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Anacanthorus toledoensis n. sp. and *Mymarothecium ianwhittingtoni* n. sp. (Dactylogyridae: Monogenoidea) Parasitizing Cage-Reared *Piaractus mesopotamicus* (Characiformes, Characidae) in the State of Paraná, Brazil

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ABSTRACT: Two new species of Dactylogyridae (Monogenoidea) found parasitizing the gills of the pacu, *Piaractus mesopotamicus* (Holmberg, 1887), are described: *Anacanthorus toledoensis* n. sp. and *Mymarothecium ianwhittingtoni* n. sp. These monogenoideans were collected in the gills of all 38 pacus reared in cages in Toledo, State of Paraná, Brazil. *Anacanthorus toledoensis* n. sp. is characterized by the slightly sigmoid male copulatory organ (MCO) with a membranous flap along the longitudinal axis, which ends at the distal, spatulated portion of the organ, and by the rod-shaped accessory piece bearing a protruding median projection. *Mymarothecium ianwhittingtoni* n. sp. differs from all other species of the genus by the morphology of the anchors and by the structure of the copulatory complex comprising an arcuate MCO, with basal flap and accessory piece with a distal rod, somewhat sigmoid, and subterminal flap hooked.

KEY WORDS: *Piaractus mesopotamicus*, fish, cages, Monogenoidea, Dactylogyridae, *Anacanthorus toledoensis* n. sp., *Mymarothecium ianwhittingtoni* n. sp., Paraná.

Piaractus mesopotamicus (Holmberg, 1887), commonly known as "pacu," is one of the most-commonly farmed native fish species in Brazil (Martins et al., 2002). Commercially grown fish like the pacu are often parasitized by Monogenoidea, which have the potential to reduce yield and cause economic loss, a problem that is especially prevalent in the Neotropical region where ecological characteristics facilitate the rapid and constant spread of various parasites (Schalch et al., 2006).

This contribution concerns pacu parasites in two monogenoidean genera. *Anacanthorus* was proposed by Mizelle and Price (1965) for 3 species obtained from the gills of *Pygocentrus nattereri*. It currently includes 69 valid species, all of characiform fish (Cohen et al., 2013). Populations of *Anacanthorus* frequently become very large in artificial settings, which suggests that they may potentially reduce productivity (Boeger et al., 1995). *Mymarothecium* Kritsky, Boeger & Jégu, 1996 was proposed for four species from the gills of serrasalmid fish (Kritsky et al., 1996). Later, Boeger et al. (2002) described *Mymarothecium viatorum* from *Piaractus brachypomus* from a warm-water canal in Poland, and Cohen and Kohn (2005) described another new species of *Mymarothecium*, *Mymarothecium boegeri*, from *Colossoma macropomum*. These workers also reported *M. viatorum* from Brazil, which was collected from both the type host and from *P. mesopotamicus*.

A number of publications have dealt with the Monogenoidea fauna parasitizing *P. mesopotamicus* (Boeger et al., 1995; Eiras et al., 1995; Martins et al., 2000; Souza et al., 2000; Cohen and Kohn, 2005, 2009; Schalch et al., 2006; Lizama et al., 2007; Francischini et al., 2013). Three species had been previously found on the gills of this fish: *Anacanthorus penilabiatus* Boeger, Husak and Martins 1995, *Anacanthorus spathulatus* Kritsky, Thatcher and Kayton, 1979, and *Mymarothecium viatorum* Boeger, Piasecki and Sobecka, 2002 (Boeger et al., 1995; Cohen and Kohn, 2005; Lizama et al., 2007). Here we describe two new species, increasing the number of monogenean parasites from *P. mesopotamicus* to 5.

MATERIALS AND METHODS

Thirty-eight fish cultivated in cages in the Paraná River, both below and above the reservoir of the Itaipu Hydroelectric Power Station, State of Paraná, Brazil, were examined. The gills were removed and placed in vials containing 1:4,000 formalin solution. After 1 hr the vials were vigorously shaken and the formalin solution in each vial was adjusted to 4%. In the laboratory, parasites were collected with the aid of a stereoscopic microscope and stored in the same fixative. Some specimens were mounted unstained in Hoyer's mounting medium (Humason, 1979) for study of their sclerotized parts and the remaining were stained with Gomori's trichrome, cleared in beechwood creosote, and slide-mounted in Canada balsam (Kritsky

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et al., 1978). All measurements are in micrometers (μm); ranges are followed by the mean in parentheses and the number of species measured; in cases of only 2 measurements the values are presented as range followed by $n = 2$ in parentheses. Measurements of the copulatory complex represent a straight-line distance between extreme points. Numbering of hook pairs follows Mizelle (1936). Holotype and paratypes are deposited in the Helminthological Collection of the Instituto Oswaldo Cruz (CHIOC), Rio de Janeiro, and Collection of Instituto Nacional de Pesquisas da Amazônia (INPA), Amazônia, Brazil.

RESULTS

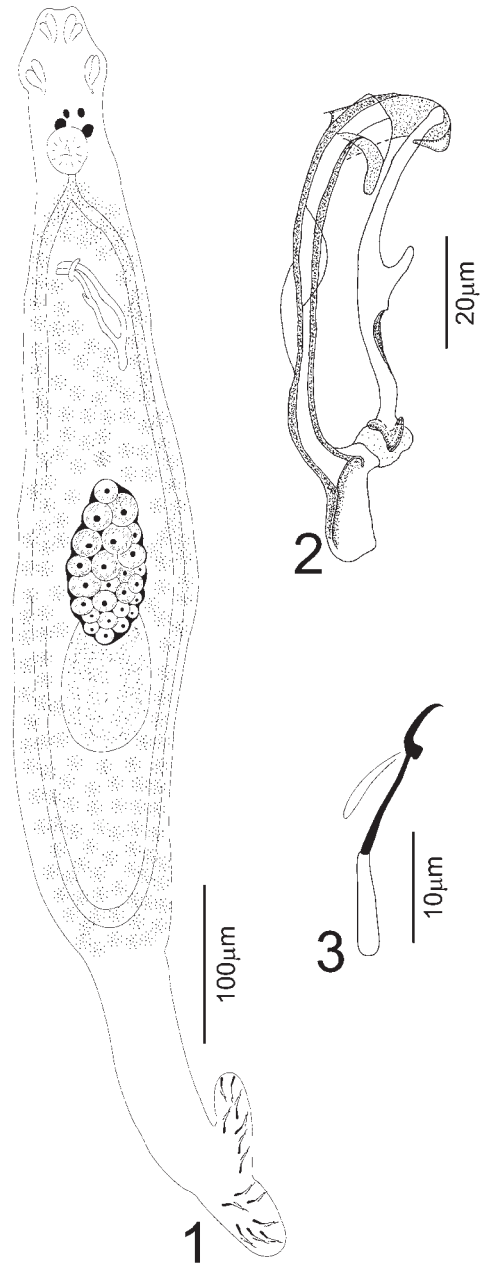
Anacanthorinae Price, 1967
Anacanthorus toledoensis n. sp.
(Figs. 1–3, 11)

Description

Based on 60 specimens: Body fusiform 450–760 (610; $n = 44$) long, 100–230 (168; $n = 43$) wide. Tegument thin, smooth. Two terminal, 2 bilateral cephalic lobes, slightly to well developed. Eyes 4, posterior pair larger and slightly farther apart than anterior pair; accessory granules spread on cephalic region. Pharynx spherical 27–37 (30; $n = 15$) wide. Esophagus short; intestinal ceca confluent in the posterior region. Haptor 100–187 (134; $n = 38$) wide, bilobed, with concave posterior border, 7 pairs of hooks with anacanthorine distribution. Anchors and bars absent. Hooks 30–45 (34; $n = 185$), similar in shape, with depressed thumb, curved shaft, short recurved point, shank proximally expanded, proximal expansion about one third of shank length; filamentous hooklet (FH) loop well developed, extending to distal limit of proximal expansion; dorsal, ventral pairs of 4A hooks proximally expanded about one half of length. Male copulatory organ (MCO) 95–130 (110; $n = 54$) long, slightly sigmoid, base funnel-shaped. Membranous flap at longitudinal axis that ends at distal spatulated portion of the organ. Accessory piece 70–95 (81; $n = 56$) long, directly connected to MCO base by the copulatory ligament, rod-shaped bearing a median projection. Testis postgermarian, 112 (112; $n = 3$) long, 45–58 (38; $n = 3$); seminal vesicle not observed. Germarium 50–60 (56; $n = 3$) long, 50–62 (54; $n = 3$) wide, subovate. Vitellaria in two bilateral fields of trunk, from pharynx to posterior region of testes, coextensive with intestinal caeca. Egg, oviduct, and ootype not observed.

Taxonomic summary

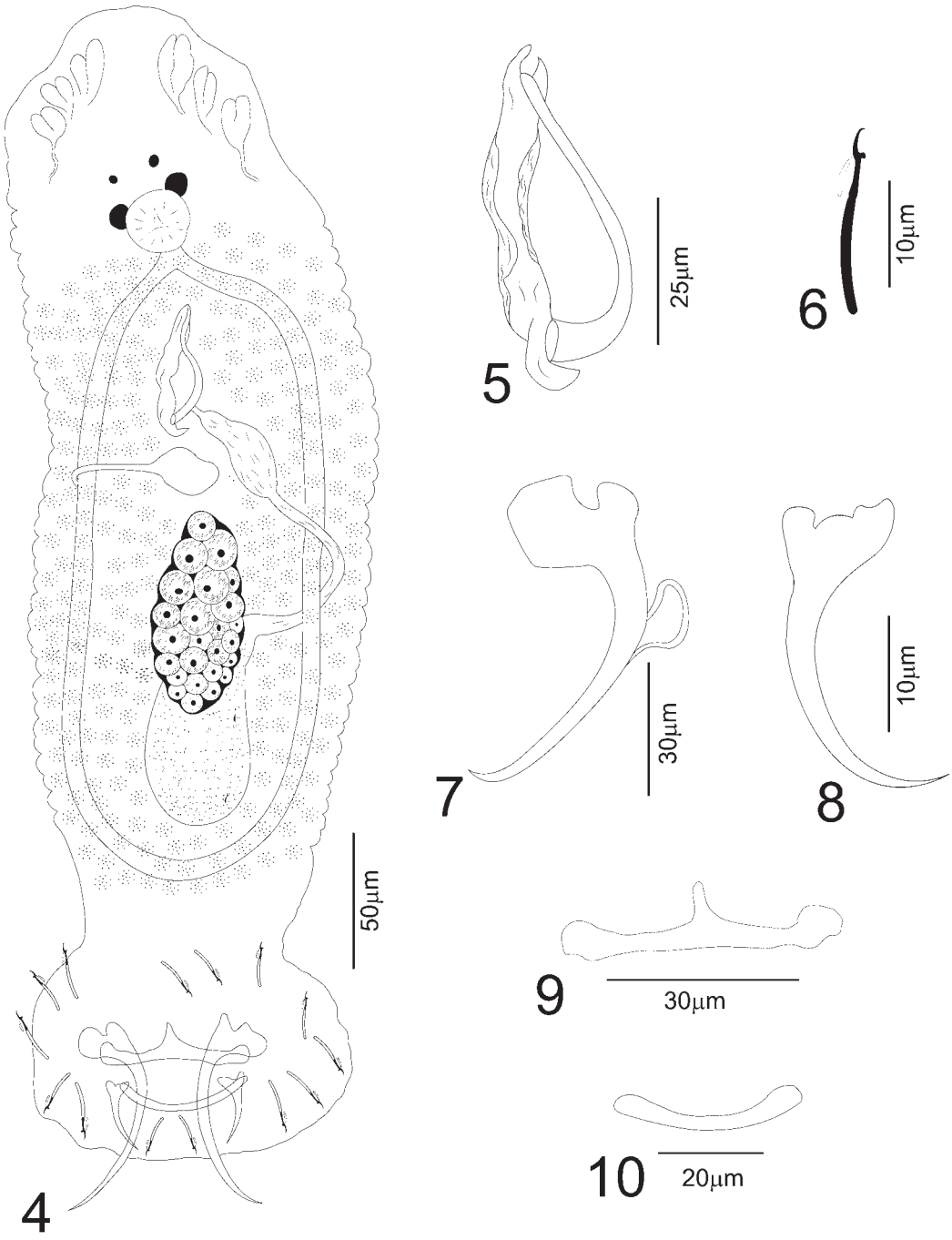
Type host: Piaractus mesopotamicus (Holmberg, 1887) (Characiformes, Characidae)



Figures 1–3. *Anacanthorus toledoensis* n. sp. from *Piaractus mesopotamicus*. **1.** Holotype (ventral view). **2.** Copulatory complex (dorsal view). **3.** Hook.

Infection site: Gills

Type-locality: Paraná River (24°44′29.0′′S, 53°44′51.2′′W) State of Paraná, in the locality of Toledo, Brazil.



Figures 4–10. *Mymarothecium ianwhittingtoni* n. sp. from *Piaractus mesopotamicus*. **4.** Holotype (ventral view). **5.** Copulatory complex (dorsal view). **6.** Hook. **7.** Ventral anchor. **8.** Dorsal anchor. **9.** Ventral bar. **10.** Dorsal bar.

Prevalence: 17 fish infected of 38 examined (45%).

Specimens deposited: Holotype, CHIOC 37905 a; paratypes, CHIOC 37905 b–c and INPA 634a–c.

Etymology: The specific name is derived from the type locality, Toledo.

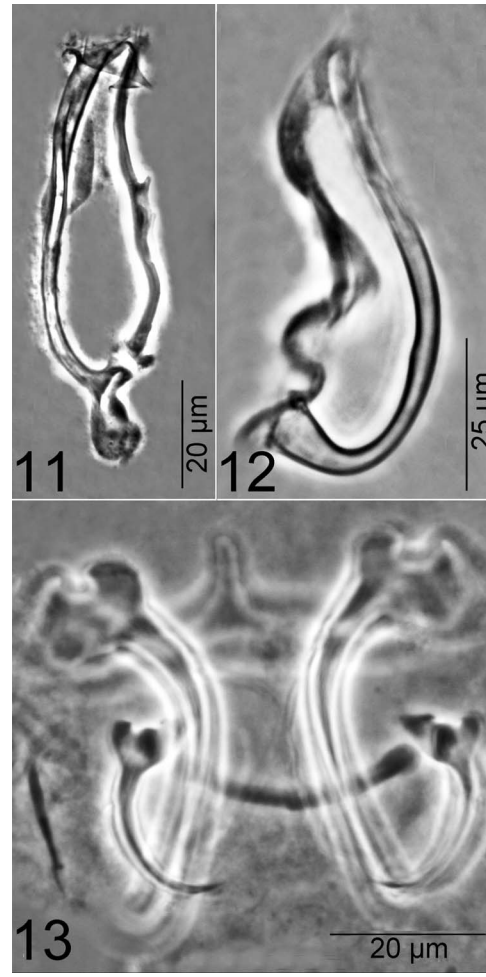
Remarks

Anacanthorus penilabiatus was described by Boeger et al. (1995) parasitizing a population of *P. mesopotamicus*, reared in the state of São Paulo, Brazil, and was also reported in several additional studies (Martins et al., 2000; Souza et al., 2000; Tavares-Dias et al., 2001; Schalch et al., 2006). *Anacanthorus toledoensis* n. sp. is more-closely related to this species based on the morphology of the MCO and the hooks. The new species is diagnosed by the detailed morphology of the copulatory complex: MCO ending in spatulated portion and accessory piece bearing a median projection (MCO subterminal aperture with long posteriorly recurved lip and accessory piece with subterminal short pointed projection in *A. penilabiatus*).

Ancyrocephalinae Bychowsky, 1937
Mymarothecium ianwhittingtoni n. sp.
(Figs. 4–10, 12, 13)

Description

Based on 31 specimens: Body 300–400 (340; n = 23) long by 100–140 (117; n = 24) wide. Tegument presenting annulations. Cephalic lobes well developed. Eyes 4, posterior pair larger and slightly farther apart than anterior pair; accessory granules spread on cephalic region. Pharynx spherical 15 and 20 (n = 2) in diameter. Haptor 100–125 (106; n = 18) wide, subhexagonal with ventral anchors larger than dorsal. Ventral anchor with heavy depressed superficial root, prominent deep root, gently curved shaft, elongate point, 55–60 (55; n = 53) long; base width 10–15 (12; n = 53); dorsal anchor elongate and depressed superficial root, short deep root, slightly curved shaft and short point, 20–23 (20; n = 43) long; base width 10–15 (12; n = 43). Ventral bar robust 45–60 (52; n = 20) long, with anteromedian projection and enlarged terminations. Dorsal bar 30–40 (35; n = 22) long, delicate, U-shaped, with slightly enlarged terminations. Seven pairs of hooks similar in shape, hooks 2–4 and 6–7 similar size, hooks 1 and 5 reduced, each with erected thumb, recurved shaft, short point, shank comprising 2 subunits, proximal subunit expanded. Filamentous hooklet (FH) loop extending to union of shank subunits. Pair 1, 15–25 (18; n = 14); pairs 2–4, 20–30 (23; n = 58); pair 5, 20 (n = 3); pairs 6–7, 20–25 (19; n = 12) long. The MCO is 45–53 (47; n = 22) long, arcuate, with basal flap. Accessory piece 48–56 (51; n = 24) long, distal rod, sigmoid; subterminal flap hooked. Testis posterior to germarium, 30 and 38 (n = 2) long, 15 and 20 (n = 2) wide; seminal vesicle elongate, a dilation of vas deferens. Germarium 60 and 70 (n = 2) long, 30 (n = 2) wide, subovate.Vagina dextrodorsal, delicate, opening into a seminal receptacle. Vitellaria in two bilateral fields of trunk, from pharynx to the posterior



Figures 11–13. Phase contrast micrographs of sclerotized structures of Monogenoidea from *Piaractus mesopotamicus*. **11.** Male copulatory organ of *A. toledoensis* n. sp. **12.** Male copulatory organ of *M. ianwhittingtoni* n. sp. **13.** Haptoral structures of *M. ianwhittingtoni* n. sp.

region of testes, coextensive with intestinal ceca. Egg oviduct, ootype not observed.

Taxonomic summary

Type host: Piaractus mesopotamicus (Holmberg, 1887) (Characiformes, Characidae).

Infection site: Gills.

Type locality: Paraná River (24°44′29.0′′S, 53°44′51.2′′W) State of Paraná, in the locality of Toledo, Brazil.

Prevalence: 18 fish infected of 38 examined (47%).

Specimens deposited: Holotype, CHIOC 37906 a; paratypes, CHIOC 37906 b–d and INPA 633a–c.

Etymology: The specific name is in honor of Dr. Ian Whittington, in recognition of his contribution in the knowledge of Monogenoidea.

Remarks

This new species is allocated to *Mymarothecium* based mainly on the dextrodorsal position of the vagina, the noncoiled MCO, and the medial projection in the ventral bar. *Mymarothecium ianwhittingtoni* n. sp. resembles *Mymarothecium whittingtoni*, originally described by Kritsky et al. (1996) from serrasalmid hosts in the Amazon basin, in the morphology of the copulatory complex. The new species differs from all other species of the genus by the size ratio of the anchors, with the ventral approximately twice the size of the dorsal.

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LITERATURE CITED

Boeger, W. A., W. S. Husak, and M. L. Martins. 1995. Neotropical Monogenoidea. 25. *Anacanthorus penilabiatus* n. sp. (Dactylogyridae: Ancyrocephalinae) from *Piaractus mesopotamicus* (Osteichthyes: Serrasalmidae), cultivated in the State of São Paulo, Brazil. Memórias do Instituto Oswaldo Cruz 90:699–670.

Boeger, W. A., W. Piasecki, and E. Sobecka. 2002. Neotropical Monogenoidea. 44. *Mymarothecium viatorum* sp. n. (Ancyrocephalinae) from the gills of *Piaractus brachypomus* (Serrasalmidae, Teleostei) captured in a warm-water canal of a power plant in Szczecin, Poland. Acta Ichthyologica et Piscatoria 32: 157–162.

Cohen, S. C., and A. Kohn. 2005. A new species of *Mymarothecium* and new hosts and geographical records for *M. viatorum* (Monogenea: Dactylogyridae) parasites of freshwater fishes in Brazil. Folia Parasitologica 52:307–310.

Cohen, S. C., and A. Kohn. 2009. On Dactylogyridae (Monogenea) of four species of characid fishes from Brazil. Check List 5:351–356.

Cohen, S. C., M. C. N. Justo, and A. Kohn. 2013. South American Monogenoidea Parasites of Fishes, Amphibians and Reptiles. Conselho Nacional de Desenvolvimento Cientifico e Tecnologico (CNPq). Oficina de Livros, Rio de Janeiro, Brazil. 663 pp.

Eiras, J. C., M. J. T. Ranzani-Paiva, C. M. Ishikawa, and A. C. Alexandrino. 1995. Ectoparasites of semi-intensively farmed tropical freshwater fish *Piaractus mesopotamicus*, *Prochilodus lineatus* and *Colossoma macropomum* in Brazil. Bulletin European Association of Fish Pathologists 15:148–151.

Francischini, L., A. C. Zago, S. H. C. Schalch, F. Garcia, D. M. Romera, and R. J. Silva. 2013. Parasitic infections of *Piaractus mesopotamicus* and hybrid (*P. mesopotamicus* x *Piaractus brachypomus*) cultured in Brazil. Revista Brasileira de Parasitologia Veterinária 22:407–414.

Humason, G. L. 1979. Animal Tissue Techniques, 4th ed. W. H. Freeman and Company, San Francisco. 661 pp.

Kritsky, D. C., W. A. Boeger, and M. Jégu. 1996. Neotropical Monogenoidea. 28. Ancyrocephalinae (Dactylogyridae) of piranha and their relatives (Teleostei, Serrasalmidae) from Brazil and French Guiana: species of *Notozothecium* Boeger and Kritsky, 1988 and *Mymarothecium* gen. n. Journal of the Helminthological Society of Washington 63:153–175.

Kritsky, D. C., P. D. Leiby, and R. J. Kayton. 1978. A rapid stain technique for haptoral bars of *Gyrodactylus* species (Monogenea). Journal of Parasitology 69:862–865.

Lizama, M. A. P., R. M. Takemoto, M. J. T. Ranzani-Paiva, L. M. S. Ayrosa, and G. C. Pavanelli. 2007. Relação parasito-hospedeiro em peixes de piscicultura da região de Assis, estado de São Paulo, Brasil. 2. *Piaractus mesopotamicus* (Holmberg, 1887). Acta Scientarium Biological Sciences 29:437–445.

Martins, M. L., F. R. Moraes, R. Y. Fujimoto, E. M. Onaka, D. T. Nomura, C. A. H. Silva, and S. H. C. Schalch. 2000. Parasitic infections in cultivated freshwater fishes a survey of diagnosticated cases from 1993 to 1998. Revista Brasileira de Parasitologia Veterinária 9:23–28.

Martins, M. L., E. M. Onaka, F. R. Moraes, F. R. Bozzo, A. M. F. C. Paiva, and A. Gonçalves, A. 2002. Recent studies on parasitic infections of freshwater

cultivated fish in the state of São Paulo, Brazil. Acta Scientiarium 24:981–985.

Mizelle, J. D. 1936. New species of trematodes from the gills of Illinois fishes. American Midland Naturalist 82: 417–428.

Mizelle, J. D., and C. E. Price. 1965. Studies on monogenetic trematodes. XXVIII. Gill parasites of the piranha with proposal of *Anacanthorus* gen. n. Journal of Parasitology 51:30–36.

Schalch, S. H. C., J. R. E. Moraes, and F. R. Moraes. 2006. Fauna parasitária de peixes oriundos de "pesque–pague" do município de Guariba, São Paulo, Brazil. Acta Scientarium Biological Sciences 28:291–297.

Souza, M. L. R., L. M. Martins, and J. M. Santos. 2000. Microscopia eletrônica de varredura de parasitos branquiais de *Piaractus mesopotamicus* Holmberg, 1887 cultivados no Estado de São Paulo, Brasil. Acta Scientarium Biological Sciences 22:527–531.

Tavares-Dias, M., F. R. Moraes, M. L. Martins, and S. N. Kronka. 2001. Fauna parasitária de peixes oriundos de pesque-pagues do município de Franca, São Paulo, Brasil. II. Metazoários. Revista Brasileira de Zoologia 18:81–95.