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Helminth fauna parasitizing *Pimelodus pohli* (Actinopterygii: Pimelodidae) from the upper São Francisco River, Brazil

Helmintofauna de *Pimelodus pohli* (Actinopterygii: Pimelodidae) do alto rio São Francisco, Brasil

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Abstract

The parasite fauna of catfish, *Pimelodus pohli*, from the São Francisco River Basin is presented. A total of 45 catfish from the upper São Francisco River (45°15'44"W 18°13'25"S), were examined from July 2009 to September 2011. Forty-three catfish (95.5%) were infected by at least one parasite species, with 885 parasite specimens being found, distributed across 17 species: Monogenea (*Demidospermus uncusvalidus*, *Pavanelliella pavanellii*, and *Scleroductus* sp.); Eucestoda (plerocercoids of Proteocephalidea); Digenea (metacercariae of *Austrodiplostomum compactum*, adults of *Auriculostoma platense* and *Kalipharynx* sp., and juvenile of *Prosthenhystera obesa*); Nematoda (larvae of *Contracaecum* sp., *Hysterothylacium* sp., *Procamallanus pimelodus*, *Procamallanus* sp., and unidentified of Cucullanidae, and adults of *Cucullanus caballeroi, Philometra* sp., and *Procamallanus freitasi*); and Acanthocephala (adults of *Neoechinorhynchus pimelodi*). *Procamallanus freitasi* and *Scleroductus* sp. were the taxa with the highest prevalence. *Demidospermus uncusvalidus*, *P. freitasi*, and *Scleroductus* sp. were the dominant species. The host's sex did not influence parasitic indexes; however, the total length of the catfish did appear to have some influence. The parasites, with except for *P. obesa*, were registered for the first time in *P. pohli,* as well as the occurrence of *Kalipharynx* sp. and *C. caballeroi* among pimelodid hosts from São Francisco River and South America.

Keywords: Parasites of endemic fish, helminth parasites of freshwater fish, parasite community.

Resumo

A fauna parasitária de mandis, *Pimelodus pohli* da bacia do rio São Francisco é apresentada. Um total de 45 mandis do alto rio São Francisco (45°15'44"W 18°13'25"S), foram examinados entre julho de 2009 e setembro de 2011. Quarenta e três mandis (95,5%) estavam infectados por pelo menos uma espécie de parasito tendo sido encontrados 885 parasitos de 17 espécies: Monogenea (*Demidospermus uncusvalidus*, *Pavanelliella pavanellii*, and *Scleroductus* sp.); Eucestoda (plerocercóides de Proteocephalidea); Digenea (metacercárias de *Austrodiplostomum compactum*, adultos de *Auriculostoma platense* e *Kalipharynx* sp. e juvenil de *Prosthenhystera obesa*); Nematoda (larvas de *Contracaecum* sp., *Hysterothylacium* sp., *Procamallanus pimelodus*, *Procamallanus* sp., larvas não identificadas de Cucullanidae e adultos de *Cucullanus caballeroi, Philometra* sp. e *Procamallanus freitasi*); e Acanthocephala (adultos de *Neoechinorhynchus pimelodi*). *Procamallanus freitasi* e *Scleroductus* sp. foram os táxons com prevalência mais elevada. *Demidospermus uncusvalidus, P. freitasi e Scleroductus* sp. foram as espécies dominantes. O sexo dos hospedeiros não influenciou os índices parasitários, mas houve alguma influência do comprimento total sobre eles. Os parasitos, com exceção de *P. obesa*, são registrados pela primeira vez em *P. pohli,* bem como a ocorrência de *Kalipharynx* sp. e *C. caballeroi* em hospedeiros pimelodídeos do rio São Francisco e da América do Sul.

Palavras-chave: Parasitos de peixe endêmico, helmintos de peixes de água doce, comunidade parasitária.

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Introduction

Pimelodus pohli Ribeiro & Lucena, 2006, a fish species popularly known as white catfish, or "mandi-branco", is found at several localities along the São Francisco River Basin (RIBEIRO; LUCENA, 2006). According to these authors, *P. pohli* is a species identified by Britski et al. (1988) as *Pimelodus* sp.. As was recently described, studies referring to its biological, behavioral, and parasitological aspects are unknown, and a comparison of its fauna with that of *Pimelodus maculatus* Lacepède, 1803 (congeneric of the same hydric system) and other pimelodids, for which its parasite faunas are already known, is urgent. Observations of the gastric content of *P. pohli* in the present study have revealed the use of aquatic invertebrates (insects, small arachnids, and crustaceans) and sediments as elements of its diet. Taking into account the study on the feeding habits of fish in the upper São Francisco River, as conducted by Alvim (1999), *P. pohli* may be considered a generalistic invertivorous and iliophagous. Thus, the endohelmintic fauna recorded in that study must reflect these feeding habits.

In the São Francisco River Basin, the records on the parasite fauna of pimelodids were established for *Conorhynchos conirostris* (Valenciennes, 1840) by Pinto et al. (1974), Pinto and Noronha (1976), Vicente et al. (1985), and Brasil-Sato and Santos (2005); for *Pseudoplatystoma corruscans* (Spix & Agassiz, 1829) by Rego and Gibson (1989), Kohn et al. (1997), and Corrêa and Brasil-Sato (2008); for *Bergiaria westermanni* (Lütken, 1874) by Moreira et al. (1991) and Vicente and Pinto (1999); for *P. maculatus* by Brasil-Sato and Pavanelli (1998, 1999, 2000, 2004), Brasil-Sato (2003), and Monteiro et al. (2010); and for *P. pohli* by Martins et al. (2012). In this last work, the authors have established the first record of a parasite species, *Prosthenhystera obesa* (Diesing, 1850), in the gall bladder of *P. pohli*.

Studies on parasitism in pimelodids have been also conducted in other localities of Brazil, such as some helminth parasites of species of *Pimelodus* Lacepède, 1803: *P. blochii* Valenciennes, 1840 in Paraná River (KOHN et al., 1997); *P. fur* (Lütken, 1874) in Paraná River (KOHN et al., 1997); *P. maculatus* in Amazon Basin (KOHN et al., 2011); in Guaiba River (KOHN; FRÓES, 1986; FORTES et al., 1993; FORTES; HOFFMANN, 1995; SARMENTO et al., 1995); in Guandu River (SANTOS et al., 2007; ALBUQUERQUE et al., 2008; AZEVEDO et al., 2010); in Itajaí-Açu River (BACHMANN et al., 2007); in Mogi Guaçu River (TRAVASSOS; KOHN, 1965; KOHN et al., 1985; KOHN; FERNANDES, 1987; AGUIAR et al., 2011); in Paraiba do Sul River (VENANCIO et al., 2010); in Paraná River (TRAVASSOS; KOHN, 1965; PAVANELLI; MACHADO DOS SANTOS, 1992; MORAVEC et al., 1993, 1997; KOHN et al., 1997; BRASIL-SATO; PAVANELLI, 2004; COHEN; KOHN, 2008; KOHN et al., 2011; LOPES et al., 2011); in Paranapanema River (RAMOS et al., 2013); *Pimelodus microstoma* Steindachner, 1877 in Mogi Guaçu River (AGUIAR et al., 2011) [note of the authors: this fish species was cited by the authors as *P. heraldoi* Azpelicueta, 2001, that is a junior synonym of *P. microstoma* Stein., *sensu* Ribeiro and Lucena (2010)]; *Pimelodus ornatus* Kner, 1858 in Paraná River (PAVANELLI; TAKEMOTO, 1996; PAVANELLI et al., 1997; FERNANDES; KOHN, 2001; KOHN et al., 2011); *Pimelodus* sp. in Amazon Basin (VICENTE et al., 1978). Through a literature review, it was possible to verify at least 131 species of helminths recorded among the pimelodids distributed in the Brazilian basins.

In this study, the helminth fauna of *P. pohli* is presented for the first time in the São Francisco River Basin, contributing to the knowledge on the parasite species of fish in the São Francisco River, and on the parasite species of pimelodids in the hydrographic basins in South America.

Materials and Methods

A total of 45 specimens of *P. pohli* were collected from July 2009 to September 2011 in the upper São Francisco River, downstream from the Três Marias Reservoir (45°15'44"W, 18°13'25"S) in the municipality of Três Marias, State of Minas Gerais, Brazil. The fish were captured by local fishers and were sent to the Centro Integrado de Recursos Pesqueiros e Aquicultura (CIRPA) of the Companhia de Desenvolvimento dos Vales do São Francisco e do Parnaíba (CODEVASF), where they were weighted (average body weight: 26.6 ± 11 g), measured (average total length: 14.5 ± 1.6 cm), and necropsied to investigate their parasite fauna. Voucher specimens of *P. pohli* were deposited in the Coleção de Peixes of the Museu de Zoologia of the Universidade de São Paulo (MZUSP: 105895), State of São Paulo, Brazil. Parasite voucher specimens were deposited in the Coleção Helmintológica of the Instituto Oswaldo Cruz (CHIOC), Rio de Janeiro, Brazil, under the numbers indicated in Table 1 of the Results section.

Ecological descriptors (prevalence, mean abundance, and mean intensity) were calculated according to Bush et al. (1997). The dispersion index was calculated for each species in order to determine the distribution standard of the species; it was tested by calculating the *d* statistic (LUDWIG; REYNOLDS, 1988). The interaction between couples of species co-occurring within the hosts was evaluated via the chi-square test (χ^2) with Yates's correction and a 2 × 2 contingency table, and by Spearman's rank correlation coefficient (*rs*). Student's *t*-test was used to evaluate the total length among the male and female hosts. Spearman's rank correlation coefficient (*rs*) was used to verify possible correlations between the total length of hosts and parasite abundance and intensity. Pearson's correlation coefficient (*r*) was used to determine possible correlations between the total length of the hosts and parasite prevalence. The influence of the host's sex on parasite abundance and prevalence was tested using the normal approximation of *Z* via the Mann–Whitney *U* test and the chi-square test (χ^2) with Yates's correction and a 2 × 2 contingency table, respectively. The statistical analysis was performed according to Zar (1996), and was applied to the study of parasite infracommunities among *P. pohli*, but only for species with a prevalence rate higher than 10% (BUSH et al., 1990). The adopted significance level was $p < 0.05$.

Results

Among the 45 examined specimens of *P. pohli*, 18 (40%) were male and 27 (60%) were female (representing a ratio of 1:1.5). Male and female catfish presented with a mean total length of

Table 1. Ecological describers (prevalence, mean intensity, intensity amplitude, mean abundance), and site of infestation/infection of helminth parasites (the developmental stages of the parasite specimens, except for adults, were indicated in parentheses following the nominal taxa) of *Pimelodus pohli* Ribeiro & Lucena, 2006 from the upper São Francisco River, State of Minas Gerais, Brazil.

Parasite	Prevalence (%)	Mean intensity	Intensity amplitude	Mean abundance	Site
Monogenea					
Demidospermus uncusvalidus Gutierrez & Suriano, 1992 (CHIOC n.37922, 37923)	51.1	17.22±19.73	1-78	8.80±16.44	Gill filaments
Pavanelliella pavanellii Kritsky & Boeger, 1998 (CHIOC n.37921)	4.4	1	1	0.04±0.21	Nasal cavity
Scleroductus sp.(CHIOC n.37924)	62.2	4.86±5.76	1-23	3.02±5.10	Body surface
Digenea					
Austrodiplostomum compactum (Lutz, 1928) (metacercariae) (CHIOC n.37927)	35.5	2.25±2.57	1-10	0.80±1.85	Eyes
Auriculostoma platense (Szidat,1954) (CHIOC n.37926)	6.6	19.67±31.47	1-56	1.31±8.34	Anterior intestine
Prosthenhystera obesa (Diesing, 1850) (juvenile) (CHIOC n. 37732)	2.2	1	1	0.02±0.15	Gall bladder
Kalipharynx sp.	2.2	3	1-3	0.07±0.45	Coelom
Cestoda					
Proteocephalidea (plerocercoids) (CHIOC n.37928)	6.7	2.70±2.10	1-5	0.18±0.80	Intestine
Nematoda					
Contracaecum sp. (larvae) (CHIOC n.35922)	17.8	3.00±2.14	1-6	0.53±1.44	Coelom
Cucullanus caballeroi Petter, 1977 (CHIOC n.35915, 35916)	6.7	1	1	0.02±0.15	Anterior and posterior intestine
Cucullanidae (larvae unidentified) (CHIOC n.35914)	4.4	1	1	0.04±0.21	Coelom
Hysterothylacium sp. (larvae) (CHIOC n.35917)	2.2	1	1	0.02±0.15	Coelom
Philometra sp. (CHIOC n.35923)	2.2	1	1	0.02±0.15	Coelom
Procamallanus freitasi (Moreira, Oliveira & Costa, 1991) (CHIOC n.35920, 35921)	64.4	5.55±5.78	1-24	3.58±5.34	Anterior, middle and posterior intestine
Procamallanus pimelodus (Pinto, Fábio, Noronha & Rolas, 1974) (larvae) (CHIOC n.35918)	6.7	1.33±0.58	1-2	0.09±0.36	Middle intestine
Procamallanus (*Spirocamallanus*) sp. (larvae) (CHIOC n.35919)	24.4	3.82 ± 3.65	1-11	0.93± 2.41	Anterior and middle intestine
Acanthocephala					
Neoechinorhynchus pimelodi Brasil-Sato & Pavanelli, 1998 (CHIOC n. 37925)	11.6	1.20±0.44	1-2	0.13±0.40	Anterior intestine

14.3 ± 1.4 cm and 14.7 ± 1.7 cm, respectively, and a mean body weight of 25.6 ± 9.8 g and 28.2 ± 13.2 g, respectively. There was no significant difference in the total length (t = 0.84; p = 0.20) and weight (t = 0.75; p = 0.45) between male and female hosts.

Among the examined hosts, 43 (95.5%) were infected by at least one parasite species. A total of 885 parasites were found, and those represented the following taxa: Monogenea (three species); Eucestoda (one species); Digenea (four species); Nematoda (eight species); and Acanthocephala (one species) (Table 1).

Nematoda and Monogenea were the taxa whose prevalence values were higher, representing 82% and 75%, respectively, of the total fauna.

In Nematoda, the adult specimens of *Procamallanus freitasi* (Moreira, Oliveira & Costa, 1991) presented with a higher prevalence rate, mean abundance, and mean intensity, followed by *Procamallanus* (*Spirocamallanus*) sp. and *Contracaecum* sp., respectively, which consisted of specimens at the larval stage. In Monogenea, *Scleroductus* sp. presented with the highest prevalence rate, and *Demidospermus uncusvalidus* Gutiérrez & Suriano, 1992, was the most abundant species with the highest mean intensity (Table 1).

The parasite community of *P. pohli* demonstrated the standard aggregated distribution pattern, except for the uniform distribution of *Neoechinorhynchus pimelodi* Brasil-Sato & Pavanelli, 1998. The dominance frequency and mean relative dominance of the parasite community were most marked in *D. uncusvalidus*, followed by *P. freitasi* and *Scleroductus* sp.. The frequency of shared dominance was highest in *P. freitasi* and *Scleroductus* sp., respectively (Table 2).

There was no correlation between the host's sex and the parasitic indexes prevalence and abundance (*D. uncusvalidus*: χ^2 = 0.18, Z = -0.81; *Scleroductus* sp.: χ^2 = 1.14, Z = -0.75; *A. compactum* χ^2 = 0.33, Z = -0.65; *Contracaecum* sp.: χ^2 = 0.06, Z = -0.08; *P. freitasi*: χ^2 = 0.01, Z = -0.20; *Procamallanus* (*S.*) sp.: χ^2 = 0.49, Z = -0.35; *N. pimelodi*: χ^2 = 0.64, Z = 0.99, respectively, $p > 0.05$ for each result).

The total length of the hosts negatively influenced the parasitic indexes of the parasite fauna of *P. pohli* – that is, the intensity and abundance of *D. uncusvalidus*, the abundance of *Contracaecum*

sp., and the prevalence of *P. freitasi*, were highest in fish with a smaller total length (Table 3).

Among the co-occurring species, the couples *D. uncusvalidus - Scleroductus* sp. and *P. freitasi – N. pimelodi* presented their correlated abundances (Table 4).

Discussion

Nematodes, both at their larval stage and as adults, are common parasites of freshwater fish, and they can attack all organs in the body; many of them are known to be disease agents in fish and humans (MORAVEC, 1998). Nematoda was the prevailing taxon in several studies on the helminth fauna of *P. maculatus*. In Brazil, Kohn and Fernandes (1987) recorded the occurrence of *Cucullanus pinnai* Travassos, Artigas & Pereira, 1928, as the most prevailing parasite in the Mogi Guaçu River, State of São Paulo, followed by *Cucullanus* sp. and *Procamallanus pimelodus* (Pinto, Fabio, Noronha & Rolas, 1974); Bachmann et al. (2007) recorded the highest prevalence of camallanids (*P. pimelodus*) in the Itajaí-Açu River, State of Santa Catarina. The highest prevalence was noted among cucullanids (*C. pinnai*) by Santos et al. (2007) and

Table 2. Values of dominance frequency, mean relative dominance, shared dominance frequency, dispersion index, and *d* statistic of helminth parasites of *Pimelodus pohli* Ribeiro & Lucena, 2006 from the upper São Francisco River, State of Minas Gerais, Brazil.

Parasite	Dominance Frequency	Mean relative-dominance	Shared dominance frequency	Dispersion Index	*d* Statistic
Monogenea					
Demidospermus uncusvalidus	17	0.26±0.29	12	30.72	41.61*
Scleroductus sp.	6	0.20±0.24	22	8.62	17.15*
Digenea					
Austrodiplostomum compactum	3	0.07±0.14	13	4.29	9.06*
Nematoda					
Contracaecum sp.	2	0.05±0.17	5	3.88	8.10*
Procamallanus freitasi	7	0.21±0.26	22	7.97	16.10*
Procamallanus (*Spirocamallanus*) sp.	1	0.04±0.11	7	6.2	12.98*
Acanthocephala					
Neoechinorhynchus pimelodi	0	0.01±0.03	4	1.22	0.01

*Significant values: $d > 1.96$

Table 3. Influence of host length in prevalence (Pearson's (*r)* correlation coefficient), intensity, and abundance (Spearman's rank (*rs)* correlation coefficient) of helminth parasites of *Pimelodus pohli* Ribeiro & Lucena, 2006 from the upper São Francisco River, State of Minas Gerais, Brazil.

Parasite	Prevalence		Intensity		Abundance	
	r	*p*	*rs*	*p*	*rs*	*p*
Monogenea						
Demidospermus uncusvalidus	–0.96	0.18	–0.42	0.04*	-0.38	0.009*
Scleroductus sp.	–0.88	0.25	–0.29	0.13	0.08	0.6
Digenea						
Austrodiplostomum compactum	0.97	0.12	0.24	0.36	0.21	0.15
Nematoda						
Contracaecum sp.	–0.30	0.8	–0.24	0.56	–0.33	0.02*
Procamallanus freitasi	–0.99	0.02*	0.04	0.83	–0.14	0.34
Procamallanus (*Spirocamallanus*) sp.	–0.55	0.62	–0.05	0.87	–0.16	0.29
Acanthocephala						
Neoechinorhynchus pimelodi	0.97	0.12	0.35	0.51	–0.44	0.77

*significant values: $p < 0.05$.

Table 4. Couples of co-occurring species of helminth parasites of *Pimelodus pohli* Ribeiro & Lucena, 2006 from the upper São Francisco River, State of Minas Gerais, Brazil

Co-occurring Species	Prevalence		Abundance	
	χ^2	*p*	*rs*	*p*
Ectoparasites (adults)				
Demidospermus uncusvalidus - Scleroductus sp.	2.74	0.09	0.34	0.02*
Endoparasites (adults)				
Procamallanus freitasi – Neoechinorhynchus pimelodi	0.72	0.39	0.35	0.02*
Endoparasites (larvae)				
Contracaecum sp. - *Procamallanus (Spirocamallanus)* sp.	0.19	0.66	0.27	0.07

(Chi-square test (χ^2) with Yates's correction; Spearman's rank (*rs)* correlation coefficient.*significant values: $p < 0.05$).

Albuquerque et al. (2008) in the Guandu River, State of Rio de Janeiro; Venancio et al. (2010) found that *C. pinnai* was the sole helminth in the fauna, presenting with a high prevalence rate in this host in the Paraíba do Sul River, State of Rio de Janeiro. In addition to the occurrence of these nematodes in high indexes in several hydrographic basins, *Cucullanus* spp. [especially *C. pinnai* (cucullanids) and *Procamallanus* spp. (camallanids)] have been constantly presented in the parasite fauna of *P. maculatus*. In this study, *P. freitasi* was the species that presented the highest prevalence among the endoparasites of *P. pohli,* with remarkable record of larvae of *Procamallanus* sp. and *P. pimelodus*, as well as adults of *Cucullanus caballeroi* Petter, 1977; this pattern was relevant, as it showed the same structural composition of the representative cucullanid and camallanid species in the helminth fauna of congeneric pimelodid hosts. This parasite–host relationship had been cited for pimelodid hosts in the Mogi Guaçu (KOHN; FERNANDES, 1987), Paraná (PAVANELLI et al., 1997), and São Francisco Rivers (BRASIL-SATO, 2003) when, in addition to the Eucestoda larvae, Nematoda was highlighted as a common parasite that was represented by the larvae of the species allotted to Anisakidae, the species of *Procamallanus* Baylis, 1923, *Cucullanus* Müller, 1777 and, among the latter, *C. pinnai* (BRASIL-SATO, 2003).

In addition to the ecological aspects that involve the use of alimentary items that predispose congeneric hosts to the same types of parasites, and which lead to the parasite–host specificity in several hydrographic basins listed in this study, it is equally significant to add that *P. freitasi* indexes were significantly higher in smaller specimens of *P. pohli* – an endemic species to the São Francisco River.

Procamallanus spp. perforate the intestinal wall of hosts with their buccal capsule and feed on blood; these nematodes are commonly found upon necropsy, and are red or dark brown in color due to such hematophagous activity (BRASIL-SATO, 2003). They can cause inflammatory reactions at the place where they adhere to, and they may cause anemia in the host due to blood loss. They can occupy the intestinal lumen in small or juvenile fish and, if they do not cause death under such conditions, they can affect growth (THATCHER, 2006). Besides the availability of the intermediate host (crustaceans and insects), which justifies the constant record of *C. pinnai* in *Pimelodus* spp., Albuquerque et al. (2008) have also suggested the possibility of a histotrophic phase in *C. pinnai* cycle. As most Brazilian rivers are related to reservoirs with hydroelectric potential, the abundance of nematodes may be enhanced, i.e. the parasitic transmission can be faster and/or more efficient among the hosts kept in smaller areas (e.g., due to fragmentation of the rivers and also due changing the flow of the rivers). Host abundance is favored in lentic environments, such as in lakes and dams (MORAVEC, 1998), and thus high indexes of infection by nematodes are found in the fish species that dwell in areas close to the reservoirs of hydroelectric power stations (FELTRAN et al., 2004). Therefore, all of these aspects must be considered in proposals that suggest raising *Pimelodus* spp. under confined conditions, and a lot of attention must be paid to parasitism in endemic species, such as *P. pohli* (endemic to the São Francisco River), when dealing with biodiversity preservation in aquatic systems.

The development stage and the parasitic indexes of *P. freitasi* and *C. caballeroi* have suggested that *P. pohli* serves as the definitive host for those nematodes, and as an intermediate host for the larvae of *Contracaecum* sp. and *Hysterothylacium* sp., which will become adult specimens in birds, according to Moravec (1998).

Santos et al. (2007) and Gutiérrez and Martorelli (1999) recorded high prevalence values for *D. uncusvalidus* and low prevalence rates for *Scleroductus* sp. in *P. maculatus* in the Guandu River, Brazil and in the la Plata River, Argentina, respectively. In the present study, the prevalence of *Scleroductus* sp. and the prevalence and mean intensity of *D. uncusvalidus* were high. In the upper São Francisco River, these two direct-transmission ectoparasite species (THATCHER, 2006) are the ones that characterized the ectoparasite community of *P. pohli* (mainly in fish with smaller body sizes), and the high values of their parasitic indexes optimized the observed co-occurrence.

The biometric data of siluriform hosts have been analyzed and were related to the parasitic indexes in several works (MACHADO et al., 1994; BRASIL-SATO; PAVANELLI, 2004; BRASIL-SATO; SANTOS, 2005; MOREIRA et al., 2005; SANTOS; BRASIL-SATO, 2006; BACHMANN et al., 2007). In the São Francisco River, parasitic indexes have been minimally influenced by fish size, and the possible cumulative effect of parasites, as proposed by Rohde (1993), has not been observed in parasite communities of fish in that hydric system. In this study, smaller fish presented with a higher abundance of ectoparasites (*D. uncusvalidus*) and, except for *A. compactum*, endohelminths also had their abundance favored, with the number of larval specimens of *Contracaecum* sp. and adults of *P. freitasi* being significantly higher in smaller *P. pohli* (Table 4). For camallanid nematodes, it is possible that the smaller fish presented with predilection for some alimentary items such as copepods, which were indicated as intermediate hosts for these parasites by Moravec (1998).

The sex of siluriform hosts has not been a determining factor in the structure of fish in the São Francisco River. In the present study, and in the studies conducted by Brasil-Sato and Santos (2005) and Santos and Brasil-Sato (2004, 2006), in the São Francisco River, there was no influence of host sex on the parasitic indexes, and this fact was supported by the similarities in feeding strategies and habits observed between male and female hosts.

Sympatric or related hosts must be similar in composition to their parasite faunas due to the level of similarity in their biological and behavioral features. In the São Francisco River, Pinto et al. (1974), Pinto and Noronha (1976), and Vicente et al. (1985) reported on the larvae of *Procamallanus* (*Spirocamallanus*) sp. in *Conorhynchos conirostris,* and Moreira et al. (1991) and Vicente and Pinto (1999) recorded *P. freitasi* in *B. westermanni*. Brasil-Sato (2003) recorded the following helminths in *P. maculatus*: *Demidospermus* sp., *Vancleaveus* sp., *Pavanelliella pavanellii* Kritsky & Boeger, 1998; *Monticellia loyolai* Pavanelli & Machado dos Santos, 1992 and *Nomimoscolex* sp. – two proteocephalid cestode species, one them presenting with larval specimens; *Auriculostoma platense* (Szidat, 1954) Scholz, Aguirre-Macedo and Choudhury, 2004 (cited as the original combination: *Crepidostomum platense* Szidat, 1954), *Creptotrema creptotrema* Travassos, Artigas & Pereira, 1928, *Sanguinicola coelomica* (Szidat, 1951) Gibson and Bray, 2002 (cited as the original combination: *Plehniella coelomica* Szidat,

1951), *Prosthenhystera obesa* (Diesing, 1850), *Thometrema overstreeti* Brooks, Mayers & Thorson, 1979, a digenean species identified in this study (*Kalipharynx* sp.), metacercariae of *Clinostomum* sp. and *Diplostomum* sp. (=*Austrodiplostomum* sp.) ; *C. pinnai, Dichelyne* sp., *Philometra* sp., *P. freitasi*, larval specimens of unidentified nematodes; and *N. pimelodi*. Larvae of *Procamallanus* (*Spirocamallanus*) sp. were recorded by Brasil-Sato and Santos (2005) in *C. conirostris*. Thus, among the species already recorded in pimelodids in the São Francisco Basin, the following parasites were found in *P. pohli* in this study: *P. pavanellii*, plerocercoids of Proteocephalidea, *A. platense*, *P. obesa*, *Kalipharynx* sp., *Philometra* sp., *P. freitasi*, larvae of *Contracaecum* sp., and *N. pimelodi*.

In other localities, some these common helminths species were also found in pimelodids. Regarding the Monogenea, in the Baia (type-locality) and Paraná Rivers, *Pavanelliella pavanelii* was described of *P. corruscans* by Kritsky and Boeger (1998) and they also reported this monogenean species of *Callophysus macropterus* (Lichtenstein, 1819) from Solimões River; *P. pavanellii* was recorded by Lopes et al. (2009) from Negro and Solimões Rivers in *Pseudoplatystoma tigrinum* (Spix & Agassiz, 1829) (*sic*) and *Pseudoplatystoma punctifer* (Linnaeus, 1766) (*sic*) [note of the authors: *P. tigrinum* as cited by the authors is *P. tigrinum* (Valenciennes, 1840), and *P. punctifer* refers to *P. punctifer* (Castelnau, 1855) *sensu* Buitrago-Suárez and Burr (2007)]. In the Guandu River, Santos et al. (2007) found *Demidospermus uncusvalidus* Gutiérrez & Suriano, 1992 and *Scleroductus* sp.; and in the Mogi Guaçu River, Aguiar et al. (2011) recorded *P. pavanellii* of *P. maculatus.* With respect to the Digenea, in the Guaiba River, *A. platense* (as *C. platense*) was found parasitizing *P. maculatus* by Kohn and Fróes (1986) and Fortes et al. (1993), respectively; in the Paraná Basin, the six Digenea species cited in *P. maculatus* from São Francisco River were common in the fauna of *P. maculatus* and their indexes were recorded and compared by Brasil-Sato and Pavanelli (2004); and in the Guandu River, Santos et al. (2007) and Azevedo et al. (2010), recorded *A. compactum* parasitizing *P. maculatus*. With relation to the Nematodes, in the Paraná Basin, Machado et al., (1994, 1995, 1996) recorded *Contracaecum* sp. and *Procamallanus* (*S.*) sp. of *P. corruscans*; and Guidelli et al. (2003) recorded larvae of *Contracaecum* sp. in *Hemisorubim platyrhynchos* (Valenciennes, 1840); and In the Aquidauana River, Campos et al. (2008) recorded larvae of *Contracaecum* sp. in *Pseudoplatystoma fasciatum* (L., 1766). Among the helminths recorded in *P. pohli*, *N. pimelodi* – the sole acanthocephalan species – was described from the parasite specimens of the congeneric *P. maculatus* and was recorded by Santos and Brasil-Sato (2006) in *Franciscodoras marmoratus* Reinhardt, 1874 (Siluriformes, Doradidae) in the São Francisco River (type-locality). Recently, Lopes et al. (2011) recorded *N. pimelodi* in *P. maculatus* and *B. westermanni* in the Paraná Basin. In the parasite community of *P. pohli*, *N. pimelodi* was the only one with a uniform distribution, but in the congeneric host *P. maculatus*, its distribution was widely dispersed, both during periods of flooding and drought in the upper São Francisco River region (BRASIL-SATO; PAVANELLI, 1999).

In this study, it is suggested that the co-occurrence of endoparasites *P. freitasi* and *N. pimelodi* was due to the use of arthropods, intermediate hosts, in the diet of *P. pohli.*

The significance of the analysis of parasitic indexes among host species with a wide distribution in the South American hydrographic basins, and among congeneric and sympatric species in this region, is highlighted to detect the main groups of parasite species that are able to affect fish. This type of predictive analysis indicates the relative specificity of parasite–host relationships in the hydrographic basins. The parasitism analysis of *P. pohli* highlighted that the smaller specimens were significantly more infested by Monogenea and infected by Nematoda; *P. pohli* is an endemic pimelodid host, whose niche and immunological plasticity is related to the available habitats that is restricted to the São Francisco River in relation to congeneric species or other pimelodids that present with a wide geographic distribution in the South and Central Americas. It was reinforced that, among the endoparasites, cucullanid and camallanid nematodes are the parasite representatives that prevail in the parasite fauna of the *Pimelodus* species. For *P. pohli*, the presence and parasitic indexes of those nematodes (as well as the endoparasite community) prove its invertivorous alimentary habits, which were not previously known.

In this study, the parasite species of *P. pohli* were presented, as well as those that are common in the fauna of *P. maculatus* in the São Francisco River and other basins. With the exception of *P. obesa*, which was recorded in *P. pohli* by Martins et al. (2012), this study revealed the parasite community of *P. pohli* and highlighted the first record of *Kalipharynx* sp. and *C. caballeroi* in the parasite community of fish in the upper São Francisco River, and in the pimelodids from South America.

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