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DESCRIPTION OF *QUADRIGYRUS MACHADOI* (FABIO, 1983) (ACANTHOCEPHALA, QUADRIGYRIDAE) IN NATIVE FISH OF WETLANDS ASSOCIATED WITH THE SAN JAVIER RIVER, SANTA FE, ARGENTINA

DESCRIPCIÓN DE *QUADRIGYRUS MACHADOI* (FABIO, 1983) (ACANTHOCEPHALA, QUADRIGYRIDAE) EN PECES NATIVOS DE HUMEDALES ASOCIADOS AL RIO SAN JAVIER, SANTA FE, ARGENTINA

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Abstract

In order to study the host-parasite interaction of native fish Middle Paraná system, Santa Fe, Argentina, the digestive tracts of 64 specimens of *Hoplias malabaricus* (Pisces, Erythrinidae) and of 70 specimens of *Pimelodus maculatus* (Pisces, Pimelodidae) were analyzed. These native species are important for the economy and recreational activities of the region. The fish were collected from two lentic environments associated with the San Javier River, Cayastá, in the province of Santa Fe, Argentina. After dissecting the digestive tracts, parasites were detected by stereoscopic microscopy, collected and preserved in alcohol at 70% for subsequent taxonomic identification and description. In the intestines of both hosts, sixty-nine specimens of *Quadrigyrus machadoi* (Acanthocephala, Quadrigyridae) were reported for the first time in the Middle Paraná System in this province. The parasitic prevalence was determined for each case (P= 20.31 %, *H. malabaricus*; P= 28.6 %, *P. maculatus*) and an extended description of the icthyoparasite was carried out. This work broadens the geographical distribution of *Q. machadoi* for both hosts and contributes to the advancement of knowledge on the icthyoparasites associated with the regional icthyc fauna.

Keywords: Acanthocephala - Argentina - *Hoplias malabaricus* - Middle Paraná System - *Pimelodus maculates* - *Quadrigyrus machadoi* - San Javier River.

Resumen

Con el objeto de estudiar la interacción hospedador-parásito en peces nativos del Sistema Paraná Medio, Santa Fe, Argentina, se analizaron los tractos digestivos de 64 ejemplares de *Hoplias malabaricus* (Pisces, Erythrinidae) y 70 de *Pimelodus maculatus* (Pisces, Pimelodidae), especies autóctonas de importancia económica y deportiva. Los peces fueron obtenidos de dos ambientes leníticos asociados al río San Javier, Cayastá, Santa Fe, Argentina. Luego de la disección de los tractos digestivos, se buscaron los parásitos bajo microscopía estereoscópica, los cuales fueron colectados y conservados en alcohol al 70% para luego identificarlos taxonómicamente y describirlos. En intestino de ambos hospedadores, se determinaron 69 ejemplares de *Quadrigyrus machadoi* (Acanthocephala, Quadrigyridae), registrados por primera vez en el Sistema Paraná Medio. Se determinó la prevalencia parasitaria para cada caso (P= 20,31 %, *H. malabaricus*; P= 28,6 %, *P. maculatus*) y se realizó una descripción ampliada del ictioparásito. Este trabajo amplía la distribución geográfica de *Q. machadoi*, para ambos hospedadores, así como un aporte al conocimiento de los ictioparásitos asociados a la fauna íctica regional.

Palabras clave: Acanthocephala – Argentina - *Hoplias malabaricus* - *Pimelodus maculatus* - *Quadrigyrus machadoi* - río San Javier - Sistema Paraná Medio.

INTRODUCTION

Among the registers of fish parasites, the Upper Paraná River floodplain exhibits a richness of 337 registered species (Takemoto, 2005; Lacerda *et al.*, 2008; Takemoto *et al.*, 2009; Takemoto & Lizama, 2010). In the Middle Paraná System, although research is still incipient, 91 taxa have already been recognized, mostly Eucestoda and Digenea (Chemes & Takemoto, 2011).

Among macroparasites, members of the phylum Acanthocephala are dioecious and present a heteroxenous life cycle, parasitizing aquatic and terrestrial vertebrates as adults, and crustaceans or insects as intermediate hosts. Each worm attaches itself to the intestinal wall of its host by means of an anterior protrusible proboscis bearing rows of recurved spines. Larvae often live in the mesentery, stomach, intestinal cecum, liver and visceral cavity (Nickol, 1995; Ruppert *et al.*, 2004; Machado da Rocha, 2011). So far, a total of 158 species of acanthocephala and 44 genera have been described in South America, most of them being endemic in the neotropical region (Amin, 2000).

The genus *Quadrigyrus* Van Cleave, 1920, was initially established in Venezuela, with species *Q. torquatus* parasitizing *Hoplias malabaricus* (Bloch, 1794), *Synbranchus marmoratus* (Bloch, 1979), *Crenicichla geayi* (Pellegrin, 1903), *Gephyrocharax valenciae* (Eigenmann, 1920) and *Astyanax bimaculatus* (Linnaeus, 1758) (Van Cleave, 1920). Later, another species was described, *Q. cholodkowskyi* proposes by Kostylew (1928), found in *Varicorhinus segangi* Rüppell 1835, which was later changed to the genus *Acanthocephalorhynchoides* Kostylew, 1941 (Diaz-Ungria & Rodrigo, 1957; Schmidt & Hugghins, 1973). The third species, *Q. brasiliensis*, was proposed by Machado Filho (1941) as parasite of *Hoplerythrinus unitaeniatus* (Spix & Agassiz, 1829) and *H. malabaricus*, in Salobra, Mato Grosso (Brazil). Schmidt & Hugghins (1973) described a new species, *Q. nickoli*, which is distinguished by the number of trunk spines, four circles of 23 to 29 spines, each of 10-20 um in length, with dendritic roots. *Q. torquatus* has three or four circles of 10 to 18 spines, each of 12 to 24 um in length with weak bases and *Q. brasiliensis* has three circles of 12 spines, each of 48 microns in length with weak roots.

Later, Fabio (1983) described *Q. machadoi* in

Campos, Río de Janeiro, Brazil, which made *H. malabaricus* its final host. In turn, larvae of *Q. machadoi* were collected in *Cichla monoculus (*Agassiz, 1831*)*, *Gymnotus* spp. and *Hemisorubim platyrhynchos* (Valenciennes, 1840) as paratenic hosts (Machado *et al.*, 2000; Isaac, 2002; Guidelli *et al.*, 2003). Rosim *et al.* (2005) registered the presence of their cystacanths in the mesentery and mature females in the intestine of *H. malabaricus*. The main features that distinguish this acanthocephala from those referred to above have to do with the location of the testicles, which in *Q. machadoi* are juxtaposed whereas in *Q. torquatus* are separated; they also differ in hook size, those of the first and second row being bigger and much smaller than those of the third and fourth rows. On the other hand, *Q. machadoi* differs from *Q. brasiliensis* in having a shorter body length, bigger lemnisci and the testes placed next to the cement gland (Fabio, 1983).

In this region, many people value and frequently consume freshwater fish. Besides, recreational fishing of freshwater species activates important economic resources thus creating interesting job opportunities (Padín, 2003). The icthyc species considered in this work form part of the native fauna both can be caught in the Middle Paraná floodplain and are among those that are highly valued by the local population. *H.malabaricus*, a fish from the Erythrinidae Family (Characiforms) popularly known as "tararira" or "dientudo", presents a wide geographical distribution being found from Costa Rica as far south as Argentina (Oyakawa, 1998). Another well-known species, *Pimelodus maculatus* La Cepède, 1803 (Pimelodidae Family, Siluriforms), generally known as "amarillo" or "bagre amarillo", can be found all over the floodplain of the River Plate Basin (Ringuelet *et al.*, 1967; Reis *et al.*, 2003).

The San Javier River is a secondary water course of the Middle Paraná constituted by alluvial deposits that make up islands which later unite to form the flood plain, where confined environments abound (Bó, 2005).

Therefore, further research is needed about the regional icthyoparasite species because of their high ecological value given by the different roles they play in the trophic patterns, their participation in the dynamics of the alluvial valley and the interactions in which they participate. Consequently, the aims of this work were to study the parasitism of *H. malabaricus* and *P. maculatus* by *Q. machadoi,* in the wetlands associated with the San Javier River, Santa Fe, Argentina and to provide an extended redescription of *Q. machadoi*.

MATERIAL AND METHODS

Sixty four *H. malabaricus* and seventy *P. maculatus* specimens were captured in two lentic aquatic ecosystems associated with the San Javier River, in middle areas of the Paraná system alluvial valley, Cayastá (Santa Fe, Argentina). The fish were caught with trawl nets of different mesh size (50 to 140 mm). For this study, helminths found within intestines were separated and preserved in alcohol 70 %, and then fixed, colored and mounted following the usual helminthology techniques (Eiras *et al.*, 2003). Taxonomical determination was based on original publications and taxonomic keys (Van Cleave, 1952; Yamaguti, 1963; Schmidt & Hugghins, 1973; Fabio, 1983; Thatcher, 2006; Santos *et al.*, 2008). The measurements are represented in mm and the drawings are the originals. Parasite infestation (P) prevalence for both hosts was considered. Parasite representative specimens were placed in the Helminthological and Invertebrates Collection of the Argentine Museum of Natural Sciences "Bernardino Rivadavia" (Buenos Aires) and in the Invertebrates Collection of the Provincial Museum of Natural Sciences "Florentino Ameghino" (Santa Fe).

RESULTS

Quadrigyrus machadoi parasite prevalence by host is shown in Fig. 1. Based on the 69 *Q. machadoi* specimens obtained, a detailed description is presented and shown in Fig. 2. Since the structures of *Q. machadoi* are similar in both hosts, the description has been unified.

Quadrigyrus machadoi Fabio, 1983
Quadrigyridae Van Cleave, 1920
Gyracanthocephalidea Van Cleave, 1936
Eoacanthocephala Van Cleave, 1936

Host: *Hoplias malabaricus.*
Prevalence, parasite number: 20.31 % (13 of 64 fish infected).
Accession number: MACN-Pa 548 (female); MACN-Pa 549 (male); MFA-ZI 05 (female); MFA-ZI 06 (male).

Host: *Pimelodus maculatus*
Prevalence, parasite number: 28.6 % (20 of 70 fish infected).
Accession number: MFA-ZI 07 (female); MFA-ZI 08 (male).

General description: Small and medium-sized helminths with an elongated body that exhibits a considerable increase in diameter in the anterior region. They possess a globular proboscis with four rows of five hooks each and an elongated lemniscus with a nucleus. The sheath of the proboscis has a single muscular wall. The lacunar system has irregularly branched chains and the trunk presents four rows of small hooks or cuticular spines.

Males: Maximum length (ML) 3.714 (1.436-5.904; n=41) and maximum width (MW) 0.503 (0.257-0.912; n=41). Relation between body length/width 7.813 (3.169-14.807; n=40)/1. Proboscis: length (L) 0.264 (0.126-1.584; n=27) and MW 0.151 (0.024-0.192; n=26). Hooks formed by a circular base and a tine. First row: base L 0.026 (0.006-0.042; n=22), width (W) 0.013 (0.008-0.020; n=21) and tine L 0.059 (0.042-0.098; n=36); second row: base L 0.022 (0.003-0.064; n=23), W 0.016 (0.003-0.016; n=23) and tine L 0.044 (0.002-0.068; n= 30); third row: base L 0.016 (0.002-0.052; n=23), W 0.014 (0.003-0.060; n=23) and tine L 0.037 (0.018-0.168; n=28); last row: base L 0.013 (0.003-0.022; n=19), W 0.010 (0.008-0.016; n=18) and tine L 0.028 (0.016-0.040; n=20).

Lemnisci differing in size: the largest is 0.434 in length (0.198-0.653; n=27) and the smallest is 0.414 in length (0.237-0.653; n=19). Receptacle of the proboscis: L 0.469 (0.092-0.752; n=27). Cuticular spines on the trunk, arranged in four rows uniformly separated: L 0.020 (0.010-0.140; n=32). Two juxtaposed testicles, anterior: L 0.302 (0.108-0.811; n=28) and W 0,142 (0.039-0.288; n=26); posterior: L 0.280 (0.128-0.811; n=25) and W 0.163 (0.042-0.277; n=19). Cement gland remote from the testicles in posterior direction: L 0.614 (0.049-1.416; n=22). Cement reservoir: L 0.304 (0.070-0.623; n=23). Seminal vesicle: L 0.466 (0.086-1.536; n=20). Saefftigen's pouch: L 0.178 (0.108-0.552; n=19). Visible and terminal copulating pouch: L 0.211 (0.044-0.480; n=22).

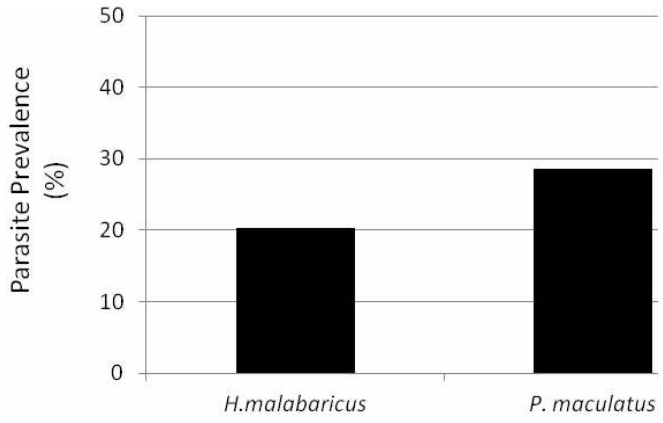

Figure 1. *Quadrigyrus machadoi* parasite prevalence by host.

Figure 2. A.

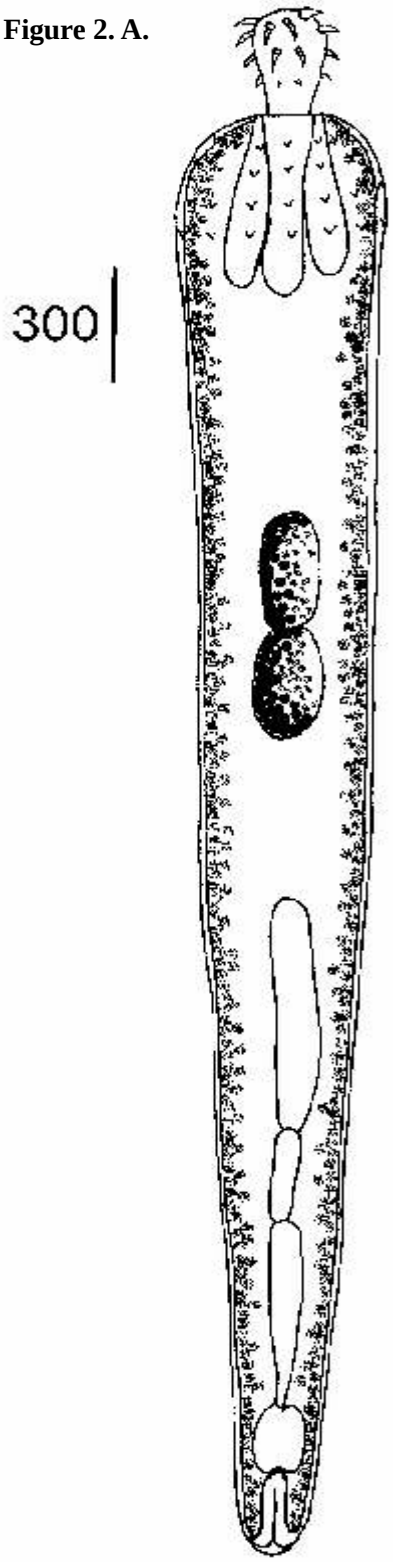

Figure 2. B.

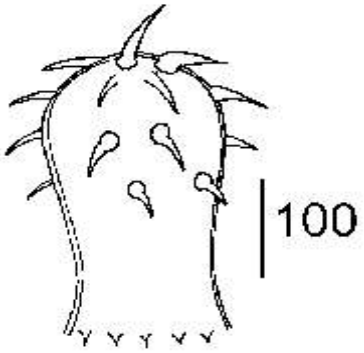

Figure 2. C.

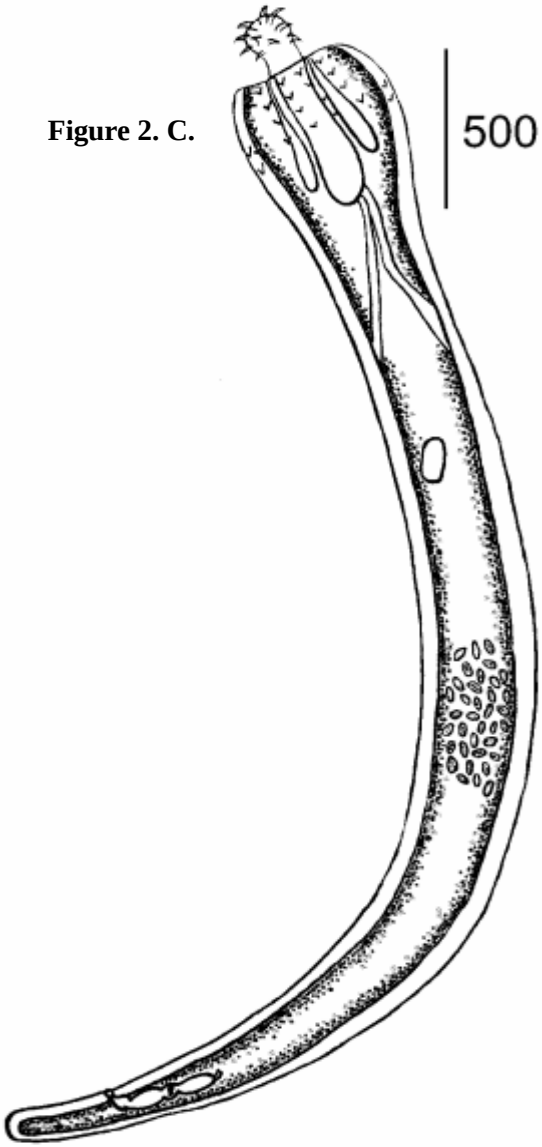

Figure 2. *Quadrigyrus machadoi* (Eoacanthocephala, Quadrigyridae). (scale bar in micrometers). A. Male, entire body ventral view. B. Proboscis. C. Female, entire body ventral view.

Females: ML 4.104 (2.232-7.200; n=28) and MW 0.511 (0.327-1.032; n=28). Relation body length/width: 8.566 (2.348-17.834; n=28). Proboscis: L 0.180 (0.118-0.384; n=19) and MW 0.163 (0.110-0.198; n=19). Hooks formed by a circular base and a tine or hook. First row: base L 0.034 (0.018-0.058; n=16), W 0.015 (0.006-0.024; n=16) and tine L 0.062 (0.042-0.082; n=25); second row: base L 0.030 (0.014-0.050; n=16), W 0.013 (0.010-0.018; n=16) and tine 0.052 (0.026-0.074; n=19); third row: base L 0.019 (0.012-0.028; n=16), W 0.011 (0.008-0.018; n=16) and tine L 0.042 (0.016-0.168; n=20); last row: base L 0.017 (0.010-0.024; n=12), W 0.011 (0.008-0.018; n=12) and tine 0.031 (0.016-0.050; n=14). Cuticular spines on the trunk, arranged in four rows uniformly separated: L 0.020 (0.006-0.168; n=25). The largest lemniscus is 0.398 in length (0.217-0.485; n=16) and the smallest lemniscus is 0.379 in length (0.267-0.465; n=15). Receptacle of the proboscis: L 0.417 (0.104-0.623; n=16). Vagina: L 0.073 (0.010-0.148; n=19). Uterine bell: L 0.166 (0.032-0.504; n=18). Tubular uterus with a diameter of 0.111 (0.012-0.544; n=19). Oval-shaped ovary with sharp edges and medium-anterior arrangement: L 0.148 (0.026-0.396; n=20) and W 0.083 (0.014-0.217; n=20). Distance from the vulva to the rear end of the body: L 0.835 (0.079-1.336; n=8). Elliptic eggs: L 0.018 (0.016-0.022; n=3) and W 0.046 (0.012-0.080; n=2).

Infestation place: intestine.
Origin: lentic habitats associated with the San Javier River, Cayastá, Santa Fe, Argentina).

Previous record in Neotropical countries: *Cichla kelberi* Kullander & Ferreira, 2006, *Gymnotus carapo* Linnaeus, 1758, *Hemisorubim platyrhynchos* Valenciennes, 1840, *H. malabaricus*, *Pimelodus maculatus*, *Potamotrygon motoro* Müller & Henle, 1841, *P. falkneri*, Castex & Maciel, 1963. They were reported in Campos, Río de Janeiro; Aguaí, São Paulo and in the Upper Paraná River floodplain (Brazil) (Fabio, 1983; Rosim, 2005; Lacerda *et al.*, 2008; Takemoto *et al.*, 2009).

DISCUSSION

The specimens found in this study correspond to the description of *Q. machadoi* reported by Fabio (1983), with some particular features. They have a smaller proportion in the length/width ratio of the body, the proboscis in females has a smaller diameter and the hooks of the proboscis are smaller, even though arranged in 4 rows and respecting the same proportions as in the original description (the hooks in the smaller rows are a third smaller than the hooks in the first two rows). Similar to the hooks of the proboscis, lemnisci have a smaller size in the *Q. machadoi* specimens from the wetland areas associated with the San Javier River.

This disparity among specimens of the same species could be attributed to regional differences (Eiras *et al.*, 2003). Both *H. malabaricus* and *P. maculatus* are widely distributed species in the neotropical region and they are generalists due to their trophic habits. This condition has been associated with parasite helminths also of wide geographical distribution, as evidenced by *Q. machadoi* in the present work (Aguilar-Aguilar *et al.*, 2005). Further studies will be needed to broaden the register of this parasite in several icthyc species and in other rivers of the basin, thus contributing to accrue the knowledge base on these organisms. The importance of this description should be remarked, being the first reference to *Q. machadoi* in *H. malabaricus* and *P. maculatus* of the Middle Paraná region, San Javier River, Santa Fe, Argentina.

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