

New species of *Urocleidoides* (Monogenoidea: Dactylogyridae) from the gills of two species of Anostomidae from the Brazilian Amazon

Novas espécies de *Urocleidoides* (Dactylogyridae) das brânquias de duas espécies de Anostomidae da Amazônia brasileira

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Abstract

Three species (2 new) of *Urocleidoides* are described and/or reported from the gills of *Schizodon fasciatus* and *Laemolyta proxima* (Anostomidae) from the Jari River in the eastern Brazilian Amazon. *Urocleidoides jariensis* n. sp. presents a sclerotized, tubular, spiral male copulatory organ (MCO) with one counterclockwise coil, a circular sclerotized tandem brim associated with the base of the MCO; a heavily sclerotized, funnel-shaped vaginal vestibule; and a broadly V-shaped ventral bar with anteromedial constriction and enlarged ends. *Urocleidoides ramentacuminatus* n. sp. has a sclerotized, tubular, spiral MCO with one counterclockwise coil; an accessory piece with a hook-shaped distal portion; and a dorsal anchor with a short, straight shaft; anchor point with ornamentation as sclerotized shredded filaments. *Urocleidoides paradoxus* is reported for the first time parasitizing *S. fasciatus*.

Keywords: Amazon, anostomidae, monogenoids, parasites, freshwater fish.

Resumo

Três espécies (2 novas) de *Urocleidoides* são descritas e/ou reportadas das brânquias de *Schizodon fasciatus* e *Laemolyta proxima* (Anostomidae) da bacia do Rio Jari, na Amazônia oriental brasileira. *Urocleidoides jariensis* n. sp. apresenta um órgão copulatório masculino (OCM) convoluto, com uma volta no sentido anti-horário, uma borda em tandem esclerotizada circular, associada à base do OCM; um vestibulo vaginal fortemente esclerotizado e em forma de funil; um canal vaginal esclerotizado na porção proximal; e uma barra ventral em forma de V com constrição anteromedial e ampliações terminais. *Urocleidoides ramentacuminatus* n. sp. tem um OCM convoluto com, aproximadamente, uma volta no sentido anti-horário; uma peça acessória com uma porção distal em forma de gancho; uma âncora dorsal com haste curta e reta; e ponta da âncora com ornamentação como filamentos desfiados esclerotizados. *Urocleidoides paradoxus* é relatada pela primeira vez parasitando *S. fasciatus*.

Palavras-chave: Amazônia, anostomidae, monogenoideos, parasitos, peixes de água doce.

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Introduction

Neotropical characiforms fish of the Anostomidae family have wide distribution in the watersheds of South and Central America (Nelson et al., 2016). This family currently comprises 14 genera and 155 species, many of which occur in the Amazon basin, with species of *Schizodon* Agassiz, 1829 and *Laemolyta* Cope, 1872 representing approximately 16% of the diversity (Nelson et al., 2016). Members of this family are important hosts for the life cycle of a broad diversity of parasites (Guidelli et al., 2006; Oliveira et al., 2017; Yamada et al., 2017), including platyhelminths belonging to the Class Monogenoidea (Cohen et al., 2013). Among anostomid species, only 7.7% has been investigated for monogenoidean parasites. Currently, 12 species of monogenoids are known to parasitize the gills, nostrils, body surface, urinary bladder, and ureter of members of 13 species of Anostomidae (see Table 1).

Table 1. Checklist of monogenoid species in fish of the family Anostomidae in Brazil.

Parasite species	Host species	Infection site	Locality	Reference
<i>Jainus leporini</i>	<i>Leporinus copelandii</i>	Gill filaments	Guandu River, Rio de Janeiro state	Abdallah et al. (2012)
<i>Jainus leporini</i>	<i>Leporinus microcephalus</i>	Gill filaments	Cruzeiro do Sul city, Acre state	Abdallah et al. (2012)
<i>Jainus leporini</i>	<i>Leporinus friderici</i>	Gill filaments	Jari and Igarapé Fortaleza rivers, Amapá State	Oliveira et al. (2017)
<i>Jainus piava</i>	<i>Leporinus friderici</i>	Gill filaments	Paranapanema, Taquari and Viados rivers, São Paulo state	Yamada et al. (2017)
<i>Jainus piava</i>	<i>Schizodon borellii</i>	Gill filaments	Paraná River, Paraná state	Karling et al. (2011)
<i>Jainus piava</i>	<i>Megaleporinus obtusidens</i>	Gill filaments	Guaíba Lake, Rio Grande do Sul state	Wendt et al. (2018)
<i>Rhinoxenus arietinus</i>	<i>Leporinus elongates</i>	Nostrils	Paraná River, Paraná state	Takemoto et al. (2009)
<i>Rhinoxenus arietinus</i>	<i>Leporinus friderici</i>	Nostrils	Paraná River, Paraná state	Guidelli et al. (2006)
<i>Rhinoxenus arietinus</i>	<i>Leporinus lacustris</i>	Nostrils	Paraná River, Paraná state	Guidelli et al. (2006)
<i>Rhinoxenus arietinus</i>	<i>Leporinus obtusidens</i>	Nostrils	Paraná River, Paraná state	Takemoto et al. (2009)
<i>Rhinoxenus arietinus</i>	<i>Rhytiodus argenteofuscus</i>	Nostrils	Solimões River, Amazonas state	Kritsky et al. (1988)
<i>Rhinoxenus arietinus</i>	<i>Schizodon fasciatus</i>	Nostrils	Solimões River, Amazonas state	Kritsky et al. (1988)
<i>Rhinoxenus nyttus</i>	<i>Schizodon fasciatus</i>	Nostrils	Solimões River, Amazonas state	Kritsky et al. (1988)
<i>Rhinoxenus nyttus</i>	<i>Megaleporinus obtusidens</i>	Nostrils	Guaíba Lake, Rio Grande do Sul state	Wendt et al. (2018)
<i>Scleroductus yuncensi</i>	<i>Leporinus copelandii</i>	Body	Guandu River, Rio de Janeiro state	Azevedo et al. (2010)
<i>Tereancistrum flabellum</i>	<i>Leporinus friderici</i>	Gill filaments	Sapucaí-Mirim and Paranapanema rivers, São Paulo state	Zago et al. (2017)
<i>Tereancistrum flabellum</i>	<i>Leporinus amblyrhynchus</i>	Gill filaments	Sapucaí-Mirim and Paranapanema rivers, São Paulo state	Zago et al. (2017)
<i>Tereancistrum parvus</i>	<i>Leporinus obtusidens</i>	Gill filaments	Paraná River, Paraná state	Takemoto et al. (2009)
<i>Tereancistrum parvus</i>	<i>Leporinus lacustris</i>	Gill filaments	Paraná River, Paraná state	Guidelli et al. (2006), Takemoto et al. (2009)
<i>Tereancistrum parvus</i>	<i>Leporinus friderici</i>	Gill filaments	Paraná River, Paraná state	Takemoto et al. (2009)
<i>Tereancistrum parvus</i>	<i>Leporinus friderici</i>	Gill filaments	Jari and Igarapé Fortaleza rivers, Amapá state	Oliveira et al. (2017)
<i>Tereancistrum parvus</i>	<i>Leporinus elongates</i>	Gill filaments	Paraná River, Paraná state	Takemoto et al. (2009)
<i>Tereancistrum parvus</i>	<i>Leporinus fasciatus</i>	Gill filaments	Paraná River, Paraná state	Takemoto et al. (2009)
<i>Tereancistrum parvus</i>	<i>Megaleporinus obtusidens</i>	Gill filaments	Guaíba Lake, Rio Grande do Sul state	Wendt et al. (2018)

Table 1. Continued...

Parasite species	Host species	Infection site	Locality	Reference
<i>Tereancistrum parvus</i>	<i>Leporinus microcephalus</i>	Gill filaments	Cruzeiro do Sul, Acre state	Martins et al. (2017)
<i>Tereancistrum paranaensis</i>	<i>Leporinus microcephalus</i>	Gill filaments	Cruzeiro do Sul, Acre state	Martins et al. (2017)
<i>Tereancistrum paranaensis</i>	<i>Megaleporinus obtusidens</i>	Gill filaments	Guaíba Lake, Rio Grande do Sul state	Wendt et al. (2018)
<i>Trinibaculum rotundus</i>	<i>Schizodon borellii</i>	Gill filaments	Paraná River, Paraná state	Karling et al. (2011)
<i>Urocleidoides paradoxus</i>	<i>Leporinus elongates</i>	Gills filament	Paraná River, Paraná state	Takemoto et al. (2009)
<i>Urocleidoides paradoxus</i>	<i>Leporinus lacustris</i>	Gill filaments	Paraná River, Paraná state	Takemoto et al. (2009)
<i>Urocleidoides paradoxus</i>	<i>Leporinus obtusidens</i>	Gill filaments	Paraná River, Paraná state	Takemoto et al. (2009)
<i>Urocleidoides paradoxus</i>	<i>Rhytidodus microlepis</i>	Gill filaments	Solimões River, Amazonas state	Kritsky et al. (1986)
<i>Urocleidoides paradoxus</i>	<i>Leporinus friderici</i>	Gill filaments	Paraná River, Paraná state	Guidelli et al. (2006)
<i>Urocleidoides paradoxus</i>	<i>Leporinus friderici</i>	Gill filaments	Jari River and Igarapé Fortaleza, Amapá state	Oliveira et al. (2017)
<i>Urocleidoides paradoxus</i>	<i>Leporinus microcephalus</i>	Gill filaments	Cruzeiro do Sul, Acre state	Martins et al. (2017)
<i>Urocleidoides paradoxus</i>	<i>Megaleporinus obtusidens</i>	Gill filaments	Guaíba Lake, Rio Grande do Sul state	Wendt et al. (2018)
<i>Urocleidoides eremitus</i>	<i>Leporinus microcephalus</i>	Gill filaments	Cruzeiro do Sul, Acre state	Martins et al. (2017)
<i>Kritskyia eirasi</i>	<i>Leporinus microcephalus</i>	Urinary bladder and ureter	Cruzeiro do Sul, Acre state	Martins et al. (2017)
<i>Kritskyia eirasi</i>	<i>Leporinus friderici</i>	Urinary bladder and ureter	Paraná River, Paraná state, Brazil	Guidelli et al. (2006)
<i>Kritskyia eirasi</i>	<i>Leporinus lacustris</i>	Urinary bladder and ureter	Paraná River, Paraná state	Guidelli et al. (2006)
<i>Kritskyia eirasi</i>	<i>Megaleporinus obtusidens</i>	Urinary bladder and ureter	Guaíba Lake, Rio Grande do Sul state	Wendt et al. (2018)

During a field survey of parasites from the gills of *Schizodon fasciatus* Spix & Agassiz, 1829 and *Laemolyta proxima* Garman, 1890 (Anostomidae) from the Jari River, a tributary of the Amazon River basin (northern Brazil), two new species of *Urocleidoides* Mizelle & Price, 1964 were found and are described herein. We also recorded for the first time *Urocleidoides paradoxus* Kritsky, Thatcher & Boeger, 1986 parasitizing the gills of *S. fasciatus* from the eastern Amazon.

Materials and Methods

Host fish collection

In March 2018, 15 specimens of *S. fasciatus* and 3 specimens of *L. proxima* were collected with fishing nets in the lower Jari River, near Jarilândia district, in municipality of Vitória do Jari, State of Amapá, Brazil (1°9'4.01"S; 52°0'53.22" W). Host scientific names were validated in accordance with Fricke et al. (2019), and identification was carried out in accordance with specialized literature (Queiroz et al., 2013).

This study was developed in accordance with the principles adopted by the Brazilian College of animal Experimentation (COBEA). Authorization from Ethic Committee in the Use of Animal of the Embrapa Amapá (Protocol N° 014/2018) was also carried out.

Parasitological procedures

Gill arches were removed and placed in vials containing hot water (65° C). Each vial was vigorously shaken, and formalin was added to obtain a 5% solution. In the laboratory, the contents of each vial were examined under a dissecting microscope (Leica S6D) and monogenoids were removed from the gills or sediment using small probes. Some specimens were stained with Gomori's trichrome (Humason, 1979; Boeger & Vianna, 2006) and mounted in Damar Gum or Canada balsam to determine the internal soft structures, while others were mounted in Hoyer's or Gray & Wess medium (Humason, 1979) for the study of the sclerotized structures. Measurements, all in micrometers, were obtained according to the procedures described by Mizelle & Klucka (1953). The measurements inner and outer for the anchors follow the scheme illustrated in Figures 1j. Dimensions of organs and structures represent the straight line distances between the extreme ends, the total lengths of the male copulatory organ were carried out using ImageJ (Rasband, 1997) on drawing tube images. The mean is followed by the range and the number (n) of specimens measured in parentheses. Illustrations were prepared with the aid of a drawing tube on a Leica DM 2500 microscope with differential interference contrast and phase contrast optics. Illustrations of the soft and hard structures were prepared using pen and ink. Plates were prepared using PhotoPaint software. Prevalence and mean intensity follow Bush et al. (1997). Type specimens and vouchers were deposited in the Invertebrate Collection of the Museu Paraense Emílio Goeldi (MPEG), Belém, Pará state, Brazil.

Results

Taxonomic summary:

Class Monogenoidea Bychowsky, 1937

Subclass Polyonchoinea Bychowsky, 1937

Order Dactylogyridea Bychowsky, 1937

Dactylogyridae Bychowsky, 1933

Urocleidoides Mizelle & Price, 1964

Urocleidoides jariensis n. sp. (Figure 1a-k)

Description: Based on nine specimens; three mounted in Gomori's trichrome, six mounted in Hoyer' medium. Body fusiform (Figure 1a) total length excluding haptor 255 (218–298; n = 9) long, 107 (59–154; n = 9) wide at level of gemarium. Tegument smooth. Cephalic margin tapered; moderately developed terminal lobes; three bilateral pairs of head organs with rod-shaped secretion; cephalic glands unicellular, posterolateral to pharynx (observed only in paratypes). Four eyes (two pairs); posterior pair larger than anterior pair; accessory chromatic granules present in cephalic area, elliptical (Figure 1a). Mouth subterminal, midventral; pharynx 21 (17–25; n = 8) long, 23 (13–30; n = 8) wide, muscular, glandular; moderately elongated esophagus. Two intestinal caeca, posteriorly confluent to gonads, lacking diverticula. Genital pore opening midventral; genital atrium muscular. Testis, seminal vesicle, vas deferens, prostatic reservoir not observed. Copulatory complex comprising male copulatory organ (MCO) and accessory piece (Figure 1b); MCO sclerotized, tubular, spiral, counterclockwise, with one coil, 39 (28–49; n = 6) long; circular sclerotized tandem brim associated with base of MCO; proximal portion of MCO slightly expanded, distal aperture slightly acute. Accessory piece sclerotized, non-articulated with MCO, comprising a variable distal sheath, surrounding the MCO (Figure 1b). Germarium elongate 68 (44–94; n = 6) long, 28 (15–45; n = 6) wide (Figure 1a). Mehlis glands, ootype and seminal receptacle not observed. Vagina single (Figure 1c), heavily sclerotized; vaginal aperture dextro-ventral, marginal; vagina comprising vaginal vestibule, funnel-shaped with short vaginal canal. Vaginal sclerite (Figure 1d) 30 (25–35; n = 4) long, hook-shaped with longitudinal superficial groove. Vitellaria dense throughout trunk, except in region of reproductive organs. Eggs not observed. Peduncle short; haptor hexagonal 68 (45–105; n = 9) long, 71 (11–106; n = 9) wide (Figure 1a). Anchors similar; well-developed superficial root, short deep root, slightly curved elongate shaft, recurved and acute point. Ventral anchor (Figure 1j), outer 38 (36–40; n = 7) long, inner 38 (35–41; n = 7) long, base 14 (13–15; n = 7) wide, evenly curved shaft and point, point acute, extending at level of tip of superficial root. Dorsal anchor smaller than ventral anchor (Figure 1k) outer 31 (31–33; n = 7) long, inner 33 (31–38; n = 7) long, base 11 (10–12; n = 7) wide, shaft elongate, point not extending level of tip of superficial root.

Ventral bar (Figure 1e) 48 (30–55; $n = 8$) long, slightly curved, broadly V-shaped with anteromedial constriction and enlarged ends. Dorsal bar (Figure 1f) 45 (33–55; $n = 8$) long, U-shaped, with slightly enlarged ends, slightly curved in posterior direction. Hook pair 1, 21 (19–23; $n = 8$) long (Figure 1h) and hooks pairs 2–4, 6–7, 27 (21–32; $n = 8$) long (Figure 1i), similar in shape, composed of two subunits, shank with inflation comprising approximately 2/3 of total shank length; erected thumb, lightly curved long shaft, delicate point; filamentous hook (FH) with loop extending to union of shank subunits; pair 5 smaller than other hooks, 15 (13–16; $n = 8$) long, composed of single unit and inflated base (Figure 1g).

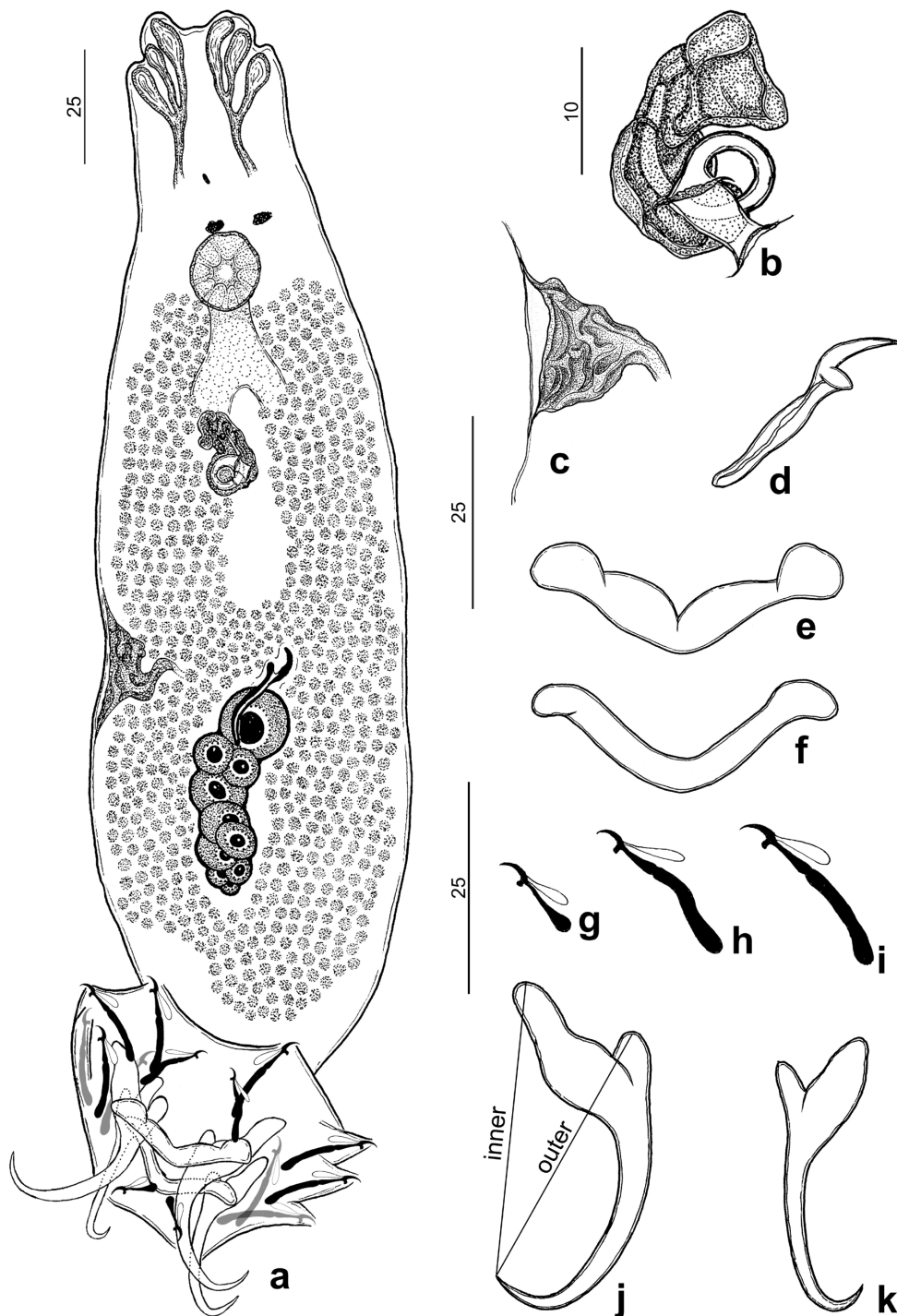


Figure 1. *Urocleidoides jariensis* n. sp. (a) Holotype, whole-mount (ventral view). (b) Male copulatory organ. (c) Vagina. (d) Vaginal sclerite. (e) Ventral bar. (f) Dorsal bar. (g) Hook (pair 5). (h) Hook (pair 1). (i) (pairs 2, 3, 4, 6 and 7). (j) Ventral anchor. (k) Dorsal anchor.

Type host: *Schizodon fasciatus* Spix & Agassiz, 1829.

Prevalence: 100%.

Mean intensity: 14.0 (11–21).

Site of infection: Gill filaments.

Type locality: Jari River, municipality of Vitória do Jari, in Amapá state, Brazil (1°9'4.01"S; 52°0'53.22"W).

Specimens deposited: Holotype MPEG N° 00206 and 8 paratypes MPEG N° 00207–00214.

Etymology: The specific name refers to the locality.

Remarks

The new species resembles *Urocleidoides malabaricus* Rosim, Mendoza-Franco & Luque, 2011 reported from the gills of *Hoplias malabaricus* (Characiformes: Erythrinidae) based on the morphology of the MCO, anchors and bars. Both species possess MCO with one ring, bars with enlarged ends, ventral bar V-shaped, dorsal bar U-shaped, and anchors with well-developed roots. However, *Urocleidoides jariensis* n. sp. differs from *U. malabaricus* in the absence of a muscular pad on the right side of the body that surrounds the copulatory complex as reported in *U. malabaricus*. The new species also differs from *U. malabaricus* by possessing a dextro-ventral vagina (sinistral in *U. malabaricus*).

Urocleidoides ramentacuminatus n. sp. (Figure 2a-j)

Description: Based on 14 specimens; nine mounted in Gomori's trichrome, five mounted in Hoyer's. Body fusiform (Figure 2a), total length excluding haptor 259 (178–323; n = 14) long, 79 (51–130; n = 14) wide at level of gemarium. Tegument smooth or scaled (Figure 2a). Cephalic margin tapered; moderately developed terminal lobes; three bilateral pairs of head organs with rod-shaped secretion; cephalic glands unicellular, posterolateral to pharynx (observed only in paratypes). Four eyes (two pairs), posterior pair larger than anterior pair; accessory chromatic granules present in cephalic area, elliptical (Figure 2a). Mouth subterminal, midventral; pharynx 14 (10–17; n = 8) long, 15 (17–18; n = 8) wide, muscular, glandular; esophagus short. Two intestinal caeca, posteriorly confluent to gonads, lacking diverticula. Genital pore opening midventral; genital atrium muscular. Testis, seminal vesicle, vas deferens, prostatic reservoir not observed. Copulatory complex comprising MCO and accessory piece (Figure 2b); MCO sclerotized, one counterclockwise coil, 56 (40–73; n = 7) long, sclerotized expansion at the base of MCO, flange-like; proximal portion of MCO slightly expanded, distal aperture acute (Figure 2b). Accessory piece sclerotized, non-articulated with the MCO, distal portion hook shaped. Germarium fusiform 43 (27–61; n = 5) long, 17 (12–25; n = 5) wide. Mehlis glands, ootype and seminal receptacle not observed. Vagina single (Figure 2c), heavily sclerotized; vaginal aperture dextro-ventral, marginal; vagina comprising vaginal vestibule, bulb-shaped with short vaginal canal. Vaginal sclerite (Figure 2d) 28 (20–42; n = 10) long, robust, with proximal portion curved, distally straight, acute, thumb rounded. Vitellaria dense throughout trunk, except in region of reproductive organs. Eggs not observed. Peduncle short; haptor hexagonal, 49 (35–75; n = 14) long, 63 (32–104; n = 14) wide. Anchors dissimilar. Ventral anchor (Figure 2i), outer 24 (21–27; n = 7) long, inner 24 (19–30; n = 7) long, base 9 (n = 7) well-developed superficial root, short deep root; evenly curved shaft and point; point acute, extending just past level of tip of superficial root. Dorsal anchor (Figure 2j) outer 20 (17–25; n = 7) long, inner 24 (20–28; n = 7) long, base 9 (8–9; n = 7) wide, subtriangular superficial root, short deep root; straight shaft, short; anchor point presents ornamentation as sclerotized shredded filaments, extending just past level of tip of superficial root. Ventral bar (Figure 2e) 34 (24–40; n = 13) long, rod-shape. Dorsal bar (Figure 2f) 29 (21–45; n = 12) long, narrow, U-shaped, with small terminal enlargement ends, slightly curved in posterior direction. Hooks pairs 2–4, 6–7, 24 (10–43; n = 10) long (Figure 2g), similar in shape, shank elongated with inflation; erected thumb, lightly curved shaft, delicate curved point; filamentous hook (FH) not observed; hooks pairs 1 and 5 smaller than other hooks with inflation comprising approximately 1/2 of the total shank length, pair 1, 14 (10–17; n = 10) long (Figure 2h); pair 5, 13 (10–18; n = 10) long (Figure 2h).

Type host: *Schizodon fasciatus* Spix & Agassiz, 1829.

Prevalence: 100%.

Mean intensity: 7.0 (5–17).

Site of infection: Gill filaments.

Type locality: Jari River, municipality of Vitória do Jari, Amapá state, Brazil (1°9'4.01"S; 52°0'53.22"W).

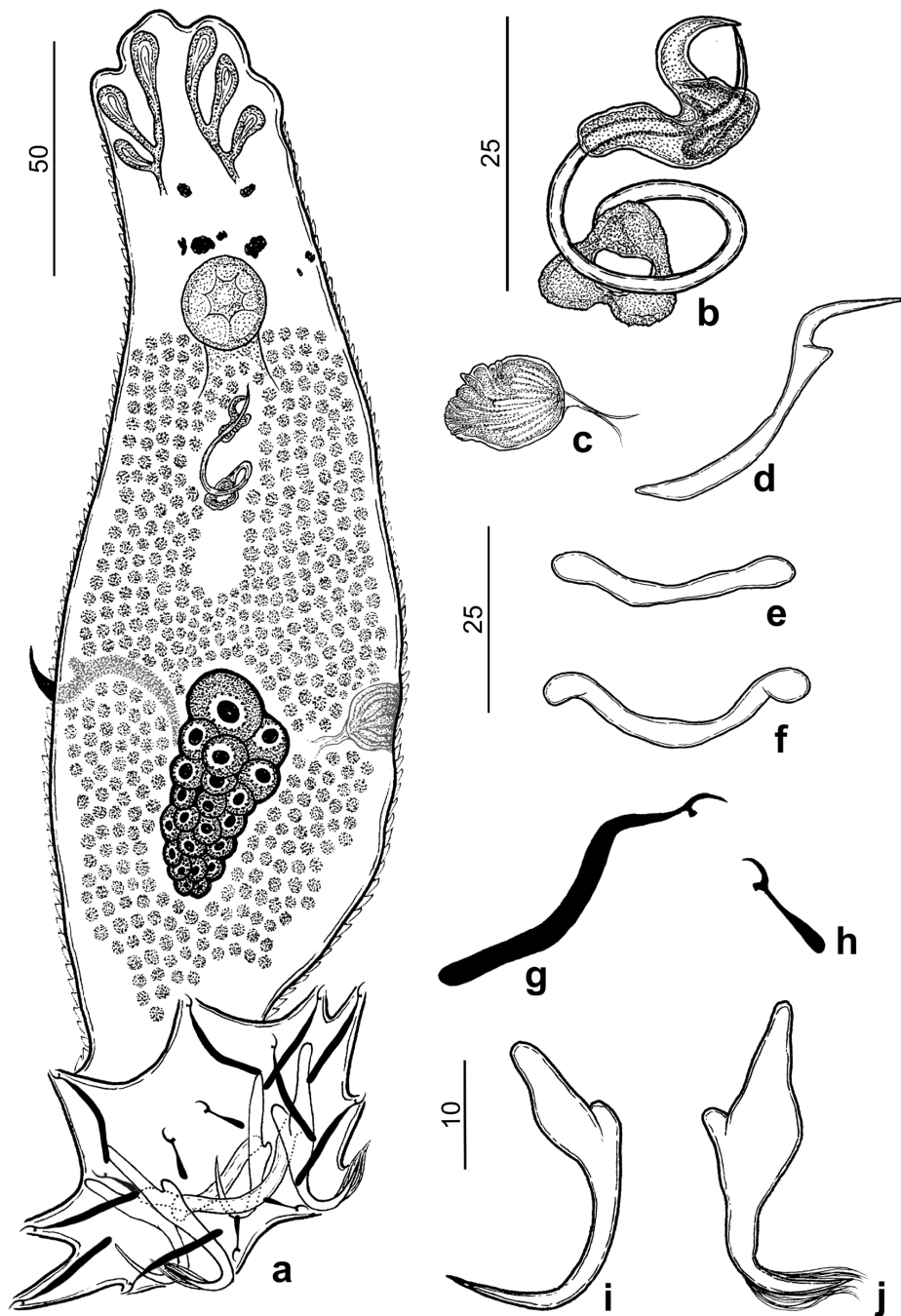


Figure 2. *Urocleidoides ramentacuminatus* n. sp. (a) Holotype, whole-mount (dorsal view). (b) Male copulatory organ. (c) Vagina. (d) Vaginal sclerite. (e) Ventral bar. (f) Dorsal bar. (g) Hooks (pair 2, 3, 4, 6 and 7). (h) Hooks (pair 1 and 5). (i) Ventral anchor. (j) Dorsal anchor.

Other records: *Laemolyta proxima* Garman, 1890.

Locality: Jari River, municipality of Vitória do Jari, Amapá state, Brazil (1°9'4.01"S; 52°0'53.22"W).

Prevalence: 66.6%.

Mean intensity: 2.0 (1–4).

Specimens deposited: Holotype MPEG N° 002015; 6 paratypes MPEG N° 00216–00221 and 7 vouchers MPEG N° 00222–00228.

Etymology: The specific epithet derives from the Latin (*rament* = shreds + *acumin* = point) and refers to the dorsal anchor morphology with ornamentation as sclerotized shredded filaments.

Remarks

Urocleidoides ramentacuminatus sp. n. is similar to *Urocleidoides carapus* Mizelle, Kritsky & Crane, 1968 from *Gymnotus carapo* (Gymnotidae: Gymnotiformes) and *Urocleidoides cultellus* Mendoza-Franco & Reina, 2008 from *Brachyhypopomus occidentalis* (Gymnotiformes: Hypopomidae) due to the morphology of the dorsal anchor. However, *U. ramentacuminatus* sp. n. can be easily distinguished from both species by possessing a robust vaginal sclerite (absent in *U. carapus*; grooved rod distally hooked in *U. cultellus*); a dextro-ventral vagina (vagina sinistral or sinistral-ventral in *U. carapus*; midventral, long and coiled in *U. cultellus*), and MCO with one counterclockwise ring (more than one ring in *U. carapus* and *U. cultellus*).

Urocleidoides paradoxus Kritsky, Thatcher & Boeger, 1986 (Figure 3a-i)

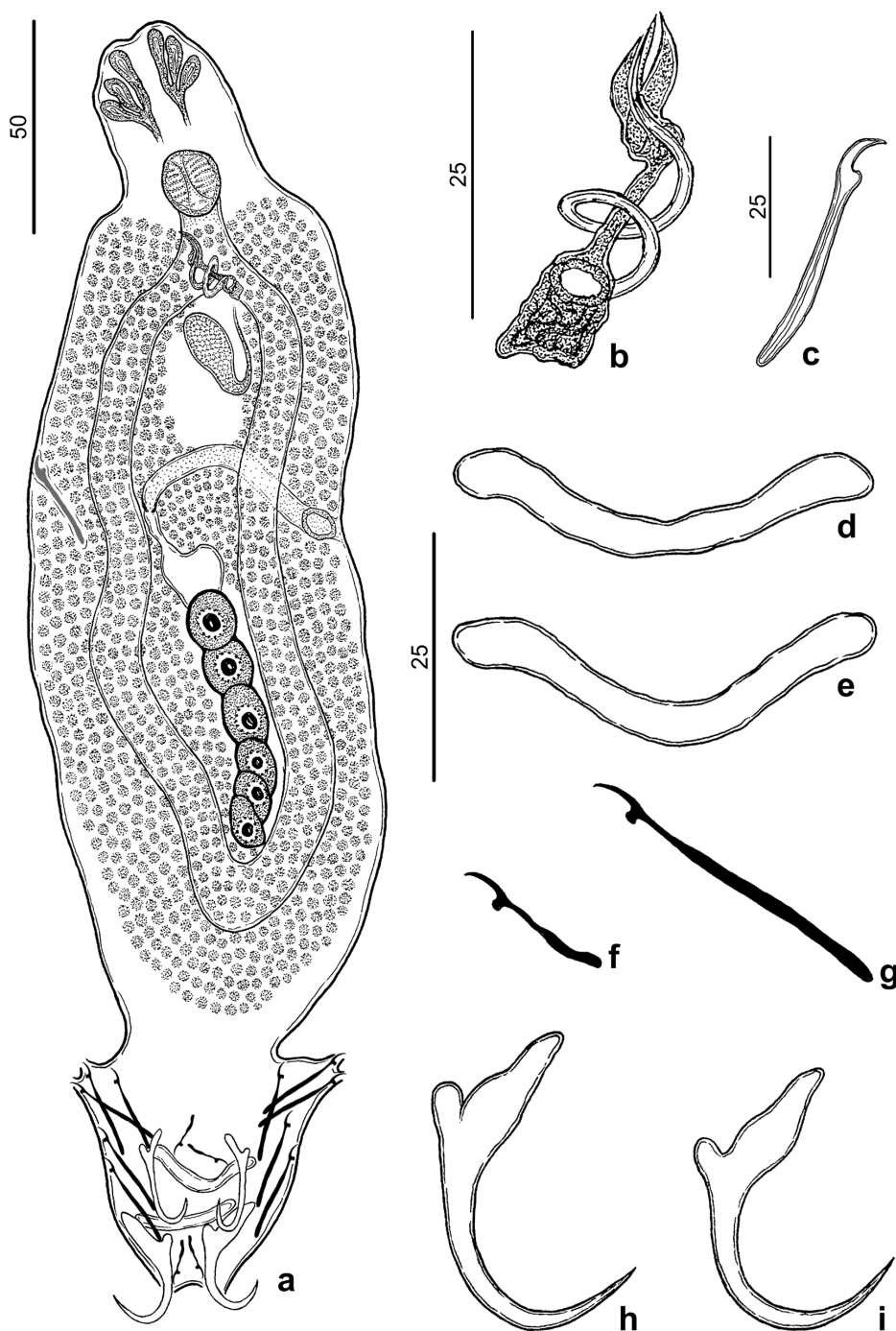


Figure 3. *Urocleidoides paradoxus* Kritsky, Thatcher & Boeger, 1986. (a) Whole mount. (b) Male copulatory organ. (c) Vaginal sclerite. (d) Ventral bar. (e) Dorsal bar. (f) Hook pair 1 and 5. (g) Hooks (pairs 2, 3, 4, 6 and 7). (h) Ventral anchor. (i) Dorsal anchor.

Urocleidoides paradoxus Kritsky, Thatcher & Boeger (1986): 5–8, Figure 10–18 (descr); Cohen et al. (2013): 67, 120–121, Figure 343 (citat).

Type host: *Rhytidodus microlepis* Kner 1858.

Site of infection: Gill filaments.

Type locality: Solimões River near Ilha Marchantaria, municipality of Manaus, Amazonas state, Brazil.

Other records: *Leporinus elongatus* (Takemoto et al., 2009), *Leporinus lacustris* (Guidelli et al., 2006; Takemoto et al., 2009); *Leporinus obtusidens* (Takemoto et al., 2009), *Rhytidodus microlepis* (Kritsky et al., 1986), *Leporinus friderici* (Guidelli et al., 2006; Oliveira et al., 2017), *Leporinus macrocephalus* (Martins et al., 2017) and *Schizodon fasciatus* (present study).

Prevalence: 100%.

Mean intensity: 10.5 (10–24).

Specimens deposited: 9 vouchers MPEG N° 00229–00237.

Comparative measurements: These are shown in Table 2.

Table 2. Comparative measurements between specimens of *Urocleidoides paradoxus*.

	<i>Urocleidoides paradoxus</i> Solimões River (type locality)	N	<i>Urocleidoides paradoxus</i> Jari River (present study)	N
Body				
Length	230 (166–291)	7	353 (295–463)	20
Width	139 (86–191)	7	83 (67–94)	20
Pharynx				
Length	15 (12–19)	7	19 (17–21)	20
Width	15 (12–20)	7	-	
Haptor				
Length	47 (37–55)	7	59 (53–67)	20
Width	101 (76–134)	7	75 (66–83)	20
Ventral anchor				
Outer	21 (18–25)	7	-	
Inner	22 (920–29)	7	-	
Base	15 (13–16)	7	-	
Dorsal anchor				
Outer	25 (24–26)	7	-	
Inner	25 (22–25)	7	-	
Base	16 (16–18)	7	-	
Ventral bar				
Length	37 (28–40)	7	39 (37–40)	20
Width	4 (4–4)	7	-	
Dorsal bar				
Length	37 (28–42)	7	37 (35–40)	20
Width	4 (4–4)	7	-	

N: Number of samples.

Table 2. Continued...

	<i>Urocleidoides paradoxus</i> Solimões River (type locality)	N	<i>Urocleidoides paradoxus</i> Jari River (present study)	N
Hook pair 1	15 (13–16)	7	(21–22)	20
Hook pair 2, 3, 4, 6, 7	31 (25–40)	7	27 (25–30)	20
Hook pair 5	23 (19–28)	7	(18–19)	20
Germarium				
Length	68 (60–72)	7	-	
Width	15 (14–18)	7	-	
MCO	43 (34–60)		77	20
Vaginal sclerite length	34 (30–37)	7	31 (28–32)	20

N: Number of samples.

Remarks

The specimens available are conspecific with *U. paradoxus*, mainly due to sharing the morphology of the anchors, bars, hooks, copulatory complex, vagina dextral and vaginal sclerite. The specimens studied here differ morphometrically in some measurements from specimens from the type locality (Table 2).

Discussion

Species of monogenoids belonging to *Urocleidoides* Mizelle & Price, 1964, *Jainus* Kritsky & Crane, 1968; *Tereancistrum* Kritsky, Thatcher & Kayton, 1980; *Trinibaculum* Kritsky, Thatcher & Kayton, 1980; *Rhinoxenus* Kritsky, Boeger & Thatcher, 1988; *Scleroductus* Jara & Cone, 1989 and *Kritskyia* Kohn, 1990 have been reported parasitizing Anostomidae species (Table 1). However, none of these taxa seems to be restrict to anostomid fish. Except by species of *Jainus*, *Tereancistrum*, *Trinibaculum* and *Rhinoxenus* that are restrict to characiform hosts, the other genera are reported from at least two different Neotropical fish order. Species of *Kritskyia* and *Scleroductus* are parasites of ureters and body surface, respectively, from characiform and siluriform hosts, whereas members of *Urocleidoides* can be found parasitizing the gills of species of 13 families from 4 different host fish orders (i.e., Characiformes, Cyprinodontiformes, Gymnotiformes and Siluriformes). In the present study, *U. paradoxus* is reported for the first time on the *S. fasciatus* gills, which has two new species of *Urocleidoides* described herein.

Urocleidoides Mizelle & Price, 1964 was proposed to accommodate *Urocleidoides reticulatus* Mizelle & Price, 1964 from *Poecilia reticulata* Peters, 1859. Twenty-six species of *Urocleidoides* are currently known parasitizing Characiformes (Erythrinidae, Lebiasinidae, Anostomidae, Crenuchidae, Ctenolucidae, Parodontidae and Curimatidae), Cyprinodontiformes (Poeciliidae, Profundulidae) and Gymnotiformes (Hypopomidae) from North, South and Central America (see Table 3). *Urocleidoides sensu* Kritsky et al. (1986) is distinguished from other dactylogyrid species by a combination of characters, including the morphology of MCO with counterclockwise rings, the presence of a sinistral vaginal sclerite, unmodified anchors, according to Kritsky et al. (1986), and hook pair 1 and 5 usually reduced with enlarged shanks. In this study, *Urocleidoides jariensis* n. sp. and *Urocleidoides ramentacuminatus* n. sp. present all these morphological characters for the diagnosis of *Urocleidoides sensu stricto*.

Some species of *Urocleidoides* have been described and posteriorly relocated to other genera: *Demidospermus lebedevi* (Kritsky & Thatcher, 1976); *Diaphorocleidus affinis* (Mizelle, Kritsky & Crane, 1968); *Diaphorocleidus kabatai* (Molnar, Hanek & Fernando, 1974); *Diaphorocleidus microstomus* (Mizelle, Kritsky & Crane, 1968); *Philocorydoras corydori* (Molnar, Hanek & Fernando, 1974); *Philocorydoris margolisi* (Molnar, Hanek & Fernando, 1974); *Palombitrema heteroancistrum* (Price & Bussing, 1968); *Characithecium costaricensis* (Price & Bussing, 1967) and *Nanayella megorchis* (Mizelle & Kritsky, 1969) (Price & Bussing, 1968; Kritsky et al., 2000; Jogunoori et al., 2004; Mendoza-Franco et al., 2009; Yamada et al., 2015; Acosta et al., 2019), due to the absence of morphological characters (i.e., presence of vaginal sclerite, MCO rolled counterclockwise, hook pair 1 and 5 reduced) that define this genus.

Urocleidoides paradoxus was described in *Rhytiodus microlepis* Kner, 1858 from the Solimões River, in Amazonas State, Brazil. This unique species of genus with a vagina that present dextral opening, and this characteristic

Table 3. List of species of *Urocleidoides sensu stricto*.

Parasite species	Host species	Infection site	Locality	Reference
<i>Urocleidoides advenai</i>	<i>Brachyhypopomus occidentalis</i>	Gill filaments	Aguas Claras River (Panamá)	Mendoza-Franco & Reina (2008)
<i>Urocleidoides aimarai</i>	<i>Hoplias aimara</i>	Gill filaments	Xingú River, Altamira, Pará state (Brazil)	Moreira et al. (2015)
<i>Urocleidoides anops</i>	<i>Characidium caucanum</i>	Gill filaments	Pance River, Cáli (Colombia)	Kritsky & Thatcher (1974)
<i>Urocleidoides brasiliensis</i>	<i>Hoplias malabaricus</i>	Gill filaments	Cuibá River (Brazil)	Rosim et al. (2011)
<i>Urocleidoides bulbophallus</i>	<i>Hoplias malabaricus</i>	Gill filaments	Caeté River, Bragança, Pará state (Brazil)	Ferreira et al. (2017)
<i>Urocleidoides cuiabai</i>	<i>Hoplias malabaricus</i>	Gill filaments	Cuibá River (Brazil)	Rosim et al. (2011)
<i>Urocleidoides cultellus</i>	<i>Brachyhypopomus occidentalis</i>	Gill filaments	Aguas Claras River (Panamá)	Mendoza-Franco & Reina (2008)
<i>Urocleidoides curimatae</i>	<i>Steindachnerina argentea</i>	Gill filaments	Arouca River, D'Abadie (Trinidad and Tobago)	Molnar et al. (1974)
<i>Urocleidoides eremitus</i>	<i>Hoplias malabaricus</i>	Gill filaments	Janauaca Lake, Manaus, Amazonas state (Brazil)	Kritsky et al. (1986)
<i>Urocleidoides flegomai</i>	<i>Piabucina panamensis</i>	Gill filaments	Frijolito River (Panamá)	Mendoza-Franco et al. (2007)
<i>Urocleidoides hypopomi</i>	<i>Brachyhypopomus brevirostris</i>	Gill filaments	Paraná River (Argentina)	Suriano (1997)
<i>Urocleidoides malabaricus</i>	<i>Hoplias malabaricus</i>	Gill filaments	Cuibá River (Brazil)	Rosim et al. (2011)
<i>Urocleidoides naris</i>	<i>Hoplias malabaricus</i>	Nostrils	Cuibá River (Brazil)	Rosim et al. (2011)
<i>Urocleidoides neotropicalis</i>	<i>Saccodon dariensis</i>	Gill filaments	Piriatí River (Panamá)	Mendoza-Franco & Reina (2008)
<i>Urocleidoides paradoxus</i>	<i>Rhytiodus microlepis</i>	Gill filaments	Amazon River, Amazonas state (Brazil)	Kritsky et al. (1986)
<i>Urocleidoides paranae</i>	<i>Hoplias malabaricus</i>	Gill filaments	Paraná River, Mato Grosso do Sul state (Brazil)	Ferreira et al. (2017)
<i>Urocleidoides piriatiu</i>	<i>Ctenolucius beani</i>	Gill filaments	Piriatí River (Panamá)	Mendoza-Franco & Reina (2008)
<i>Urocleidoides reticulatus</i>	<i>Poecilia reticulata</i>	Gill filaments	Aquarium, Sacramento (California, USA)	Mizelle & Price (1964)
	Actinopterygii	Gill filaments	México	
<i>Urocleidoides similuncus</i>	<i>Poecilia gillii</i>	Gill filaments	Frijolito River (Panamá)	Mendoza-Franco et al. (2007)
<i>Urocleidoides simonae</i>	<i>Profundulus punctatus</i>	Gill filaments	Nandalumi River, Chiapas (Mexico)	Mendoza-Franco et al. (2015)
<i>Urocleidoides surianoae</i>	<i>Cyphocharax voga</i>	Gill filaments	Lake Chascomús, Buenos Aires (Argentina)	Rosin & Timi (2016)
<i>Urocleidoides triangulus</i>	<i>Cyphocharax voga</i>	Gill filaments	Lake Chascomús, Buenos Aires (Argentina)	Rosin & Timi (2016)
<i>Urocleidoides vaginoclaustroides</i>	<i>Pseudoxiphophorus bimaculatus</i>	Gill filaments	Danta River, Chiapas (Mexico)	Mendoza-Franco et al. (2015)

Table 3. Continued...

Parasite species	Host species	Infection site	Locality	Reference
<i>Urocleidoides vaginoclastrum</i>	<i>Xiphophorus hellerii</i>	Gill filaments	Hyderabad and Secunderabad (India)	Jogunoori et al. (2004)
<i>Urocleidoides visiofortatus</i>	<i>Brachyhyppopomus occidentalis</i>	Gill filaments	Aguas Claras River (Panamá)	Mendoza-Franco & Reina (2008)
<i>Urocleidoides xinguensis</i>	<i>Hoplias aimara</i>	Gill filaments	Xingú River, Altamira, Pará state (Brazil)	Moreira et al. (2015)
<i>Urocleidoides jariensis</i> n. sp.	<i>Schizodon fasciatus</i>	Gill filaments	Jari River, Amapá state (Brazil)	Present study
<i>Urocleidoides ramentacuminatus</i> n. sp.	<i>Schizodon fasciatus</i> and <i>Laemolyta proxima</i>	Gill filaments	Jari River, Amapá state (Brazil)	Present study

was added for diagnose of this genus (see Kritsky et al., 1986). *Urocleidoides jariensis* n. sp. and *Urocleidoides ramentacuminatus* n. sp. resemble *U. paradoxus* because both species share the presence of the vaginal dextral opening, a characteristic present only in the species of *Urocleidoides* reported to members of Anostomidae family. Studies suggest that most monogenoids species are restricted to their hosts at highest taxonomic levels (i.e., family or order), probably due to broad historical restrictions (e.g., immunological, morphological and/or evolution), which acts at a large scale (Boeger & Kritsky, 1997; Desdevises et al., 2002).

The present study increased the species number of *Urocleidoides sensu stricto* to 27, as well as that of monogenoids in Amazonian fish, thus contributing to knowledge of the diversity of these parasites in this important Neotropical region, which includes a great, yet underestimated diversity of monogenoids. However, *Urocleidoides* is one of the most specious and taxonomically problematic genera among Neotropical dactylogyrids. It is possible that, in the future, the taxonomic position of *incertae sedis* species are clarified with the aid of molecular studies together with morphological analyses of holotypes and paratypes.

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