ASPECTS OF THE ECOLOGY OF PROTEOCEPHALID CESTODES, PARASITES OF *Sorubim lima* (PIMELODIDAE), OF THE UPPER PARANÁ RIVER, BRAZIL: II. INTERSPECIFIC ASSOCIATIONS AND DISTRIBUTION OF GASTRINTESTINAL PARASITES

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ABSTRACT

One hundred and seven specimens of *Sorubim lima* (Bloch & Schneider, 1801) were collected in the floodplain of the upper Paraná River, Brazil between March 1992 and February 1996. Ninety-five specimens (88.78%) were parasited by at least a species of proteocephalid cestode. 7,573 parasites specimens of four different species were collected (average intensity 79.71 parasites/host): *Paramonticellia itaipuensis* Pavanelli & Rego, 1991; *Nupelia portoriquensis* Pavanelli & Rego, 1991; *Spatulifer maringaensis* Pavanelli & Rego, 1989 and *Spasskyellina spinulifera* (Woodland, 1935). The two most prevalent species, *Spatulifer maringaensis* and *Paramonticellia itaipuensis*, were parasiting the entire gastrointestinal tract. *Nupelia portoriquensis* parasited only the anterior and posterior intestine of the host.

Key words: ecology, interspecific associations, gastrointestinal distribution, *Sorubim lima*, Proteocephalids, upper Paraná River, Brazil.

RESUMO

Aspectos da ecologia de cestóides proteocefalídeos parasitas de *Sorubim lima* (Pimelodidae) do alto Rio Paraná, Brasil: II. Associações interespecíficas e distribuição gastrintestinal

No período de março de 1992 a fevereiro de 1996 foram coletados 107 espécimes de *Sorubim lima* (Bloch & Schneider, 1801) na planície de inundação do alto Rio Paraná, sendo que 95 (88,78%) estavam parasitados por pelo menos uma espécie de cestóide proteocefalídeo. Foi coletado um total de 7.573 espécimes de parasitos (intensidade média de 79,71 parasitos/hospedeiro) de quatro espécies diferentes: *Paramonticellia itaipuensis* Pavanelli & Rego, 1991; *Nupelia portoriquensis* Pavanelli & Rego, 1991; *Spatulifer maringaensis* Pavanelli & Rego, 1989 e *Spasskyellina spinulifera* (Woodland, 1935). As duas espécies mais prevalentes, *S. maringaensis* e *P. itaipuensis*, foram encontradas parasitando todo o trato gastrintestinal do *Sorubim lima* e *Nupelia portoriquensis* foi encontrado parasitando somente o intestino anterior e posterior do hospedeiro.

Palavras-chave: ecologia, associações interespecíficas, distribuição gastrintestinal, *Sorubim lima*, Proteocefalídeos, alto Rio Paraná, Brasil.

INTRODUCTION

Many studies on fish parasites refer to taxonomy and pathology and few deal with the ecological approach. According to Rego & Pavanelli (1992) and Pavanelli *et al*. (1997a) the following species of proteocephalid cestodes parasites of *Sorubim lima* (Bloch & Schneider, 1801) have been registered in the floodplain of the upper Paraná River: *Paramonticellia itaipuensis* Pavanelli & Rego, 1991; *Goezeella nupeliensis* Pavanelli & Rego, 1991 (= *P. itaipuensis*); *Nupelia portoriquensis* Pavanelli & Rego, 1991 and *Spatulifer maringaensis* Pavanelli & Rego, 1989.

In a previous paper Takemoto & Pavanelli (2000) have studied the structure of the parasite community of *Sorubim lima* of the floodplain of the upper Paraná River. The authors examined and compared the distribution patterns of parasite infrapopulations as related to sex and size of hosts. In this paper an analysis of interspecies associations and the gastrointestinal distribution of the parasites will be given.

MATERIALS AND METHODS

Collection of specimens of *Sorubim lima* was undertaken monthly between March 1992 and January 1994 and randomly till February 1996 in the floodplain of the upper Paraná River (22º40'-22º50'S and 53º15'-53º40'W).

Simple stationary nets with mesh sizes 3 to 16 cm between opposite knots, stationary trammel nets with 6 and 8 mesh, and boulters were used for capture. Collection, preparation and mounting of cestodes followed techniques by Amato *et al.* (1991).

Interspecies associations among pairs of cooccurring species were determined by chi-square test with Yates' correction when required. Correlations among species intensities forming associations were analyzed by correlation coefficient per Spearman ranks (rs) (Ludwig & Reynolds, 1988).

Preference of cestodes for a certain segment of the gastrointestinal tract was determined by Kruskal-Wallis test, Dunn test was used when significant differences were present (Zar, 1996). Terminology related to parasite ecology was based on Margolis *et al.* (1982) modified by Bush *et al.* (1997).

RESULTS

Interspecific associations

The three most prevalent species (over 10%) were separated in pairs to detect possible interspecific relationship. The pairs *P. itaipuensis* and *S. maringaensis* and *S. maringaensis* and *N. portoriquensis* were associated and confirmed positive correlation with regard to abundance (Table 1).

Percentage distribution of proteocephalid cestodes in the gastrointestinal tract

For this analysis 33 were fish examined and only cestode species with prevalence over 10% were taken into account. Place of installation of cestode in the stomach has been investigated although it is not the characteristic site of parasitism. The two most prevalent species, *Spatulifer maringaensis* and *Paramonticellia itaipuensis*, were parasiting the entire gastrointestinal tract while *Nupelia portoriquensis* was parasiting only the anterior and posterior intestine (Fig. 1).

According to Kruskall-Wallis test (Table 2), followed by Dunn's, the stomach was the least parasited site by *S. maringaensis*. The parasite didn't show any preference for any specific region in the intestine. *Paramonticellia itaipuensis* showed a significantly higher parasitism in the anterior region of the intestine. *Nupelia portoriquensis* didn't demonstrate preference for any specific site.

DISCUSSION

Interspecific associations

Many factors interfere in the parasite community. They cause competition among species (the presence of one inhibits or impairs the presence of the other) or form associations among them (species occur simultaneously). Struggle for space and food, the reproductive barrier to hinder hybridization among taxonomically close species, low immunity of host with regard to the parasite, susceptibility differences in hosts, similarity and difference of hosts and need of parasite species for similar conditions to survive may be mentioned (Stone & Pence, 1978; Custer & Pence, 1981; Bush & Holmes, 1986; Holmes, 1990).

Within the three associations possible among species with over 10% prevalence, the pairs *P. itaipuensis* and *S. maringaensis* and *S. maringaensis* and *N. portoriquensis* are associated.

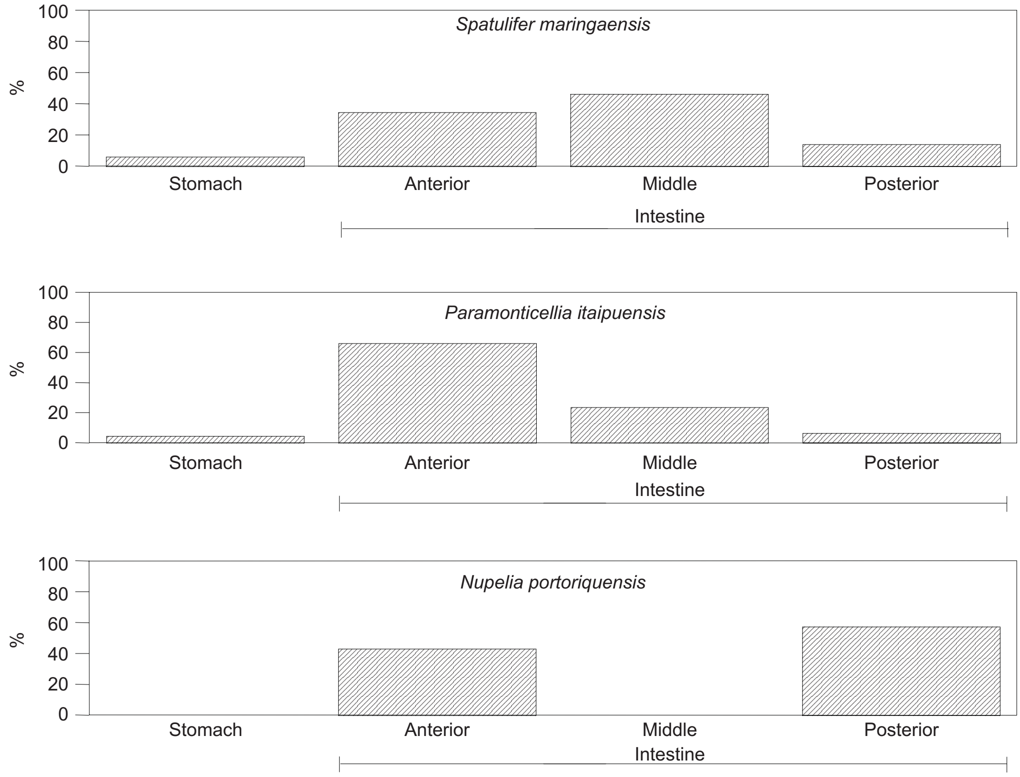

Fig. 1 — Percentage distribution of proteocephalid cestodes, parasites of *Sorubim lima*, in the gastrointestinal tract, collected in the floodplain of the upper Paraná River, Brazil.

Table 1

Pairs of species of proteocephalids co-occurring in *Sorubim lima* of the floodplain of the upper Paraná River, Porto Rico region PR Brazil (rs = values of Spearman's ranks correlation coefficient; χ^2 = values of chi-square test; underlined values are significant).

		rs	
Parasites	*P. itaipuensis*	*S. maringaensis*	*N. portoriquensis*
P. itaipuensis	———	0,507	0,359
S. maringaensis	20,343	———	0,549
N. portoriquensis	3,067	6,108	———

χ^2

They have positive correlation between their abundances, or rather, the species coexist in the same host without any competition. The reproduction barrier is the factor that determines competition among taxonomically close species so that hybridization would be hindered. This has not been observed although parasite species are taxonomically very close.

Result also suggests that these species of proteocephalids use the same intermediate hosts which are also food of the *Sorubim lima* and the cycle is thus complete.

This result has been suggested because in each fish parasites occupy different areas, when space is available. The reproductive barrier is reinforced, hybridization is impaired and the possibility of intercourse between specimens of the same species increases (Rohde, 1977).

In previous studies Machado *et al.* (1996) have also found associations among species of proteocephalid cestodes of *Pseudoplatystoma corruscans* (Agassiz, 1829) of the same region.

With regard to *Schizodon borelli* (Boulenger, 1900) no association has been found among species of helminthes.

This fact suggests that in this case the intermediary hosts are not simultaneously ingested by the fish.

TABLE 2

Gastrointestinal distribution of proteocephalid cestodes in 33 *Sorubim lima* collected from March 1992 to February 1996 in the floodplain of the upper Paraná River (H = values of Kruskall-Wallis test; P = significance level; Values between parentheses = number of organs or positive sections followed by percentage of all collected specimens).

Parasite	Stomach	Intestine			H	P
		Anterior	Middle	Posterior		
Spatulifer maringaensis	(2) 5,8 [a]	(18) 34,4 [b]	(14) 46,0 [b]	(21) 13,8 [b]	19,726*	P = 0,0002
Paramonticellia itaipuensis	(2) 4,3 [a]	(24) 66,0 [b]	(8) 23,4 [a]	(4) 6,3 [a]	45,888*	P < 0,0001
Nupelia portoriquensis	_______	(3) 42,9 [a]	_______	(2) 57,1 [a]	6,495 [ns]	P = 0,0899

* = reject H_0
ns = acept H_0

Percentage distribution of proteocephalid cestodes in the gastrointestinal tract

Many factors influence the occupation of niches in the inside of the intestine. According to Holmes (1990), the chief factor is competition among species, as has been commented above. Intensity of competition is directly related to the number of specimens of interacting species in which a decrease in installation, maturation, development and reproduction occurs as a negative interaction. Holmes (1990) also states that the use of nutrients by parasites is an important factor which regulates competition among parasites of the intestine, chiefly in cestodes and acanthocephalans. Parasites may also use interference mechanisms or may modify their environment so that it would become hostile to another species (Stock & Holmes, 1988). Christensen *et al.* (1987) hold that in mammals the increase in number of specimens of a certain species may stimulate immunity responses contrary to competing species.

With the aim at impairing hybridization, species that occupy close niches have different intercourse organs (Rohde, 1979, 1986). However, this is not confirmed by Holmes (1990) in digenea and in other parasites of the intestine.

Collection method is another important factor. Williams *et al.* (1991) verified that certain methods of capture (traps or nets) cause significant stress in fish. Stress causes regurgitation and contributes towards the expelling of some intestine parasites. Distribution of helminthes along the intestine is thus affected. In this research a small number of specimens of helminthes was found in the stomach in contrast to the great number found in the intestine. Probably the stomach is an atypical site for these parasites. The intestine is the most common place. The presence of these parasites in the stomach is secondary and migration may have occurred after the host's death because of changes in peristaltic movements or because of regurgitation at the time of capture. Fish used in analysis underwent necropsy in the least possible time after capture to avoid significant changes.

According to Mackenzie & Gibson (1970) migration of parasites after host's death may also affect the linear distribution of helminthes in the gastrointestinal tract. They reported that in fish examined immediately after capture parasites were installed in the anterior section of the intestine. When examined 3 to 4 days after capture, parasites were in the rectum. Shotter (1973) also remarks that seasonal variations and age of fish affect linear distribution of helminthes along the intestines.

In the case of cestodes and nematodes Shostak & Dick (1989) suggest migration of parasites towards food in the stomach. Migration may take place immediately after food digestion, probably causing stimuli such as nervous activity of the intestine. However, in their study on the parasites of *Esox lucius* (Linnaeus, 1758) the same authors didn't perceive any significant differences in the localization of the scolex and strobila with regard to the stomach contents of the host.

According to Bush & Holmes (1986) and Stock & Holmes (1988) the increase in infection area in the intestine occurs when there is an increase in the size of parasite population. This fact was perceived in the present research. *Spatulifer maringaensis* was the most abundant species in the fish analyzed and was also the species distributed throughout the entire intestine. The same cannot be said for the other species. *Paramonticellia itaipuensis* preferred the anterior region of the intestine while *N. portoriquensis* the extremities, or rather, the anterior and the posterior regions. Contact among species has been shown.

Nevertheless, Haukisalmi & Henttonen (1993) ask whether changes observed in the linear distribution of intestine helminthes would be related to the latter's fitness. According to these authors, who studied parasites in rodents, there is evidence that helminthes don't affect abundance of other species. However, changes in intestine distribution may affect the population of helminthes. Helminthes in next-to-best microhabitats probably show delay in growth and consequently a different fecundity.

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