Ecology of endoparasites of the fluvial stingray
*Potamotrygon falkneri* (Chondrichthyes: Potamotrygonidae)
from the upper Paraná River floodplain, Brazil

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Abstract

The present study investigated the ecological relationships between endoparasites and the host *Potamotrygon falkneri*
from the upper Paraná River by using as indicators the host’s relative condition factor (Kn), sex and hepatosomatic
relation (HSR). Forty-seven specimens of *P. falkneri* were analyzed between March 2005 and September 2006.
Statistical analysis showed that the Kn was positively correlated with the abundance of *Acanthobothrium regoi*
and *Rhinebothrium paratrygoni*; only the abundance of *A. regoi* was positively correlated to the HSR, whereas
*R. paratrygoni* did not present correlation and there was no influence of the host’s sex on the abundance and prevalence
of parasites. This is the first study concerning the ecology of parasites of potamotrygonids.

Keywords: potamotrygonids, parasites, relative condition factor, hepatosomatic relation, Paraná.

1. Introduction

*Potamotrygon falkneri* Castex (Potamotrygonidae) is a fluvial stingray found in the Paraná-Paraguay basin, from
the Cuiabá River to La Plata River (Carvalho et al., 2003). Despite of some studies on the systematic (Rego, 1979;
Marques and Brooks, 2003) and phylogeny (Brooks, 1992)
of endoparasites of potamotrygonids, little is known about
this host-parasite association. The application of indicators
that use organs as the liver and the relative condition factor
of fishes regarding the levels of parasitism are important
tools for understanding the ecological relationship be-
tween parasites and hosts (Lizama et al., 2006). Thus, the
present study had the objective to analyze *P. falkneri* and
its endoparasites from the upper Paraná River floodplain,
using the sex, the relative condition factor and the hepato-
somatic relation of the hosts.

2. Materials and Methods

Forty-seven specimens of *P. falkneri* were analyzed,
captured between March 2005 and September 2006 in
the upper Paraná River floodplain, near the City of Porto Rico, Paraná and Mato Grosso do Sul States (22° 43’ S
and 53° 10’ W) (Figure 1).
Lacerda, ACF., Takemoto, RM. and Pavanelli, GC. (2009). The relative condition factor (Kn) was calculated, considering the coefficient between the observed weight and the weight theoretically expected for a given length (Le Cren, 1951). The hepatosomatic relation (HSR%) was calculated by the expression: liver weight (g)/body weight (g) x 100. For each species of parasite, the Spearman rank correlation “rs” was calculated between abundance and Kn and abundance and HSR. The tests adopted level of significance of p ≤ 0.05 and were applied only to the species that presented prevalence higher than 10%. The ecological terminology was based on Rózsa et al. (2000).

3. Results

Twenty-two out of 47 specimens of *P. falkneri* presented at least one species of endoparasite (46.8%). In total, 175 specimens of parasites were collected from the...
Association parasite-host in fluvial stingray

The species richness of the infracommunities varied from one to five, being constituted by only one species of parasite in the majority of the hosts (Figure 3). The community of endoparasites presented mean diversity of \( HB = 0.32 \pm 0.35 \), with the majority of the hosts under 0.5. The parasites that presented prevalence higher than 10\%, \( A. \) regoi and \( R. \) paratrygoni, presented aggregated distribution (ID = 12.71; \( d = 24.67 \); GI = 0.38 and ID = 13.25; \( d = 25.38 \); GI = 0.14, respectively). No species of parasite was considered central. \( R. \) paratrygoni was considered secondary and all the other species were considered satellites. There was not dominance in the proportion of parasitized fish regarding the species of parasites (C = 0.22).

The total length of the fish varied between 39.00 and 89.80 cm (55.80 \( \pm \) 13.80). Total weight varied from 375.00 to 7300.00 g (1771.90 \( \pm \) 1534.60). Kn varied between 0.72 and 1.44 (1.01 \( \pm \) 0.19) and the HSR from 0.99 to 6.67 (3.23 \( \pm \) 1.33). The Kn was positively correlated to the abundance of \( A. \) regoi (rs = 0.29; p = 0.04) and \( R. \) paratrygoni (rs = 0.29; p = 0.04). Only the abundance of \( A. \) regoi was positively correlated to the HSR of the hosts (rs = 0.34; p = 0.04), while \( R. \) paratrygoni did not present correlation (rs = 0.15; p > 0.05).

Twenty-five hosts were females and 22 were males. Significant influences of the host sex on the abundance and prevalence of \( A. \) regoi (Z = 0.08; 0.08).

Table 1. Parasite taxa, infection sites and parasitism indexes in 47 specimens of \( Potamotrygon falkneri \) collected in the upper Paraná River floodplain between March 2005 and September 2006. PF = parasitized fish; P = prevalence; MI = mean intensity \( \pm \) SD; MOI = mode of intensity; MA = mean abundance \( \pm \) SD.

| Parasite taxa | Infection sites | Parasitism indexes |
|---------------|----------------|--------------------|
|               | PF P (%)       | MI \( \pm \) SD    | MOI    | MA \( \pm \) SD |
| **Digenea**   |                |                    |        |                |
| *Clinostomum complanatum* (Rudolphi, 1819) (metacercaria) | Spiral valvae | 1 | 2.13 | 1 | 1 | 0.02 |
| *Tylodelphis* sp. (metacercariae) | Spiral valvae | 1 | 2.13 | 8 | 8 | 0.17 |
| *Genarchella* sp. | Stomach | 2 | 4.25 | 1 | 1 | 0.04 |
| **Cestoda**   |                |                    |        |                |
| *Acanthobothrium regoi* Brooks, Mayes and Thorson, 1981 | Spiral valvae | 6 | 12.76 | 5.83 \( \pm \) 6.88 | 1 | 0.74 \( \pm \) 3.00 |
| *Paroncomesgaraya* (Woodland, 1934) | Spiral valvae | 3 | 6.38 | 3 \( \pm \) 2.00 | 1;3;5 | 0.19 \( \pm \) 1.04 |
| *Potamotrygonocestus travassosi* Rego, 1979 | Spiral valvae | 1 | 2.13 | 4 | 4 | 0.58 |
| *Rhinebothrium paratrygoni* Rego and Dias, 1976 | Spiral valvae | 17 | 36.17 | 5 \( \pm \) 7.29 | 1 | 2 \( \pm \) 4.98 |
| **Nematoda**  |                |                    |        |                |
| *Brevimulticaecum* sp. (larvae) | Stomach (external wall) | 1 | 2.13 | 16 | 16 | 0.34 |
| *Cucullanus* (Cucullanus) sp. | Spiral valvae | 1 | 2.13 | 3 | 3 | 0.06 |
| *Echinocephalus* sp. | Spiral valvae | 2 | 2.13 | 1 | 1 | 0.02 |
| *Spinitectus* sp. | Spiral valvae | 1 | 2.13 | 3 | 3 | 0.06 |
| **Acanthocephala** |                |                    |        |                |
| *Quadrigyrus machadoi* Fabio, 1983 | Spiral valvae | 3 | 6.38 | 2 \( \pm \) 1 | 1;2;3 | 0.13 \( \pm \) 0.54 |
Echinocephalus sp., Spinitectus sp., Cucullanus sp., Tylodelphis sp. (metacercariae), Genarchella sp. and Clinostomum complanatum (metacercaria) occurred only in females.

4. Discussion

Considering all species of parasites, approximately half of the analyzed fish were parasitized (46.8%). Only one metacercaria of Clinostomum complanatum was found in a single host. It is possible to consider that the host Potamotrygon falkneri acted as an accidental host for this metacercaria, since its prevalence was very low and it is an abundant species in the study region (Pavanelli et al., 2004). The same can be considered for Tylodelphis sp., Brevimulticaecum sp., Cucullanus (Cucullanus) sp. and Spinitectus sp., that were found in only one host, but with higher intensity.

The most prevalent species were Acanthobothrium regoi (12.76%) and Rhinebothrium paratrygoni (36.17%), cestodes that are not very specific, but parasitize only potamotrygonids (Brooks and Amato, 1992; Lacerda et al., 2008). Unfortunately, the majority of the studies with parasites of fluvial stingrays do not present information about parasitism levels, but we can say that the prevalence of Acanthobothrium regoi in P. falkneri in the present study is low when compared to other species of Acanthobothrium and other species of hosts, being closer to the values found in Argentina (Ivanov, 2005). Those values indicate that the genus is better represented (in relation to infected hosts) in the populations of marine stingrays. In fact, these parasites are more adapted to the marine environment, since they probably occupied the freshwater environment with the ancestor of the potamotrygonids, during Plioceno (three to five millions years ago) (Brooks, 1992).

Although the number of hosts did not permit a seasonal analyses, a higher number of parasites was observed in May 2005 and May and June 2006. The annual cycles and reproductive periods of fish parasites are frequently related to the hydrologic variation of the habitat of the host, as well as to the fluctuations in the abundance of plankton and benthic organisms (Ginetinskaya, 1970) and fish that feed on them. Analysing the annual variation of the hydrologic level (monthly mean) of the region, Souza Filho et al. (2004) emphasized a decrease in May and June, being the lowest level recorded in August. According to Machado et al. (1994), intermediate hosts present a tendency to aggregate in the low water period, when the activity of feeding of the fish is more intense. In addition, Lonardoni et al. (2007) analysed the feeding habits of Potamotrygon falkneri in the upper Paraná River floodplain, where they consumed predominantly molluscs in the period of flood and mainly fishes in the dry period. Thus, the high values of prevalence of cestodes observed in June 2005 and May and June 2006 can be explained by the low hydrologic level and consequent increase of the aggregation of intermediate hosts (fish) and of the feeding activity of the stingrays. These re-
sults contrast with Machado et al. (1994) for the hosts *Pseudoplatystoma corruscans* and *Schizodon borelli*, where the highest occurrence of three species of proteocephalideans occurred in the period of high water in the same studied region. The increase of the aggregation of intermediate hosts and of the feeding activity when the climate is dry can also explain the highest species richness recorded in June 2005 and 2006.

According to Poulin (1998), one of the factors that can increase the aggregation of parasites is the reproduction inside the host. When the parasites do not present monoxenlic reproduction, the aggregation can be explained by the heterogeneity in the exposition of the individuals to the parasites and in the susceptibility of the individuals to the infections. Considering that the cestodes are not capable of reproducing directly inside the host, the aggregated distribution of *A. regoi* and *R. paratrygoni* in the analyzed individuals of *P. falkneri* suggests that the population of hosts occupies a great variety of environments in the studied region. Besides, the hosts should also exhibit different levels of tolerance to the infection by parasites, due to genetic or environmental factors (food, stress).

Caswell (1978), cited by Bush and Holmes (1986), proposed the idea that a community is formed by a nucleus of dominant species in equilibrium, enclosed by species interacting against this equilibrium. Hanski (1982), cited by Bush and Holmes (1986), then, elaborated the concept of central species (few frequent and numerous species) and satellites (many species limited in number and low frequency). According to Bush and Holmes (1986), only the central species (in equilibrium) present foreseeable patterns, while satellite species behave in an unstable way. As expected, the majority of the species of parasites were considered satellites. However, the absence of species considered central indicates the absence of this equilibrium proposed by Caswell (1978), cited by Bush and Holmes (1986) and consequently the unpredictability of patterns in the infracommunities of parasites of *P. falkneri* in the studied region. The absence of dominance between the species of parasites was also confirmed by the index of dominance of Simpson, a result that according to Poulin (1998) suggests low, or the absence of, competition inside the infracommunities.

Considering that the parasites are harmful to their hosts, a negative correlation is expected between abundance and Kn. However, in the present study, positive correlation occurred. Studies about the condition factor (K) of parasitized fish show that the parasitism can be related to low values of K or Kn (Tavares-Dias et al., 2000) or increase with the host’s condition factor (Lizama et al., 2006), as well as the absence of correlation (Ranzani-Paiva et al., 2005). The positive correlations between the relative condition factor of *P. falkneri* and the abundances of *A. regoi* and *R. paratrygoni* indicate that the number of parasite specimens increases along with the condition factor of the fish. As these parasites are transmitted by the feeding activity, these results can be explained by a cumulative process, where stingrays that are in better physical conditions fed on a great quantity of potential intermediate hosts (fish), being more susceptible to infections (Luque et al., 1996).

The present study did not find significant differences between the host’s sex regarding parasitism, as mentioned by other authors studying teleosts (Machado et al., 1994). Other authors found differences in the abundance of parasites between males and females, some finding males more parasitized (Takemoto and Pavanelli, 2000), others finding females more parasitized (Lizama et al., 2005).

The composition of the parasite fauna is a product of interactions of biotic and abiotic factors of the environment (Dogiel, 1970). Still according to the same author, the parasite fauna is affected more seriously by the physiological characteristics of the hosts, food being the most important factor. Lonardoni et al. (2007) pointed to molluscs, crustaceans, small fish and aquatic insects as part of the diet of *P. falkneri* in the upper Paraná River basin, not differing males from females. Despite the absence of significant differences between males and females in the present study, some species of parasites were recorded only in females. The difference between males and females regarding the species of parasites found can be an indicator of feeding and/or behavioural differences between the sexes, or still a result of the cumulative process previously mentioned, since females of *P. falkneri* exhibit bigger measures than males (Silva, 2006).

According to Aime and Pappas (1983) the effects of parasitism can be observed in organs with which the cestodes do not have contact; fibrosis was observed in the intrahepatic ducts and also lesions on the liver surface of vertebrate hosts.

In teleosts, parasitism can be related with the reduction of the hepatosomatic relation (Kurovskaia and Osadchaya, 1993), to hepatomegaly (Tierney et al., 1996) or do not present liver alterations (Lizama et al., 2006). According to Griffith et al. (1973), correlation exists between the hepatosomatic index and the health of the potamotrygonids; fish with low indexes present very low values of glucose, total carbohydrates, cholesterol, urea and proteins. Thus, the present study indicates that the parasitism by *A. regoi* can be related to damage to the host’s health. *R. paratrygoni* did not present correlation with the hepatosomatic index of the hosts. According to Aime and Pappas (1983), many authors affirm that adult cestodes have little or no harmful effect on the host. That can be due to the long evolutionary relation between hosts and parasites and/or to the compensatory effects of alternative physiological mechanisms that can occur in parasitized animals.

Considering that *A. regoi* presented positive correlation with the condition factor and with the HSR of the hosts, doubts arise about which is the best indicator of the real condition of the fish. Future studies are necessary for the determination of the most efficient indicator.
for the evaluation of the damage caused by the relationship parasite-host in potamotrygonids.

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