Journal of Helminthology (2009) **83,** 51–55 doi:10.1017/S0022149X08092171

Helminths parasitizing larval fish from Pantanal, Brazil

A.C.F. Lacerda[1]*, M. Santin[1], R.M. Takemoto[1], G.C. Pavanelli[1], A. Bialetzki[1] and F.C. Tavernari[2]

[1]Department of Biology, Nupélia, Postgraduate Course in Ecology of Continental Aquatic Environments (PEA), State University of Maringá (UEM), Maringá, Paraná, Brazil: [2]Department of Animal Sciences, Postgraduate Course in Animal Sciences, Federal Rural University of Pernambuco (UFRPE), Recife, Pernambuco, Brazil

Abstract

Fish larvae of '*corvinas*' (*Pachyurus bonariensis* and *Plagioscion ternetzi*) from Sinhá Mariana Lagoon, Mato Grosso State, were collected from March 2000 to March 2004, in order to determine the parasitic fauna of fishes. Larvae from the two species were parasitized by the same endoparasites: *Contracaecum* sp. Type 2 (larvae) (Nematoda: Anisakidae) in the mesentery and *Neoechinorhynchus* (*Neoechinorhynchus*) *paraguayensis* (Acanthocephala: Neoechinorhynchidae) in the stomach and the terminal portion of the intestine. Statistical analysis showed that there was a significant positive correlation between the standard length of hosts and the abundance of acanthocephalans and nematodes, and that the prevalence of nematodes presented a significant positive correlation with the standard length of the two species of hosts, indicating the presence of a cumulative process of infection. The present study constitutes the first record of nematodes and acanthocephalans parasitizing larval fish, as well as the first record of endoparasites in fish larvae in Brazil. In addition, it lists a new locality and two species of hosts for *Contracaecum* sp. Type 2 (larva) and *N.* (*N.*) *paraguayensis*.

Introduction

From 2000 to 2004 in the Sinhá Mariana Lagoon, Mato Grosso State, *Pachyurus bonariensis* (Boulenger, 1895) and *Plagioscion ternetzi* (Steindachner, 1879) (Perciformes: Scianidae) commonly known as '*corvinas*', were among the species of fish with the highest abundance of larvae (Universidade Estadual de Maringá, Nupélia/Furnas Centrais Elétricas, 2005).

Pachyurus bonariensis are relatively small, but with some commercial value (Casatti, 2003) in the basins of the Paraná (Agostinho *et al.*, 1993), Paraguay and Uruguay rivers (Montero & Fuentes, 1997). Their larvae can be categorized as zooplanktivorous (Santin, 2007), while juveniles and adults are benthivorous (Fugi *et al.*, 2007).

*E-mail: ana-carol-lacerda@hotmail.com

Plagioscion ternetzi reach a considerable size and their weight may exceed 5 kg (Severi, 1997). They are known in the region as '*corvina*' or '*surubina*', occurring from Rio Grande do Sul (Paraguay River) to the State of Amazonas (Amazonas River). They are zooplanktivorous (personal observation), while the young and the adults are piscivorous (Universidade Estadual de Maringá, Nupélia/Furnas Centrais Elétricas, 2005).

According to Ahlstrom & Ball (1954), modified by Nakatani *et al.* (2001), what separates a fish larva from a juvenile fish is that the former does not present morphological differentiation regarding the formation of the fins, while juveniles present all fins fully formed, including the segmentation of the rays. When larvae become juveniles, the recruitment length is about 10.01 mm for *P. ternetzi* (Nakatani *et al.*, 2001) and 26.5 mm for *P. bonariensis* (Santin, 2007).

In the few studies on parasites of fish larvae, the protozoa is the only group found, and in artificial

https://doi.org/10.1017/S0022149X08092171 Published online by Cambridge University Press

environments only (Ferraz de Lima *et al.*, 1991; Ceccarelli *et al.*, 1993; Meneses & Vendrell, 2002). There are no records of endoparasites in fish larvae in natural environments in Brazil; however, there are for ectoparasites in adults of *P. bonariensis* (Fehlauer, 2005). Among the few studies that recorded endoparasites in fish larvae are those of Dauvin & Dodson (1990), who noted a high incidence of parasitism (92%) of unidentified cestodes in *Osmerus mordax* (Michill, 1814) in an estuary near Quebec, Canada; Mackenzie (1974), who recorded on the east coast of Scotland, immature digeneans *Opechona* sp. in the stomach, intestine and pyloric caeca of haddock *Melanogrammus aeglefinus* (Linnaeus, 1758); Cooper (1996), who found in Roanoke River (from North Carolina) cestodes (plerocercoids) and metacercariae in the striped bass *Morone saxatilis* (Walbaum, 1972); and Cribb *et al.* (2000) who found 13 species of parasites (none of them nematodes or acanthocephalans) in the larvae of 38 species of fish from the coral reefs in New Caledonia, Australia. No information exists as to what happens to the transmission of parasites at that stage.

The aim of this study was to record for the first time the presence of nematodes and acanthocephalans parasitizing fish larvae, as well as to relate parasitism indexes to the standard length of hosts.

Materials and methods

Samples were taken in the Sinhá Mariana Lagoon, in the State of Mato Grosso (16°20′342″S/55°54′172″W), which is permanently connected to the Mutum River in the upper Paraguay Basin and located on a flood plain.

From March 2000 to March 2004 larval fish were collected using a plankton net, and then fixed in 4% formalin buffered with calcium carbonate. In the laboratory, the standard length of each larva was obtained and larval fish were necropsied. Parasites were processed following the methodology of Eiras *et al.* (2006). Identifications of helminths were based on Machado (1959), Thatcher (1991), Amin (2002) and Moravec (1998).

Representative specimens of parasites numbered 36999 to 37002 were deposited at the 'Coleção Helmintológica do Instituto Osvaldo Cruz' (CHIOC) in Rio de Janeiro, Brazil. Fish larvae deposited at 'Laboratório de Ictioplâncton', 'Núcleo de Pesquisa em Limnologia, Ictiologia e Aquicultura' (Nupélia), Maringá, Brazil, are being incorporated to the 'Seção de Ictioplâncton' of 'Coleção Ictiológica do Nupélia'.

Parasitism indexes proposed by Bush *et al.* (1997) were used and variance/abundance ratios were calculated to inform about the distribution of parasites in their hosts. The distribution is considered random when the variance/abundance ratio is close to 1, aggregated when higher than 1 and regular when lower than 1 (Combes, 2001). Spearman's rank correlation coefficient, *rs*, was used to check the relationship between the standard length of hosts and parasite abundances (number of individuals) of each species of parasite. To test correlations between the standard length and the prevalence of infection of each species of parasite (percentage of parasitized in relation to the examined hosts), Pearson's correlation coefficient, *r*, was used, with angular processing of prevalence data (arc sine $\sqrt{x}$) (Zar, 1996) and separation of hosts into six classes of standard length for *P. bonariensis* and into four classes for *P. ternetzi*.

Results

One hundred larvae of each species were analysed, with standard length varying from 2.1 to 13.2 mm for *P. bonariensis* and from 2.1 to 9.8 mm for *P. ternetzi*. The smallest infected fish larvae were 5.25 mm (*P. bonariensis*) and 4.70 mm long (*P. ternetzi*). The same species of endoparasites were found infecting larvae of the two species: nematodes (larvae) in the mesentery and acanthocephalans (adults) in the terminal portion of the stomach and intestine. Nematodes were identified as *Contracaecum* sp. Type 2 (larva) Moravec, Kohn & Fernandes, 1993 (Nematoda: Anisakidae), with length between 1.4 and 2.0 mm, while acanthocephalans were identified as adults of *Neoechinorhynchus* (*Neoechinorhynchus*) *paraguayensis* Machado, 1959 (Acanthocephala: Neoechinorhynchidae), length between 0.4 and 1.2 mm.

Variance/abundance ratio and distribution are shown in table 1. Parasitism indexes were higher in classes 4–6 in *P. bonariensis* and 3 and 4 in *P. ternetzi* (table 2).

Spearman's rank correlation coefficient indicated a positive correlation between the standard length of hosts and the parasitic abundance of *N.* (*N.*) *paraguayensis* and *Contracaecum* sp. Type 2 (larva) in larvae of the two species studied (table 3). Pearson's correlation coefficient showed that the prevalence of *Contracaecum* sp. Type 2 (larva) was positively correlated with the standard length of the two species of hosts.

Table 1. Variance/abundance ratio (V/A) and distribution (D) of the parasites *Contracaecum* sp. Type 2 (larva) and *Neoechinorhynchus* (*Neoechinorhynchus*) *paraguayensis* in larvae of *Pachyurus bonariensis* and *Plagioscion ternetzi* collected from March 2000 to March 2004 in Sinhá Mariana Lagoon, Mato Grosso State, Brazil.

	Pachyurus bonariensis		*Plagioscion ternetzi*	
Parasites	V/A	D	V/A	D
Contracaecum sp. Type 2 (larva)	0.01965	Regular	0.0095	Regular
N. (*N.*) *paraguayensis*	0.04066	Regular	0.0420	Regular

https://doi.org/10.1017/S0022149X08092171 Published online by Cambridge University Press

Table 2. Abundance (A), prevalence (P%), mean intensity (MI), mean abundance (MA) and range (R) by length classes of parasites *Contracaecum* sp. Type 2 (larva) and *Neoechinorhynchus* (*Neoechinorhynchus*) *paraguayensis* in larvae of *Pachyurus bonariensis* and *Plagioscion ternetzi* collected from March 2000 to March 2004 in Sinhá Mariana Lagoon, Mato Grosso State, Brazil.

		Contracaecum sp. Type 2 (larva)					*N.* (*N.*) *paraguayensis*				
	Length classes (mm)	A	P%	MI	MA	R	A	P%	MI	MA	R
Pachyurus bonariensis	1 (2.0–3.9)	0	0	0	0	–	0	0	0	0	–
	2 (4.0–5.9)	0	0	0	0	–	1	0.03	1	0.03	1–1
	3 (6.0–7.9)	4	10	1.33	0.13	1–2	26	33	2.6	0.87	1–5
	4 (8.0–9.9)	3	13	1.5	0.2	1–2	32	66	3.2	2.3	1–6
	5 (10.0–11.9)	5	100	2.5	2.5	2–3	12	100	6	6	2–10
	6 (12.0–13.9)	4	100	2	2	1–3	7	50	7	3.5	7–7
Plagioscion ternetzi	1 (2.0–3.9)	0	0	0	0	–	–	0	0	0	–
	2 (4.0–5.9)	1	0.02	1	0.02	1–1	18	0.12	3	0.36	1–7
	3 (6.0–7.9)	3	11	1	0.11	1–7	16	30	2	0.59	1–6
	4 (8.0–9.9)	1	10	1	0.1	1–1	30	70	4.3	3	2–9

Discussion

Adults of *Contracaecum* are widely distributed throughout Central and South America. Unfortunately, the taxonomy of larvae is relatively poor, based only on morphology. Larvae are characterized by the presence of a cuticle with transverse striations, one ventral cuticular tooth on the head, a short posterior ventricular appendix and three small unicellular rectal glands. According to Moravec (1998), *Contracaecum* sp. Type 2 (larva) has already been reported as infecting more than 20 species of fish in Brazil, Venezuela, Argentina, Cuba and Mexico.

Neoechinorhynchus Stiles & Hassall, 1905 is a cosmopolitan genus and one of the largest within Acanthocephala, with 88 valid species, 48 belonging to the subgenus *Neoechinorhynchus* Stiles & Hassall, 1905 (Amin, 2002). *Neoechinorhynchus* (*Neoechinorhynchus*) *paraguayensis* is characterized by having anterior hooks much larger than the median and the posterior, with basal series with a considerable space between them, and eggs with tube-shaped internal ornamentation (Amim, 2002). Nickol & Padilha (1979) found *N.* (*N.*) *paraguayensis* in *Geophagus brasiliensis* (Quoy & Gaimard, 1824) in Rio de Janeiro, Brazil, and according to them, Masí-Pallares (1979) found the same species in *Hoplias malabaricus* (Bloch, 1794) in Paraguay.

Species of parasites recorded in the present study have never been reported in adults of *P. bonariensis* and *P. ternetzi*. Specimens collected presented measures of length lower than the ones found in previous studies, possibly because the hosts were larvae.

This is the first record of nematodes and acanthocephalans infecting larval fish in the natural environment, as well as the first occurrence of endoparasites in fish larvae in Brazil. Moreover, it adds one more locality and two more species of hosts for the parasites found.

In the research area, there are no studies concerning parasitism of fish. However, several studies comparing the levels of parasitism to the standard length of fish hosts have already been done in the southern region of Brazil, specifically in the flood plain of the upper Paraná River. Some authors found a positive correlation between the size of the fish and the abundance of cestodes (Takemoto & Pavanelli, 1994), and the intensity and prevalence of digeneans (Isaac *et al*., 2000; Machado *et al*., 2005).

Distribution was regular for all parasites and hosts, which is not typical of parasites in wild hosts. According to Poulin (1996), density-dependent parasite mortality and parasite-induced host mortality, are forces acting to decrease aggregation. It is possible that these factors are responsible for the regular distribution of parasites, since larval fish are smaller and probably cannot support a high parasite density.

Higher length classes presented higher parasitism indexes. Positive correlations between the standard length of *P. bonariensis* and *P. ternetzi* and the abundance of *Contracaecum* sp. Type 2 (larva) and *N.* (*N.*) *paraguayensis*

Table 3. Values of Spearman's rank correlation coefficient (*rs*) and Pearson's correlation coefficient (*r*) obtained in relations between standard length, prevalence and abundance of parasites *Contracaecum* sp. Type 2 (larva) and *Neoechinorhynchus* (*Neoechinorhynchus*) *paraguayensis* in larvae of *Pachyurus bonariensis* and *Plagioscion ternetzi* collected from March 2000 to March 2004 in Sinhá Mariana Lagoon, Mato Grosso State, Brazil.

	Pachyurus bonariensis				*Plagioscion ternetzi*			
Parasites	*rs*	*P*	*r*	*P*	*rs*	*P*	*r*	*P*
Contracaecum sp. Type 2 (larva)	0.421	0.009*	0.918	0.009*	0.205	0.041*	0.964	0.036*
N. (*N.*) *paraguayensis*	0.547	>0.001*	0.796	0.058	0.428	>0.001*	0.631	0.369

P = level of significance, * = significant values.

https://doi.org/10.1017/S0022149X08092171 Published online by Cambridge University Press

indicate that the number of specimens of parasites is greater as the standard length of larvae increases. The same occurs between the standard length of larvae and the prevalence of *Contracaecum* sp. Type 2 (larva), which indicates that the number of infected fish is higher as the standard length increases. Larvae from both species are zooplanktivorous (Santin, 2007). As these parasites are transmitted through the feeding of larvae, these results can be explained by a cumulative process where larger larvae fed on a greater range of potential intermediary hosts (zooplanktonic microcrustaceans), and thus are more liable to infection (Luque *et al.*, 1996). Future studies are needed to investigate the epithelial damage to hosts caused by these parasites, considering that the length of a parasite can reach 11% of the length of larval fish.

Acknowledgements

The authors would like to thank Nupélia for logistic support and Furnas Centrais Elétricas for their financial support. A.C.F.L. and M.S. were supported by CAPES (Masters scholarship); R.M.T., G.C.P. and A.B. were supported by CNPq (productivity grant); F.C.T. was supported by Fundação Araucária (undergraduate scholarship).

References

Agostinho, A.A., Mendes, V.P., Suzuki, H.I. & Canzi, C. (1993) Avaliação da atividade reprodutiva da comunidade de peixes dos primeiros quilômetros a jusante do reservatório da Itaipu. *Revista Unimar* **15** (Suppl), 175–189.

Ahlstrom, E.H. & Ball, O.P. (1954) Description of eggs and larvae of jack mackerel (*Trachurus symmetricus*) and distribution and abundance of larvae in 1950 and 1951. *Fishery Bulletin* **56**, 209–245.

Amin, O.M. (2002) Revision of *Neoechinorhynchus* Stiles & Hassal, 1905 (Acanthocephala: Neoechinorhynchidae) with keys to 88 species in two subgenera. *Systematic Parasitology* **53**, 1–8.

Bush, A.O., Lafferty, K.D., Lotz, J.M. & Shostak, A.W. (1997) Parasitology meets ecology on its own terms: Margolis *et al.* revisited. *Journal of Parasitology* **83**, 575–583.

Casatti, L. (2003) Family Sciaenidae. pp. 599–602 *in* Reis, R.E., Kullander, S.O. & Ferraris, C.J. Jr (*Eds*) *Check list of the freshwater fishes of South and Central America*. Porto Alegre, EDIPUCRS.

Ceccarelli, P.S., Alcântara Rocha, R.C.G. & De Melo, J.S.C. (1993) Efeito de produtos químicos sobre a *Trichodina* sp. e *Linguadactyloides* sp. em alevinos de pacu, *Piaractus mesopotamicus* Holmberg, 1887. *Boletim Técnico do CEPTA* **6**, 23–30.

Combes, C. (2001) *Interactions durables. Écologie et évolution du parasitisme*. 518 pp. Paris, Masson.

Cooper, J.E. (1996) Parasites and cyclopoid predators of age-0 fish in the Roanoke River, North Carolina. *Estuaries* **19**, 146–161.

Cribb, T.H., Pichelin, S., Dufour, V., Bray, R.A., Chauvet, C., Faliex, E., Galzin, R., Cédrik, M.L., Alain, L.-Y., Morand, S., Rigby, M.C. & Sasal, P. (2000) Parasites of recruiting coral reef fish larvae in New Caledonia. *International Journal of Parasitology* **30**, 1445–1451.

Dauvin, J.-C. & Dodson, J.J. (1990) Relationship between feeding incidence and vertical and longitudinal distribution of rainbow smelt larvae (*Osmerus mordax*) in a turbid well-mixed estuary. *Marine Ecology Progress Series* **60**, 1–12.

Eiras, J.C., Takemoto, R.M. & Pavanelli, G.C. (2006) *Métodos de estudo e técnicas laboratoriais em parasitologia de peixes*. 2nd edn. 199 pp. Maringá, Eduem.

Fehlauer, K.H. (2005) Análise histórica da fauna de Monogenoidea (Platyhelminthes) de Pachyurinae (Teleostei, Perciformes) em cinco regiões hidrográficas da América do Sul. Masters dissertation, Universidade Federal do Paraná, Curitiba.

Ferraz de Lima, C.L.B., Reis, N.S. & Ceccarelli, P.S. (1991) Caracterização histológica da ictiofitiríase em pacu, *Piaractus mesopotamicus* Holmberg, 1887 (Teleostei, Serrasalminae). *Boletim Técnico do CEPTA* **4**, 39–46.

Fugi, R., Hahn, N.S., Novakowski, G.C. & Balassa, G.C. (2007) Ecologia alimentar da corvina, *Pachyurus bonariensis* (Perciformes, Sciaenidae) em duas baías do pantanal, Mato Grosso, Brasil. *Iheringia. Série Zoologia* **97**, 343–347.

Isaac, A., Guidelli, G.M., Takemoto, R.M. & Pavanelli, G.C. (2000) *Prosthenhystera obesa* (Digenea), parasita de *Salminus maxillosus* (Characidae) da planície de inundação do alto rio Paraná, Brasil: influência do tamanho e do sexo do hospedeiro. *Acta Scientiarum, Biological Sciences* **22**, 523–526.

Luque, J.L., Amato, J.F.R. & Takemoto, R.M. (1996) Comparative analyses of the communities of metazoan parasites of *Orthopristis ruber* and *Haemulon steindachneri* (Osteichthyes: Haemulidae) from the Southeastern Brazilian littoral: I. Structure and influence of the size and sex of hosts. *Revista Brasileira de Biologia* **56**, 279–292.

Machado, D.A. (1959) Uma nova espécie do gênero '*Neoechinorhynchus*' Hamann, 1892 parasita de 'Peixe-martim' do Paraguai (Neoechinorhynchidae, Archiacanthocephala). *Revista Brasileira de Biologia* **19**, 379–381.

Machado, P.M., Takemoto, R.M. & Pavanelli, G.C. (2005) *Diplostomum* (*Austrodiplostomum*) *compactum* (Lutz, 1928) (Platyhelminthes: Digenea) metarcercariae in fish from the floodplain of the upper Paraná River, Brazil. *Parasitology Research* **97**, 436–444.

Mackenzie, K. (1974) Immature digeneans from the alimentary tract of larval and juvenile pelagic stages of haddock, *Melanogrammus aeglefinus* (L.). *Journal of Fish Biology* **6**, 103–106.

Meneses, I. & Vendrell, C. (2002) Parasitismo em ovos de peixe: uma causa dissimulada de grande mortalidade. *Ipimar* **24**, 1–4.

Montero, G. & Fuentes, C. (1997) Huevos y larvas. pp. 26–32 *in* Montero, G. & Fuentes, C. (*Eds*) *Conservación de la faune íctica en el embalse de Salto Grande*. Salto Grande, publicación de la Comisión Administradora del Río Uruguay y la Comisión Técnica Mixta de Salto Grande.

https://doi.org/10.1017/S0022149X08092171 Published online by Cambridge University Press

Moravec, F. (1998) *Nematodes of freshwater fishes of the neotropical region*. Prague, Academia.

Nakatani, K., Agostinho, A.A., Baumgartner, G., Bialetzki, A., Sanches, P.V., Makrakis, M.C. & Pavanelli, A.S. (2001) *Ovos e larvas de peixes de água doce: desenvolvimento e manual de identificação*. 378 pp. Maringá, Eduem.

Nickol, B.B. & Padilha, T.N. (1979) *Neoechinorhynchus paraguayensis* (Acanthocephala: Neoechinorhynchidae) from Brazil. *Journal of Parasitology* **65**, 987–989.

Poulin, R. (1996) *Evolutionary ecology of parasites*. 212 pp. London, Chapman & Hall.

Santin, M. (2007) Distribuição temporal e ontogenia alimentar de larvas e juvenis de *Pachyurus bonariensis* Steindachner, 1879 (Perciformes, Sciaenidae) da Sinhá Mariana Lagoon, Rio Cuiabá, Mato Grosso. Masters dissertation, Universidade Estadual de Maringá, Maringá.

Severi, W. (1997) Ecologia do ictioplâncton no Pantanal de Barão de Melgaço, bacia do rio Cuiabá, Brasil. Doctoral thesis, Universidade Federal de São Carlos, São Carlos.

Takemoto, R.M. & Pavanelli, G.C. (1994) Ecological aspects of proteocephalidean cestodes parasites of *Paulicea luetkeni* (Steindachner) (Osteichthyes: Pimelodidae) from the Paraná River, Paraná, Brasil. *Revista Unimar* **16**, 17–26.

Thatcher, V.E. (1991) Amazon fish parasites. *Amazoniana* **11**, 443–447.

Universidade Estadual de Maringá, Nupélia/Furnas Centrais Elétricas, (2005) Ictiofauna. pp. 23–47 *in* Agostinho, A.A., Bialetzki, A., Suzuki, H.I., Latini, J.D., Gomes, L.C., Fugi, R. & Domingues, W.M. (*Eds*) *Biologia pesqueira e pesca na área de influência do APM Manso – relatório final*. Maringá.

Zar, J.H. (1996) *Biostatistical analysis*. 3rd edn. 662 pp. New Jersey, Prentice Hall.

(Accepted 1 September 2008)
First published online 15 October 2008
© 2009 Cambridge University Press

https://doi.org/10.1017/S0022149X08092171 Published online by Cambridge University Press