

LISTS OF SPECIES

Digenea, Nematoda, Cestoda, and Acanthocephala, parasites in Potamotrygonidae (Chondrichthyes) from the upper Paraná River floodplain, states of Paraná and Mato Grosso do Sul, Brazil.

Ana C. F. Lacerda
Ricardo M. Takemoto
Gilberto C. Pavanelli

Programa de Pós-graduação em Ecologia de Ambientes Aquáticos Continentais, Núcleo de Pesquisas em Limnologia, Ictiologia e Aquicultura (Nupélia), Departamento de Biologia, Universidade Estadual de Maringá, Avenida Colombo 5790, bl. G90, sl. 11, CEP 87020-900, Maringá, PR, Brazil. E-mail: ana-carol-lacerda@hotmail.com

Abstract: The present paper represents the first study on the endoparasitic fauna of *Potamotrygon falkneri* and *P. motoro* in the upper Paraná River floodplain. Fishes were collected by fishing rod and gillnetting in different stations of the floodplain, from March, 2005 to September, 2006. Parasites were sampled, fixed and preserved according to specialized literature. About half of the analyzed fish were parasitized by at least one of the following species of endoparasites: *Clinostomum complanatum*, *Genarchella* sp. and *Tylodelphys* sp. (metacercaria) (Digenea); *Acanthobothrium regoi*, *Rhinebothrium paratrygoni*, *Paroncomegas araya* and *Potamotrygonocestus travassosi* (Cestoidea); *Brevimulticaecum* sp. (larva), *Cucullanus* sp., *Echinocephalus* sp. and *Spinitectus* sp. (Nematoda); and *Quadrigyrus machadoi* (Acanthocephala). Some species were already registered in Chondrichthyes and others were previously recorded in Osteichthyes from the study area. The study listed ten new records of parasites in the host *P. falkneri*, one new record in the host *P. motoro* and five new records in the locality upper Paraná River.

Introduction

Stingrays of the family Potamotrygonidae are the only elasmobranches permanently adapted to the freshwater environment, inhabiting rivers of South America that discharge into the Atlantic Ocean and Caribbean Sea (Compagno and Cook 1995). According to Lovejoy et al. (2006), this group appears to have entered South America since the isolation of the continent by the Cretaceous opening of the Atlantic. Such taxa display a diversity of biogeographic and phylogenetic patterns, having members of endemic Neotropical freshwater radiations with distributions that encompass multiple river basins.

Potamotrygonidae is formed by three genera: *Paratrygon* Duméril, 1865, *Plesiotrygon* Rosa, Castello & Thorson, 1987, and *Potamotrygon* Garman, 1877. The two former are monospecific, while *Potamotrygon* has approximately 26 valid species (Carvalho et al. 2003). Fifteen of these species have parasitological records, including the species of the present study, considering several regions: Salobra River (Paraguay River Basin, state of Mato Grosso, Brazil) (Rego 1979); vicinity of Corumbá (state of Mato Grosso do Sul, Brazil) (Brooks and Amato 1992); Amazonas Ri-

ver (Amazonas River Basin, Brazil) (Campbell et al. 1999); Orinoco River delta (Orinoco River Basin, Venezuela) (Marques and Brooks 2003); upper Madre de Dios River (Manu River Basin, Peru) (Reyda and Olson 2003).

In general, the species of potamotrygonids exhibit distribution restricted to a single basin or fluvial system — *P. falkneri* is restricted to Paraná-Paraguay Basin (Carvalho et al. 2003) and *P. motoro* is present in Amazonas River, Orinoco River and La Plata system (Araújo et al. 2004). In the study area, only two species of Potamotrygonidae are registered: *Potamotrygon falkneri* Castex & Maciel, 1963 and *P. motoro* (Müller & Henle, 1841). These two species moved upstream from the middle to the upper Paraná River when the reservoir of Itaipu Hydroelectric Power Plant flooded Sete Quedas Falls, which was a physical barrier for fishes (Agostinho et al. 2004).

Pavanelli et al. (2004) summarized data concerning more than 80 identified species of parasites from 57 species of fishes in the region, disclosing great biodiversity. However, detailed

LISTS OF SPECIES

studies on the parasitic fauna of potamotrygonids were never performed in the study area. The identification of new hosts and new localities for parasites contribute to the knowledge of local biodiversity as well as for the understanding of the evolution of parasites and their hosts. The present study aimed to perform a survey of the endoparasites of potamotrygonids from the upper Paraná River floodplain, and constitutes the register of new occurrences.

The study area is part of the upper Paraná River floodplain, Paraná River Basin, limit between the states of Paraná and Mato Grosso do Sul, near the city of Porto Rico (state of Paraná, 22°43' S, 53°10' W). The region is characterized as a fluvial floodplain, with periodic floods that result in the flooding of the marginal areas in the state of Mato Grosso do Sul. The area was characterized in details by Thomaz et al. (2004) (Figure 1).

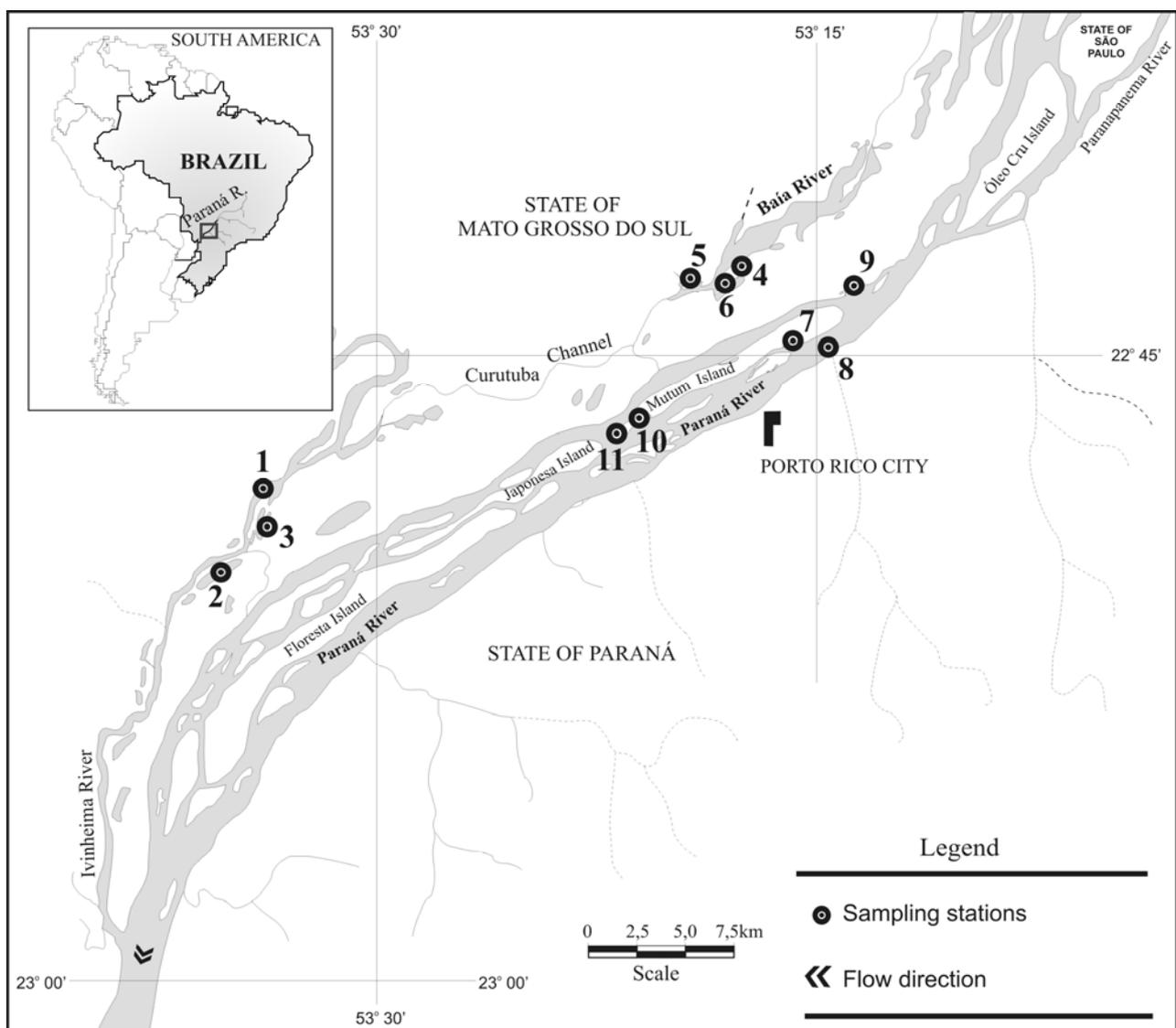


Figure 1. Upper Paraná River floodplain. Sampling stations: 1-Ivinheima River; 2-Ventura Lagoon; 3-Patos Lagoon; 4-Fechada Lagoon; 5-Guaraná Lagoon; 6-Baía River; 7-Pau Véio Backwater; 8-Paraná River; 9-Garças Lagoon; 10-Osmar Lagoon; 11-Mutum Island.

LISTS OF SPECIES

Materials and Methods

Fish were collected by fishing rod in the south margin of Mutum Island, from March 2005 to September 2006 (*P. falkneri*) and from April 2005 to December 2006 (*P. motoro*). Moreover, at the same time, fish were captured by gillnetting in different stations of Baía River, Ivinhema River and Paraná River (Figure 1). The samples were authorized by IBAMA (*Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis*), authorizations 003/2005 and 137/2006.

Sampling, fixation and preservation of parasites were according to Eiras et al. (2006). Identification of the parasites followed Szidat (1969), Rego and Dias (1976), Brooks et al. (1981), Fábio (1983), Moravec (1998), Campbell et al. (1999), Gibson et al. (2002), and Marques et al. (2003). The taxonomic classification follows

Moravec (1998) for nematodes, Bush et al. (2001) for cestodes, and Gibson et al. (2002) for digeneans and acanthocephalans. Voucher specimens were deposited at *Coleção Helminológica do Instituto Oswaldo Cruz*, numbers 36969 to 36982.

Results and Discussion

Among the 47 specimens of *P. falkneri* collected, 22 presented at least one species of endoparasites (46.8 %) and of the 19 specimens analyzed of *P. motoro*, 11 were parasitized (57.9 %). One hundred and seventy five endoparasites were collected in *P. falkneri*, including adults and larvae. In *P. motoro*, 22 adult endoparasites were collected. Taxa, sites of infection, and levels of parasitism are shown in Table 1. In total, three species of digeneans, five species of cestodes, four species of nematodes and one species of acanthocephalan were recorded (Table 1).

Table 1. Parasites taxa, deposit numbers in CHIOC (*Coleção Helminológica do Instituto Oswaldo Cruz*), infection sites (ES = external wall of stomach, S = stomach and SV = spiral valvae), number of parasitized fish (PF) and range of the number of parasites in infected hosts (R) in *Potamotrygon falkneri* and *P. motoro* collected in the upper Paraná River floodplain from March 2005 to September 2006 (*P. falkneri*) and from April 2005 to December 2006 (*P. motoro*).

Parasites taxa	CHIOC numbers	Site of infection	Parasitized fish					
			<i>Potamotrygon falkneri</i>			<i>Potamotrygon motoro</i>		
			PF	MI	R	PF	MI	R
Digenea								
<i>Clinostomum complanatum</i> (metacercaria)	36971	SV	1	1	1	—	—	—
<i>Tylodelphis</i> sp. (metacercaria)	36970	SV	1	8	8	—	—	—
<i>Genarchella</i> sp.	36969	S	2	1	1	—	—	—
Cestoidea								
<i>Acanthobothrium regoi</i>	36972	SV	6	5.3	1–19	7	2	1–7
<i>Rhinebothrium paratrygoni</i>	36973, 36974	SV	17	5.2	1–26	4	1.5	1–11
<i>Paroncomegas araya</i>	36975	SV	3	3	1–5	—	—	—
<i>Potamotrygonocestus travassosi</i>	36976	SV	1	4	4	—	—	—
Nematoda								
<i>Brevimulticaecum</i> sp. (larva)	36977	ES	1	16	16	—	—	—
<i>Cucullanus</i> sp.	36978	SV	1	3	3	—	—	—
<i>Echinocephalus</i> sp.	36979	SV	2	1	1	—	—	—
<i>Spinitectus</i> sp.	36980	SV	1	3	3	—	—	—
Acanthocephala								
<i>Quadrigyus machadoi</i>	36981,36982	SV	3	2	1–3	1	2	2

LISTS OF SPECIES

Phylum Platyhelminthes

Class Trematoda Rudolphi, 1808

Subclass Digenea Carus, 1863

Order Strigeida (La Rue, 1926)

Superfamily Clinostomoidea Lühe, 1901

Family Clinostomidae Lühe, 1901

Genus *Clinostomum* Leidy, 1856

Clinostomum complanatum Rudolphi, 1814

According to Szidat (1969), *Clinostomum complanatum* (= *Clinostomum marginatum* Rudolphi, 1819) (metacercaria) is one of the most common species of Clinostomidae and is distributed in the tropical and subtropical regions of Americas. Also according to Szidat (1969), metacercariae of *Clinostomum* are found encapsulated in several South American cichlids and free in the killifish *Neofundulus paraguayensis* (Eigenmann & Kennedy, 1903) (Cyprinodontiformes). In the upper Paraná River floodplain, *C. complanatum* was already registered encysted in *Gymnotus carapo* Linnaeus, 1758 (Gymnotiformes), *Parauchenipterus galeatus* (Linnaeus, 1766) (Siluriformes), *Hoplosternum littorale* (Hancock, 1828) (Siluriformes), and *Loricariichthys platymetopon* Isbrücker & Nijssen, 1979 (Siluriformes) (Pavanelli et al. 2004). Dias et al. (2003) studied the life cycle of *C. complanatum* in the same region, identifying the mollusk *Biomphalaria peregrina* (Orbigny, 1835) (Mollusca, Gastropoda) as first intermediate host and the Cooi heron *Ardea cocoi* Linnaeus, 1766 (Aves, Ciconiiformes) and the Neotropical cormorant *Phalacrocorax brasilianus* (Gmelin, 1789) (Aves, Pelecaniformes) as main definitive hosts. There are no previous records of *C. complanatum* parasitizing potamotrygonids.

Superfamily Hemiuroidea Looss, 1899

Family Derogenidae Nicoll, 1910

Subfamily Halipeginae Poche, 1926

Genus *Genarchella* Travassos, Artigas & Pereira, 1928

Genarchella sp.

The genus *Genarchella* parasitizes anterior portions of the digestive tract (usually stomach) of freshwater fishes of Central and South Americas (Gibson 2002). According to Brooks and Amato (1992), there are records of *Genarchella overstreeti* (= *Paravitellotrema overstreeti* Brooks, Mayes & Thorson, 1981) in *Potamotrygon magdalenae* (Valenciennes, 1865) from Magdalena River (Colombia). *Genarchella fragilis* Lunaschi, 1990 was registered parasitizing *Pimelodus ornatus* Kner, 1858 (Siluriformes) in Paraná River by Fernandes and Kohn (2001). This is the first record of *Genarchella* sp. parasitizing *P. falkneri*.

Superfamily Diplostomoidea Poirier, 1886

Family Diplostomidae Poirier, 1886

Subfamily Diplostominae Poirier, 1886

Genus *Tylodelphis* Diesing, 1850

Tylodelphis sp. (metacercaria)

In the studied region, *Tylodelphis* sp. (metacercaria) was already registered parasitizing *Cyphocharax nagelli* (Steindachner, 1881) (Characiformes) (Pavanelli et al. 2004), *Gymnotus carapo* (Gymnotiformes) (Isaac et al. 2004), *Prochilodus lineatus* (Valenciennes, 1837) (Characiformes) (Lizama et al. 2005), and *Leporinus lacustris* Amaral Campos, 1945 (Characiformes) (Guidelli et al. 2006). There are no previous records of *Tylodelphis* parasitizing potamotrygonids.

Class Cercomeridea Brooks, O'Grady & Glen, 1985

Subclass Cercomeromorphae Bychowsky, 1937

Infraclass Cestodaria Monticelli, 1891

Cohort Cestoidea Rudolphi, 1808

Subcohort Eucestoda Southwell, 1930

Order Tetraphyllidea Carus, 1863

Family Onchocothriidae Braun, 1900

Genus *Acanthobothrium* van Beneden, 1848

Acanthobothrium regoi Mayes, Brooks & Thorson, 1981

LISTS OF SPECIES

According to Ivanov (2005), more than 150 species of *Acanthobothrium* were described parasitizing the digestive tract of elasmobranchs, being only four species described parasitizing freshwater elasmobranchs: *Acanthobothrium quinonesi* Mayes, Brooks & Thorson, 1978 in *Potamotrygon magdalenae*, from Magdalena River (Colombia); *Acanthobothrium amazonensis* Mayes, Brooks & Thorson, 1978 in *P. circularis* (Müller & Henle, 1841) from Itacuai River (Amazonas River Basin, Brazil); *Acanthobothrium regoi* in *P. hystrix* (Müller & Henle, 1841) from Orinoco River Delta (Venezuela) and *Acanthobothrium terezae* Rego & Dias, 1976 in *Potamotrygon motoro* from Salobra River (upper Paraguay River Basin, Brazil). *Acanthobothrium regoi* was described parasitizing the spiral valvae (intestine) of *P. hystrix* in Orinoco River (Brooks et al. 1981). Brooks and Amato (1992) also registered species of this taxon parasitizing *P. motoro* in the city of Corumbá (state of Mato Grosso do Sul, Brazil). There are no records of *A. regoi* parasitizing another species of potamotrygonid in the studied region.

Genus *Potamotrygonocestus* Brooks & Thorson, 1976

***Potamotrygonocestus travassosi* Rego, 1979**

Potamotrygonocestus travassosi was described parasitizing the spiral valvae (intestine) of *Potamotrygon orbignyi* (Castelnau, 1855) in the Amazonas River (Maicuru, state of Pará, Brazil). Brooks et al. (1981) recorded the parasite in the delta of Orinoco River (Venezuela). Marques et al. (2003) in their redescription of the species also recorded *Paratrygon ayereba* (Müller & Henle, 1841), *Potamotrygon constellata* (Vaillant, 1880) and *Potamotrygon motoro* as new hosts, and the lower Amazonas River (state of Pará, Brazil) and Paraná Januacá (state of Amazonas, Brazil) as new localities. The present study registered *P. travassosi* for the first time parasitizing *P. falkneri* and it is the first record of the parasite in the upper Paraná River.

Family Phyllobothriidae Braun, 1900

Genus *Rhinebothrium* Linton, 1890

***Rhinebothrium paratrygoni* Rego & Dias, 1976**

Rhinebothrium paratrygoni was described parasitizing the spiral valvae of the intestine of *P. ayereba* in the region of Salobra (upper Paraguay River Basin, Brazil). Later it was found in *Potamotrygon hystrix* and *Potamotrygon reticulatus* (Günther, 1880) in the delta of the Orinoco River (Venezuela), in *P. falkneri* in Paraná River Basin (near Hohenau, Paraguay) (Brooks et al. 1981) and in *P. motoro* in Corumbá (state of Mato Grosso do Sul, Brazil). In the present study, *R. paratrygoni* was found in *P. falkneri* and *P. motoro*, being this the first register for those species in the studied region.

Order Trypanorhyncha Diesing, 1863

Family Eutetrarhynchidae Guiart, 1927

Genus *Paroncomegas* Campbell, Marques & Ivanov, 1999

***Paroncomegas araya* (Woodland, 1934)**

Paroncomegas araya corresponds to the cestode originally described as *Tentacularia araya* in *P. motoro* from Amazonas River (Brazil), and to *Eutetrarhynchus araya* described in *P. motoro* (Salobra River). In their work, Campbell et al. (1999) also registered as additional hosts *Potamotrygon reticulatus* (Garman, 1980) and *P. falkneri*, and they added the delta of Orinoco River (Venezuela), Paraná River (Paraguay) and Puerto Reconquista (Santa Fé, Argentina), respectively, as new occurrence localities. In the present study, *P. araya* was only found in *P. falkneri*, also the first register for the upper Paraná River floodplain. Besides the four species of adult cestodes, one larva was found in one specimen of *P. falkneri*, with 38.8 long by 12.2 width. The specimen could not be identified because of its early stage of development.

Phylum Nematoda

Class Rhabditea Inglis, 1983

Order Ascaridida Skrajabin & Schulz, 1940

Superfamily Ascaridoidea Railliet & Henry, 1915

Family Acanthocheilidae Wülker, 1929

Genus *Brevimulticaecum* Mozgovoy, 1951

***Brevimulticaecum* sp. larvae of Moravec, Prouza & Royero, 1997**

LISTS OF SPECIES

A larva of *Brevimulticaecum* sp. was registered for the first time parasitizing potamotrygonids by Rego (1979) in *Paratrygon motoro*, Salobra River (upper Paraguay River Basin, Brazil). The specimens presented herein resemble the ones described by that author and were also found in the same site (stomach) in *P. falkneri*.

Family Cucullanidae Cobbold, 1864

Genus *Cucullanus* sp. Müller, 1777

***Cucullanus* sp.**

The genus *Cucullanus* was registered in the upper Paraná river floodplain parasitizing *Serrasalmus marginatus* Valenciennes, 1837 (Characiformes), *Schizodon borelli* (Boulenger, 1900) (Characiformes), *Pseudoplatystoma corruscans* (Spix & Agassiz, 1829) (Siluriformes), *Pimelodus maculatus* Lacepède, 1803 (Siluriformes), *Hemisorubim platyrhynchos* (Valenciennes, 1840) (Siluriformes) and *Paulicea luetkeni* (= *Zungaro zungaro* Humboldt, 1821) (Siluriformes) (Pavanelli et al. 2004), being this study the first register of *Cucullanus* sp. parasitizing potamotrygonids.

Order Spirurida Chitwood, 1933

Superfamily Gnathostomatoidea Railliet, 1895

Family Gnathostomatidae Railliet, 1895

Genus *Echinocephalus* sp. Molin, 1858

***Echinocephalus* sp.**

Deardorff et al. (1981) described *Echinocephalus daileyi* Deardorff, Brooks & Thorson, 1981 parasitizing the intestine of *Potamotrygon circularis* and *P. hystrix* in Leticia (Colombia), in the delta of Orinoco River (Venezuela) and Itacuai River (Amazonas Basin, Brazil). In the present study, only one specimen of the genus was found parasitizing *P. falkneri* (*Echinocephalus* sp.). There is no previous record of the genus *Echinocephalus* in Paraná River, neither parasitizing *P. falkneri*.

Superfamily Habronematoidea Chitwood & Wehr, 1932

Family Cystidicolidae Skrjabin, 1946

Genus *Spinitectus* Fourment, 1883

***Spinitectus* sp.**

In the studied region, the genus *Spinitectus* was never recorded, even so there are registers of *Spinitectus asperus* Travassos, Artigas & Pereira, 1928 parasitizing Prochilodontidae and Anostomidae in Paraná River, in Emas Falls (Pirassununga, state of São Paulo, Brazil) and in the lower Paraná River (Argentina) (Moravec 1998). Still according to Moravec (1998), the genus parasitizes the digestive tract of marine and freshwater fishes and also amphibians. Due to the low number of specimens, the identification at species level was not possible. However, the genus could be identified by presenting cuticle with numerous transversal rings and by having a row of spines (Moravec 1998).

Phylum Acanthocephala

Class Eoacanthocephala Van Cleave, 1936

Order Gyraacanthocephalida Van Cleave, 1936

Family Quadrigyridae Van Cleave, 1920

Genus *Quadrigyrus* Van Cleave, 1920

***Quadrigyrus machadoi* Fabio, 1983**

The only Acanthocephala found in the present study was *Quadrigyrus machadoi*. This species was already registered in the upper Paraná River floodplain parasitizing *Hoplias* sp. (Characiformes: Erythrinidae) as adult and *Hemisorubim platyrhynchos* (Valenciennes, 1840) and *Cichla monoculus* Spix & Agassiz, 1831 (Perciformes) as larvae (Pavanelli et al. 2004). This is the first register of this species in potamotrygonids from upper Paraná. According to Brooks (1992), the majority of the known parasites of Potamotrygonidae are restricted to this family of fish. However, four of eleven new records of parasites for Potamotrygonidae in the present study had already been registered in fishes of other families in the study region.

LISTS OF SPECIES

Conclusions

The following parasitic forms are recorded for the first time in *Potamotrygon falkneri*: *Clinostomum complanatum* (metacercaria), *Genarchella* sp., *Tylodelphis* sp. (metacercaria), *Acanthobothrium regoi*, *Potamotrygonocestus travassosi*, *Brevimulticaecum* sp. (larva), *Cucullanus* sp., *Echinocephalus* sp., *Spinitectus* sp., and *Quadrigrurus machadoi*. The present study also represents the first record of *Q. machadoi* parasitizing *Potamotrygon motoro* and *A. regoi*, *Rhinebothrium paratrygoni*, *Paroncomegas araya*, *P. travassosi*, and *Echinocephalus* sp. parasitizing fishes from the upper Paraná River.

Acknowledgments

The authors would like to thank Nupelia for the logistic support and CNPq for the financial support. A.C.F. was supported by CAPES (Master Scholarship). R.M. and G.C. were supported by CNPq (Productivity Grants).

Literature cited

- Agostinho, A. A., L. M. Bini, L. C. Gomes, H. F. Júlio Jr, C. S. Pavanelli, and C. S. Agostinho. 2004. Fish assemblages; p. 223–246 In S. M. Thomaz, A. A. Agostinho, and N. S. Hahn (ed.). The Upper Paraná River and its Floodplain: physical aspects, ecology and conservation. Leiden: Backhuys Publishers.
- Araújo, M. L. G., P. Charvet-Almeida, M. P. Almeida, and H. Pereira. 2004. Freshwater Stingrays (Potamotygonidae): status, conservation and management challenges. Cites – Twentieth Meeting of the Animals Committee, Information document AC20 Inf.08. p. 6. Accessible at <http://www.cites.org/common/com/ac/20/E20-inf-08.pdf>. Captured on 05 March 2008.
- Brooks, D. R. 1992. Origins, diversification, and historical structure of the helminth fauna inhabiting neotropical freshwater stingrays (Potamotygonidae). *Journal of Parasitology* 78(4): 588–595.
- Brooks, D. R. and F. R. Amato. 1992. Cestodes Parasites in *Potamotrygon motoro* (Natterer) (Chondrichthyes: Potamotygonidae) from South-western Brazil, including *Rhinebothroides mclennanae* n. sp. (Tetraphyllidea: Phyllobothriidae), and a revised host-parasite checklist for helminths inhabiting Neotropical freshwater stingrays. *Journal of Parasitology* 78(3): 393–398.
- Brooks, D. R., M. A. Mayes, and T. B. Thorson. 1981. Systematic review of cestodes infecting freshwater stingrays (Chondrichthyes: Potamotygonidae) including four new species from Venezuela. *Proceedings of the Helminthological Society of Washington* 48(1): 43–64.
- Bush, A. O., J. C. Fernández, G. W. Esch, and J. R. Seed. 2001. Parasitism: the diversity and ecology of animal parasites. Cambridge: Cambridge University Press. 566 p.
- Campbell, R. A., F. Marques and V. A. Ivanov. 1999. *Paroncomegas araya* (Woodland, 1934) n. gen. et comb. (Cestoda: Trypanorhyncha: Eutetrarhynchidae) from the freshwater stingray *Potamotrygon motoro* in South America. *Journal of Parasitology* 85(2): 313–320.
- Carvalho, M. R., N. R. Lovejoy, and R. S. Rosa. 2003. Family Potamotygonidae (River stingrays); p. 22–28 In R. E. Reis, S. O. Kullander, and C. J. Ferraris Jr (org.). Check list of fishes of South and Central America. Porto Alegre: Edipucrs.
- Compagno, L. J. V. and S. F. Cook. 1995. The exploitation and conservation of freshwater elasmobranchs: status of taxa and prospects for the future. *Journal of Aquaculture & Aquatic Sciences* 7: 62–90.
- Deardorff, T. L., D. R. Brooks and T. B. Thorson. 1981. A new species of *Echinocephalus* (Nematoda: Gnathostomidae) from Neotropical stingrays with comments on *E. diazi*. *Journal of Parasitology* 67: 433–439.
- Dias, M. L. G. G., J. C. Eiras, M. H. Machado, G. T. Souza, and G. C. Pavanelli. 2003. The life cycle of *Clinostomum complanatum* Rudolphi, 1814

LISTS OF SPECIES

- (Digenea, Clinostomidae) on the floodplain of the high Paraná River, Brazil. *Parasitology Research* 89(6): 506–508.
- Eiras J. C., R. M. Takemoto and G. C. Pavanelli. 2006. Métodos de estudio y técnicas laboratoriales en parasitología de peces. 2nd edition. Spain: Editorial Acibria. 133 p.
- Fábio, S. P. 1983. Sobre alguns Acanthocephala parasitos de *Hoplias malabaricus*. *Arquivos da Universidade Federal Rural do Rio de Janeiro* 6(2): 173–180.
- Fernandes, B. M. M. and A. Kohn. 2001. On Some Trematodes Parasites of Fishes From Paraná River. *Brazilian Journal of Biology* 61(3): 461–466.
- Gibson, D. I., A. Jones and R. A. Bray (ed.). 2002. Keys to the Trematoda (1). London: CAB International and The Natural History Museum. 521 p.
- Guidelli, G. M., W. L. G. Tavechio, R. M. Takemoto, and G. C. Pavanelli. 2006. Fauna parasitária de *Leporinus lacustris* e *Leporinus friderici* (Characiformes, Anostomidae) da planície de inundação do alto rio Paraná, Brasil. *Acta Scientiarum Biological Sciences* 28(3): 281–290.
- Isaac A., G. M. Guidelli, J. G. França, and G. C. Pavanelli. 2004. Composição e estrutura das infracomunidades endoparasitárias de *Gymnotus* spp. (Pisces: Gymnotidae) do rio Baía, Mato Grosso do Sul, Brasil. *Acta Scientiarum Biological Sciences* 26(4): 453–462.
- Ivanov, V. A. 2005. A new species of *Acanthobothrium* (Cestoda: Tetraphyllidea: Onchobothriidae) from the ocellate river stingray, *Potamotrygon motoro* (Chondrichthyes: Potamotrygonidae), in Argentina. *Journal of Parasitology* 91(2): 390–396.
- Lizama, M. de los A. P., R. M. Takemoto, and G. C. Pavanelli. 2005. Influence of host sex and age on infracommunities of metazoan parasites of *Prochilodus lineatus* (Valenciennes, 1836) (Prochilodontidae) of the Upper Paraná River floodplain, Brazil. *Parasite, Journal de la Societé Française de Parasitologie* 12(4): 299–304.
- Lovejoy, N. R., J. S. Albert and G. R. Crampton. 2006. Miocene marine incursions and marine/freshwater transitions: Evidence from Neotropical fishes. *Journal of South American Earth Sciences* 21: 5–13.
- Marques, F. P. L. and D. R. Brooks. 2003. Taxonomic revision of *Rhinebothroides* (Eucestoda: Tetraphyllidea: Phyllobothriidae), parasites of Neotropical freshwater stingrays (Rajiformes: Myliobatoidei: Potamotrygonidae). *Journal of Parasitology* 39(5): 994–1017.
- Marques, F. P. L., D. R. Brooks, and M. L. G. Araújo. 2003. Systematics and phylogeny of *Potamotrygonocetus* (Platyhelminthes, Tetraphyllidea, Onchobothriidae) with descriptions of three new species from freshwater potamotrygonids (Myliobatoidei, Potamotrygonidae). *Zoologica Scripta* 32(4): 367–396.
- Moravec, F. 1998. Nematodes of Freshwater Fishes of the Neotropical Region. Praha: Academia. 464 p.
- Pavanelli G. C., M. H. Machado, R. M. Takemoto, G. M. Guidelli, and M. A. P. Lizama. 2004. Helminth fauna of fishes: diversity and ecological aspects; p. 309–329 In S. M. Thomaz, A. A. Agostinho, and N. S. Hahn (ed.). *The Upper Paraná River and its Floodplain: physical aspects, ecology and conservation*. Leiden: Backhuys Publishers.
- Rego, A. A. 1979. Contribuição ao conhecimento dos helmintos de raias fluviais Paratrygonidae. *Revista Brasileira de Biologia* 39(4): 879–890.
- Rego, A. A. and P. L. Dias. 1976. Estudos de cestóides de peixes do Brasil. 3^a nota: cestóides de raias fluviais Paratrygonidae. *Revista Brasileira de Biologia* 36(4): 941–956.
- Reyda, F. B. and D. Olson. 2003. Cestodes of Peruvian freshwater stingrays. *Journal of Parasitology* 89(5): 1018–1024.
- Szidat, L. 1969. Structure, development and behaviour of new strigeatoid metacercariae from subtropical fishes of South America. *Journal of the Fisheries Research Board of Canada* 4: 753–756.
- Thomaz, S. M., A. A. Agostinho, and N. S. Hahn (ed.). 2004. *The Upper Paraná River and its Floodplain: physical aspects, ecology and conservation*. Leiden: Backhuys Publishers. 393 p.

Received December 2007

Accepted March 2008

Published online April 2008