* (2007) in experimental infection with camallanid larvae in *Notodiaptomus* sp. (Crustacea: Calanoida). Parasitic infection in Amazonian fish is related to a variety of food items along their ontogenetic development in rivers, as suggested by Goulding (1980). These changes were observed at the beginning of fish development, when fish feed temporarily on zooplankton (Cowan *et al.* 1997).

High prevalence of *Contracaecum* larvae in piscivorous fish *H. malabaricus*, reported by Martins *et al.* (2003b), suggests *I. spilurus* as intermediate host. The presence of capillariid

larvae in the liver suggests that *I. spilurus* is an intermediate host, once adult nematodes are normally found in piscivorous birds (Yanong 2002).

No correlation between condition factor and parasitism was observed, which demonstrates that, in this case, the nematode larvae did not harm fish health, as also reported by Dias *et al.* (2004) and Moreira *et al.* (2005), who observed no influence of parasitism on the condition factor of Neotropical fish. In contrast, increased condition factor was reported to parasitized curimbata, *Prochilodus lineatus*, from the upper Parana River floodplain.

CONCLUSION

The liver was the most sensitive organ to nematode larvae. In the rainy season, increased parasitism was found in the stomach, posterior intestine and caecum of *I. spirulus.* The parasitological assessment was not influenced by abiotic factors (pH, oxygen and temperature), but this study reported for the first time the presence of nematode larvae in *I. spirulus*, a poorly studied Amazonian freshwater fish species. Further studies should be carried out not only with Amazonian freshwater ornamental fishes, but also with the first intermediate hosts.

ACKNOWLEDGEMENTS

The authors are grateful to the National Council of Scientific and Technological Development - CNPq for the financial support to M.L. Martins and to Coordination for the Improvement of Higher Education Personnel. CAPES for the PhD scholarship to Fabrício Ramos Menezes.

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Aceito em: 22/08/2012
Recebido em: 15/01/2013