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Metazoan parasite community of *Steindachnerina brevipinna* (Curimatidae) from Southern Brazil

T. L. CESCHINI*, R. M. TAKEMOTO, F. H. YAMADA, L. H. A. MOREIRA, G. C. PAVANELLI

Laboratório de Ictioparasitologia, Núcleo de Pesquisas em Limnologia, Ictiologia e Aqüicultura (Nupelia), Universidade Estadual de Maringá, Bloco G-90, Av. Colombo, 5790 87020-900, Maringá, Paraná, Brazil, E-mail: *tiago.spp@gmail.com*

Summary

In order to examine the ecological relationships of metazoan parasites and their hosts, 63 specimens of *Steindachnerina brevipinna* have been collected from April to September 2006, in the rivers Guairacá and Corvo, tributaries of the low Paranapanema River. Five different parasite species have been found (*Paranaella* sp., *Sphicterodiplostomum musculosum*, *Cosmoxynema vianai*, *Travnema travnema* and *Spinoxyuris* sp.), with parasite richness from 1 to 4. The dominance index (C > 0.25) was calculated for *S. musculosum* and aggregation of *S. musculosum* and *Paranaella* sp. were reported. There were no associations or covariations between the species of parasites. Values did not show interference of parasite abundance at different gonadal maturity stages. The relative condition factor (Kn) did not show significant values regarding quantitative and qualitative data on parasitism. Statistical tests were significant between the prevalence and the abundance of parasites and the standard length of the hosts, as well as for the parasite abundance in different months and tributaries.

Keywords: ecological relationships; metazoan parasite; *Steindachnerina brevipinna*

Introduction

Steindachnerina brevipinna (Eigenmann & Eigenmann, 1889) (Curimatidae), popularly known as "biru" or "sagüiru" presents a maximum size of 10 to 16 cm, considering males and females, respectively (Graça & Pavanelli, 2007). Its occurrence is restricted to some South American countries (Argentina, Brazil, Paraguay and Uruguay), inhabiting benthic-pelagic environments in the rivers Paraguay, lower and upper Paraná and lower Uruguay, being very abundant and occupying an important role in the food chain (Vari, 1991). According to Prioli *et al.* (2004), this fish has been established in the upper Paraná River only after the flooding of the Sete Quedas Falls by the construction of the reservoir of the Itaipu hydroelectric power plant. There are no parasitological studies regarding this fish, only a record of the endoparasite *Diplostomum* sp. for *Steindachnerina insculpta* (Pavanelli *et al.*, 2004), an endemic fish from the upper Paraná River (Pavanelli & Britski, 1999). This study aimed to examine the ecological relationships of metazoan parasite of *S. brevipinna* collected in the rivers Corvo and Guairacá, tributaries of the Paranapanema River.

Materials and methods

Sixty-three specimens of *S. brevipinna* were collected between April and September 2006 (Table 1) in the tributaries Guairacá and Corvo, in the low Paranapanema River, a region flooded by the reservoir of the Rosana, Paraná, Brazil (22° 36´S; 52°52'W).

Table 1. Number of specimens by month

Nº Specimens	04	08	13	16	08	14
Month	April	May	June	July	August	September

Gills nets with different mesh sizes were used for capturing the fish, disposed for a period of 24 hours, with collections at every eight hours. The specimens were identified and the following information was recorded: date, mesh size, total and standard length (cm), total weight (g), sex, gonadal weight (g) and gonadal maturity stage. Parasites were collected and processed according to Eiras *et al.* (2006) and identifications were based on Khon *et al.* (2000).

The terminology used in parasite ecology was based on Bush *et al.* (1997). The analyses included only the species with prevalence greater than or equal to 10 % (Bush *et al.* 1990) and the statistical significance level adopted was $p \leq 0.05$. The degree of importance of Caswell (1978) and

Hanski (1982) *apud* Bush and Holmes (1986), was used to check the relevance of the species of parasites in the sample, where: Central = species present in more than 66.6 % of fish examined; Secondary = present in 33.3 % to 66.6 % of the sample; Satellite = present in less than 33.3 % of the sample. The Green index was used with the dispersion index (variance and mean abundance ratio) to verify the dispersion of parasites in the sample. The dispersion index was tested according to Elliott (1973) *apud* Ludwig and Reynolds (1988), where d > 1.96 = aggregate distribution; d < -1.96 = uniform and d < 1.96 = random. The Chi-square test with Yates correction was used to determine possible interspecific associations between pairs of co-occurring species, being considered significant when $\chi 2 \geq 3.481$ (Ludwig & Reynolds, 1988). Covariations of the abundances of parasites were tested by the Spearman´s rank correlation coefficient "rs". These analyses were made only with species that were parasitizing the same organ. The Kruskal-Wallis test was used to check if abundances of parasites differed at different stages of gonadal maturity (immature, maturation, reproduction and rest) of females in the sample. Parasite diversity was calculated using the Brillouin index (Zar, 1996). Two statistical tests related to the correlation coefficient were used for each species of parasite: Pearson "r" (hosts were divided into six length classes, with minimum 7 and maximum 14 cm) used to determine possible relations of the length of the hosts and the prevalence (Zar, 1996). The Spearman´s test was used to determine relations between the length of the host and the abundance of parasites (Bush *et al.*, 1997). Spearman´s rank correlation coefficient was also used to check the influence of different species of parasites on the relative condition factor (Kn), which is basically the state of health or welfare of the hosts, and if so assume the value of one, which is calculated by the ratio of the observed weight (the minimum weight of the sample was 5.44 g and maximum 60 g) and the theoretically expected weight for a given length (Le Cren, 1951). The Mann-Whitney non-parametrical test (U) was used to check whether there is difference between the parasite abundance between the tributaries Corvo and Guairacá, where the specimens of the sample were collected (Siegel, 1975), and to obtain the qualitative result of the different species of parasites on the condition factor (Kn). To verify relevant species within the infracommunity, the dominance index of Simpson "C" was calculated for the two tributaries, assuming dominance when $C \geq 0.25$ (Stone & Pence, 1978).

Results

Ecological aspects of the component community of metazoan parasites

All of the 63 specimens of *S. brevipinna* collected in the tributaries Corvo and Guairacá were parasitized, presenting species richness up to four in a single host (41.26 % of hosts with one specie parasite, 39.68 % with two, 17.46 % with three and 1.58 % with four species).

Thirty-six out of 63 hosts examined were collected in the tributary Guairacá River and 27 in the Corvo River, summing 3095 specimens of parasites and five different parasite species. The digenean *Sphincterodiplostomum musculosum* Dubois, 1936 was parasitizing the ovary and was considered dominant (C = 0.325) with the highest prevalence (90.47 %) and abundance, in addition to being classified as a central species by the degree of importance. The three nematodes, *Travnema travnema* Pereira, 1938, *Cosmoxynema. vianai* Travassos, 1949 and *Spinoxyuris* sp. (Pharyngodonidae), were found in the intestine and the monogenean *Paranaella* sp. (Microcotylidae) was parasitizing the gills, the latest species being considered satellite.

Among the parasites selected for the statistical analyses, *Paranaella* sp. was more aggregate than *S. musculosum* according to the Green index. Unlike *T. travnema* and *C. vianai* that were classified as random. Association analyses ($\chi 2 = 0.424$) and abundance covariation (rs = 0.105 and (p) = 0.408) showed no significant values for nematodes.

Statistical analyses that required values of parasite diversity used the Brillouin (1962) index (mean = 0.169).

Gonadal Maturity Stages

Parasite did not show significant differences regarding the levels of parasitism in relation to the gonadal maturity stages.

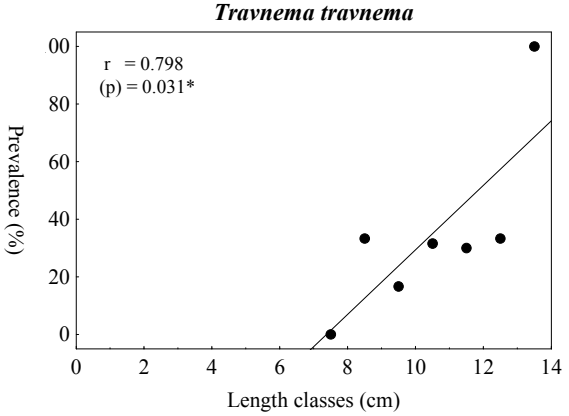

Fig. 1. Correlation between length classes of *S. brevipinna* and the prevalence of the parasite *Travnema travnema*. *Significant value.

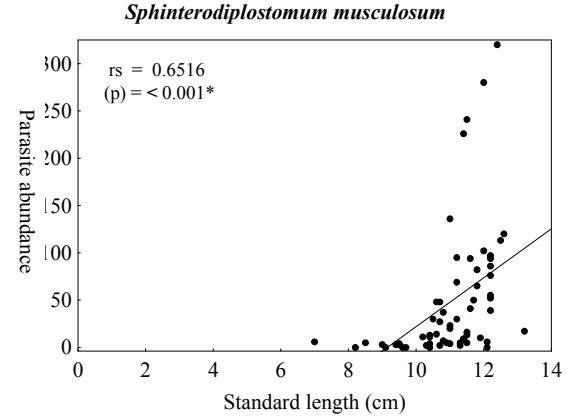

Fig. 2. Correlation between standard length of *S. brevipinna* and the abundance of the parasite *Sphincterodiplostomum musculosum*.

Standard length

Only the nematode *T. travnema* showed significant positive correlation between the standard length and the prevalence of parasites (Fig. 1). Unlike *S. musculosum* that showed significant positive correlation between standard length and the abundance (Fig. 2).

There were no significant values that proved the interference of different parasite species on the relative condition factor (Kn) of the hosts.

Environmental differences between the tributaries

The tributaries differed only regarding the species *T. travnema*, being more abundant in the Corvo River.

Discussion

Parasite fauna and parasite richness are characteristics that may be related to the following factors occurring to the host: amplitude of the space scope, feeding habit or its variations, diversity of intermediate hosts that are part of the diet of the final host (Dogiel, 1961), physiological differences between males and females (Takemoto *et al.*, 1996), immunity (Bauer, 1961) and if the hosts are juveniles or adults (Moser & Hsieh, 1992).

Steindachnerina brevipinna presented a parasite fauna of only five species, considered low when compared to other studies. According to Lizama *et al.* (2005), specimens of *Prochilodus lineatus* collected in the upper Parana River floodplain, region close to the tributaries Corvo and Guairacá, harbored a fauna of 33 metazoan parasites. Specimens of *Leporinus lacustris* and *Leporinus friderici* collected in the same locality presented 31 and 32 species of parasites, respectively (Guidelli *et al.*, 2006).

According to Luque *et al.* (1996), the relation between body length or age of the host and parasite diversity is based on the cumulative process of parasites, when the infection area increases with the growth of the host, and also may be influenced by the diet.

In this case the low parasite diversity found in *S. brevipinna* may be related to the size of the host in accordance with its ontogenetic development and its feeding habit.

The aggregate distribution is considered a natural characteristic of parasites (Hanski, 1982). According to Poulin (1998), it occurs when the majority of hosts harbor few or no parasites and a few hosts harbor the majority. One of the factors that may increase aggregation is the direct reproduction of parasites within the host, and if not the case, it can be explained by the variety of environments explored and the host´s susceptibility to infection.

According to Dobson (1990), this characteristic tends to increase the stability of the parasite/host relationship, acting as a regulatory mechanism, such as the mortality of the host or reductions in fertility and survival of density dependent parasites, influencing the parasite population.

The aggregation of *Paranaella* sp. possibly occurred because these organisms are hermaphrodites and have an intense direct reproduction. Their eggs have a long filament that probably facilitates their fixation to their parent's region and also do not need an intermediate host.

The hypothesis cited anteriorly cannot be applied for *S. musculosum*, because metacercariae do not reproduce. This aggregation probably does not occur as a result of the exploitation of several environments by the host, because *S. brevipinna* is classified as sedentary or migrant of short distances (Suzuki *et al.*, 2004). The susceptibility to the parasite can also be discarded, since parasite prevalence reached over 90 %.

Larvae of this endoparasite were found encysted only on the ovary of the specimens of *S. brevipinna*, being also reported in the eyes of *Cyphocharax gilbert* in the Guandu River, Rio de Janeiro, Brazil (Abdallah *et al.*, 2005) and for *Sphincterodiplostomum* sp. in the visceral cavity of *Hemisorubim platyrhynchos* in the Paraná River, Brazil (Guidelli *et al.*, 2003).

According to Lunaschi & Drago (2006), the adult form of *S. musculosum* was found infecting the intestine of *Ardea alba*, (white heron) in Formosa Province, Argentina. This bird was also reported in the Northwest of Paraná State (Gimenes *et al.*, 2008), where the tributaries Corvo and Guairacá are located. Possibly this bird feeds on *S. brevipinna* when this fish is in shallow waters, since this bird is considered opportunistic (Franz *et al.*, 2007), then closing the life cycle of the parasite.

Being the larval stage considered more pathogenic (Eiras *et al.*, 2006), this association between the aggregation of *S. musculosum* on the ovaries of *S. brevipinna* may be considered a successful relationship, because the parasite possibly does not cause severe damage to the animal, since its pathogenicity can be considered low because of its large amount. This point will be discussed later.

As mentioned above the same parasite was found in the eyes of *C. gilbert* (Abdallah *et al.*, 2005), then allowing a greater possibility of closing the cycle, because the vision of the host is drastically reduced, leaving it more exposed to predators.

The nematodes *T. travnema* and *C. vianai* showed random distributions and possibly their presence in the host were accidental. However, the same genera were found with low mean intensity in *C. gilbert*, which belongs to the same family of *S. brevipinna* (Abdallah *et al.*, 2005).

Hanski (1982), based on the idea that a community is formed by a core of dominant species in equilibrium, surrounded by a larger number of species against this balance (Bush & Holmes, 1986), proposed the concept of core, secondary (few species, but with a large population number) and satellite species (many species, but with a low population number). For the analysis, only *S. musculosum* was classified as core and through the index of Simpson, considered dominant. But the same cannot be competing directly with any of the other parasites, because it is on an isolated organ (ovary). Unlike *T. travnema* and *C. vianai* that parasitize the intestine and also showed no competition when based on the statistic data that was not significant for the correlation between them.

The result is in accordance with Poulin (1998), who suggested the absence or lack of competition within the infra-

communities when there is not a core species, which in this case is accepted.

Gonadal maturity stages

For the gonadal maturity stages, there were no significant values for any species of parasite. *Sphincterodiplostomum musculosum* presented higher prevalence and mean abundance, parasitizing the ovary. Probably there was no damage to the host in this case, because the gonads visibly maintained their normal development, and this was observed until the last collection in September, when this organ was mature. The rest stage of the organ showed the highest abundance of parasites.

According to Giorgio (1995), the virulence caused by the parasite to the host is determined by natural selection in order to maximize the transmission of the parasite. Possibly for *S. musculosum* the low abundance and high virulence promoted their process of transmission to the final host.

Possibly this parasite coevolved for a long time with similar hosts, because there are also records for *C. gilbert* that belongs to the same family of *S. brevipinna*. As the two different species of hosts are possibly considered necessary for the parasite, virulence high enough to kill them would not be advantageous, if could disrupt the life cycle of the parasitic.

Standard length

The standard length of the host is related to the expression of its age (Shotter, 1976) and is one of the most important factors in the variation of the parasite fauna (Dogiel, 1961). The growth of the host increases the area of infection, facilitating the cumulative process of parasites (Luque *et al.*, 1996), and also changing the behavior and biology of fish, which also affects the parasite infrapopulation (Takemoto & Pavanelli, 1996). The cumulative effect can be exponencial in parasites that have a long lifespam (Rohde, 1993), because it will be longer in contact with the host.

Possibly this effect did not occur to *Paranaella* sp. because the parasite occupies a large space in the branchial cavity of the host, thwarting a high cumulative process, because a heavy parasitism could enable a high competition and therefore an unnecessary expenditure of energy, and they could even cause the death of the host by apoxia by impairing its breathing.

The positive correlation between the abundance of *S. musculosum* and the standard length of the host supports the idea of the cumulative effect of parasites by increasing the area of infection with the growth of the host. With the standard length increasing with the ontogenetic development of *S. brevipinna*, also increases the area of the body surface, increasing the chances of occurring the process of active penetration of cercariae.

For *T. travnema* there was a positive correlation between the standard length of the host and parasite prevalence. Therefore, according to the growth of fish, most hosts are parasitized. Possibly this has occurred because of the feeding habit of *S. brevipinna*, for being in contact with more intermediate hosts of the parasite over the course of its growth because it needs more energy to sustain themselves. The same parasite was also found in *Pseudocurimata elegans*, *P. gilbert* (= *Cyphocarax gilbert*) and *P. plumbea* (Moravec, 1998), who have their diet similar to *S. brevipinna*, in addition belonging to the same family. According to Abdallah *et al.* (2005), a nematode of the same genus (*Travnema araujoi*) was infecting the intestine of *C. gilbert*.

Cosmoxynema vianai did not present significant values of prevalence and / or abundance in relation to the standard length of the host. Probably it also occurred because of the feeding habit or habitat of the host, maintaining the same contact with intermediary hosts of the parasite during its ontogenetic development. According to Moravec (1998), there are no studies on the biology of *C. vianai*.

These events support the idea that the quantity and quality of food consumed may be responsible for the increase in prevalence and abundance of parasites with the age of the host (Hanek & Fernando, 1978).

Relative condition factor

When the factor of analysis is related to the condition of dynamic equilibrium of the host in accordance with the parasite variation, the interpretation of the data tends to be more difficult because other diseases caused by several reasons can also interfere on the host and pass unnoticed, as well of natural occurrences, such as predation of a debilitate individual that was not sampled among other characteristics that reduce the chances of real results.

According to Chubb (1973), it is difficult to find a "normal" state for the host, because in most cases the specimens of a sample are parasitized.

No parasite reached significant values, attesting interference on the condition factor of the host. Probably in this case, the parasite fauna is not altering the balance of *S. brevipinna*, since the previous analyses did not show results that parasites are injurious to the host, such as the standard length and gonadal maturity stage (even being found up to 320 parasites in the same ovary), which are important factors for the development of the host.

Environmental differences between the tributaries

The nematode *T. travnema* with prevalence above 10 %, but with low abundance, showed significant differences in the abundance values between the tributaries, being higher in the Corvo River. Possibly the "coincidence" favored the outcome of these analyses, as the same parasite was classified as satellite and random species for *S. brevipinna* in previous data and this is related to the instability of the parasite, in addition to the values of mean abundance that show how low is the difference between the rivers. More sampling could show concrete results for this analysis.

The environment is one of the factors that can determine the diversity and richness of helminth endoparasites (Bell & Burt, 1990) and consequently the abundance. Because they are very close, these tributaries probably have very

similar biotic and abiotic characteristics. Thus, to affirm that the difference in the abundance of *T. travnema* is a consequence of environmental variation would be very pretensious.

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