

New and Previously Described Species of *Urocleidoides* (Monogenoidea: Dactylogyridae) Infecting the Gills and Nasal Cavities of *Hoplias malabaricus* (Characiformes: Erythrinidae) From Brazil

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NEW AND PREVIOUSLY DESCRIBED SPECIES OF *UROCLEIDOIDES* (MONOGENOIDEA: DACTYLOGYRIDAE) INFECTING THE GILLS AND NASAL CAVITIES OF *HOPLIAS MALABARICUS* (CHARACIFORMES: ERYTHRINIDAE) FROM BRAZIL

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ABSTRACT: During an investigation of the biodiversity and structure of parasite communities among native populations of the erythrinid fish *Hoplias malabaricus* (Characiformes) from 7 rivers in Brazil, the following monogenoidean (Dactylogyridae) species were found: *Urocleidoides malabaricus* n. sp., *Urocleidoides naris* n. sp., *Urocleidoides cuiabai* n. sp., *Urocleidoides brasiliensis* n. sp., and *Urocleidoides eremitus* Kritsky, Thatcher, and Boeger, 1986. Specimens considered as a new genus of Dactylogyridae were also found. The new species are mainly distinguished from the other 14 species of *Urocleidoides* in the general morphology of their copulatory and anchors/bar complexes. These new species and the new dactylogyrid genus are described, as well as supplemental observations and new illustrations of *U. eremitus* are provided. The present findings expand the known geographical distribution of species of *Urocleidoides* to southeastern and midwestern Brazil. A high speciation of this genus in the tropics is hypothesized, and it is briefly discussed.

Most of the 14 known species of *Urocleidoides* Mizelle and Price 1964 (Monogenoidea: Dactylogyridae) (as amended by Kritsky et al., 1986) have been described so far from the Neotropical (Brazil, Argentina, Trinidad, Colombia, and Panama) freshwater fish species of *Characidium* (Characidae), *Brachyhypopomus* (Hypopomidae), *Ctenolucius* (Ctenoluciidae), *Curimata* (Curimatidae), *Hoplias* (Erythrinidae), *Hypopomus* (Hypopomidae), *Piabucina* (Lebiasinidae), *Poecilia*, *Xiphophorus* (Poeciliidae), *Rhytiodus* (Anostomidae), and *Saccodon* (Parodontidae) (Kritsky et al., 1986; Jogunoori et al., 2004; Mendoza-Franco et al., 2007; Mendoza-Franco and Reina, 2008). Species of *Urocleidoides* have also been described and/or reported from aquarium fishes, usually collected from their native habitats in the Neotropics, e.g., *Urocleidoides reticulatus* Mizelle and Price, 1964, from *Poecilia reticulata* Peters, 1859, and *Urocleidoides vaginoclastrum* Jogunoori, Kritsky, and Venkatanarasaiah, 2004, from its type host, *Xiphophorus hellerii* Heckel, 1848. Both of these latter host species have been introduced into local streams, lakes, or aquariums in Israel, Czech Republic, India, California (U.S.A.), Trinidad, and central Mexico (see Kritsky et al., 1986; Jogunoori et al., 2004; Mendoza-Palmero and Aguilar-Aguilar, 2008). During an ongoing study of the biodiversity and structure of parasite communities among native populations of *Hoplias malabaricus* (Bloch, 1794) (Characiformes) in Brazilian rivers, specimens of 4 new species of *Urocleidoides* were found. In addition, 1 new dactylogyrid species (uncertain generic position) and 1 previously described species, *Urocleidoides eremitus* Kritsky, Thatcher, and Boeger, 1986, were also found. Herein, descriptions of the new species and some supplemental observations of *U. eremitus* are provided.

MATERIALS AND METHODS

In total, 344 specimens of the trahira *H. malabaricus* were collected by using gill nets or baited hooks between rainy and dry seasons from May 2006 to August 2007 in 7 rivers situated in 3 distinct geographic regions of Brazil: Guandu (22°48'N, 43°37'W), Jaguari-Mirim (22°28'N, 43°37'W), and Machado (21°26'N, 45°50'W) from the southeast; Araguaia (13°23'N, 50°39'W), Cristalino (13°22'N, 50°52'W), and Cuiabá (16°58'N, 56°25'W) from the midwest; and Paraná (22°45'N, 53°16'W) between the south and midwestern regions. Collected fish were stored whole at -20 °C until examination. After thawing, gill arches were removed and placed in finger bowls containing 4–5% formalin solution to fix any of the ectoparasites that were present. The area between anterior and posterior nostrils was dissected, after which the nasal cavity was washed with a strong current of water using a syringe. The washings were placed in petri dishes and examined using a dissecting microscope.

Monogenoids found were transferred individually to vials containing 5% formalin for fixation. Subsequently, parasites found from the gills and nasal cavities were isolated and stained with Gomori's trichrome and mounted in Canada balsam for the study of their soft internal structures (Vidal-Martínez et al., 2001). Additional specimens were mounted unstained using Gray and Wess's medium or a mixture of lactic-acid and glycerin-ammonium picrate (GAP; see Mendoza-Franco et al., 2009) to generate measurements and line drawings of sclerotized structures.

Processed worms were remounted in Canada balsam according to Ergens (1969). All other measurements were obtained from unflattened specimens stained with Gomori's trichrome. Drawings were made with the aid of a drawing attachment for an Olympus microscope (Olympus Corporation, Tokyo, Japan) using differential interference contrast microscopy (DIC). Measurements, in micrometers, represent straight-line distances between extreme points of the structures measured (body length includes the haptor).

Type and voucher specimens are deposited in the Helminthological Collection of the Oswaldo Cruz Institute (CHIOC), Rio de Janeiro, Brazil; the Colección Nacional de Helmintos (CNHE), Universidad Nacional Autónoma de México, Mexico City; and the United States National Parasite Collection (USNPC), Beltsville, Maryland, as indicated. For comparative purposes, 4 paratype specimens of *U. eremitus* (USNPC 78764) were also examined. Scientific and common names of hosts are consistent with FishBase (Froese and Pauly, 2010).

RESULTS

With exception of the Araguaia and Cristalino Rivers from midwestern Brazil, specimens of *Hoplias malabaricus* from all other rivers sampled were positive for mixed infections with different monogenoidean species. For example, *H. malabaricus* from Cuiabá was infected with 6 species; in contrast, only 1 monogenoidean species was observed on the same host species

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TABLE I. Occurrence of 5 species (4 new) of *Urocleidoides* (sensu stricto) and 1 at status of Dactylogyridae (Monogenoidea) on *Hoplias malabaricus* (Characiformes, Erythrinidae) from 7 rivers located in Brazil.

	Localities and hydrographic and geographic regions						
	Guandu		Jaguari-Mirim		Araguaia	Cristalino	Cuiabá
	Atlântico Sudeste	Paraná	Machado	Paraná	Tocantins-Araguaia		Paraguai (Pantanal)
					Midwestern		
<i>Urocleidoides malabaricus</i>				+			+*
<i>Urocleidoides naris</i>	+	+	+				+*
<i>Urocleidoides cuiabai</i>	+	+			+		+*
<i>Urocleidoides brasiliensis</i>	+			+		+	+*
<i>Urocleidoides eremitus</i>	+	+	+				+
Dactylogyridae gen. sp.		+	+	+			+

* Type locality.

from Araguaia and Cristalino (see Table I). While specimens of 5 species infected the gill lamellae of *H. malabaricus*, specimens of a single species appear to be restricted to the nasal cavities of this host.

DESCRIPTIONS

***Urocleidoides malabaricus* n. sp.**

(Figs. 1, 4–12)

Diagnosis (based on 3 stained specimens): Body 294 (260–352; n = 3) long, fusiform, slender; greatest width 51 (47–58; n = 3), at level of copulatory complex. Cephalic margin rounded; cephalic lobes moderately developed; 3 bilateral pairs of head organs; cephalic glands distinct, posterolateral to pharynx. Eyespots absent; accessory granules scattered in cephalic region. Pharynx spherical, 12 (10–14; n = 3) in diameter; esophagus moderately long. Peduncle slightly elongated; haptor subhexagonal, 58 (55–60; n = 3) wide. Ventral anchor 33 (31–37; n = 4) long, with elongate tapered superficial root, short tapered deep root, evenly curved shaft, elongate point; base (14–15; n = 2) wide. Dorsal anchor 30 (26–35; n = 4) long, with moderately elongate tapered superficial root, poorly differentiated deep root, curved shaft, short point; base (15–17; n = 2) wide. Ventral bar 33 (32–35; n = 3) long, straight or slightly U-shaped with enlarged terminations directed anteriorly. Dorsal bar 24 (22–26; n = 3) long, slightly U-shaped. Hooks similar in shape, each with recurved point, depressed thumb, dilated shank; hook pair 1 reduced in size (pair 5 not measured); filamentous hooklet (FH) loop one-half shank length; hook pair 1, 18 long; hook pairs 2, 3, 4, 6, and 7, 22 (20–25; n = 7) long. Copulatory complex surrounded by a conspicuous pad on the right side of the body midline, at level of anterior trunk (immediately posterior to the esophagus). Male copulatory organ (MCO) a looping or loose coil of about one-half ring, base with sclerotized flaps, 13–15 (n = 2) diameter of the first ring (when present) of the MCO. Accessory piece 13–14 (n = 2) long, comprising delicate sheath enclosing copulatory organ. Vagina sinistral, a delicate and slightly undulated tube, twisted before connecting to medial seminal receptacle anterior to germarium. Gonads slightly overlapping, germarium 24 long, 8 wide; testis dorsal, slightly visible at end of germarium. Seminal vesicle a distal enlargement (expansion) of vas deferens; 1 prostatic reservoir; oviduct, ootype, uterus not observed. Vaginal sclerite 24 (23–27; n = 4) long, composed of a variable grooved rod, distally hooked. Vitellaria scattered throughout trunk, absent in regions of reproductive organs.

Taxonomic summary

Type host: *Hoplias malabaricus* (Bloch, 1794) (Characiformes: Erythrinidae).

Site of infection: Gill lamellae.

Type locality/collection date: Cuiabá (16°58'N, 56°25'W), May 2007.

Another locality/collection date: Paraná (22°45'N, 53°16'W), October 2006 (Table I).

Specimens deposited: Holotype, 2 paratypes, and 2 vouchers in CHIOC 37466 and 37467.

Etymology: *Urocleidoides malabaricus* is named after its host.

Remarks

Although only 3 specimens of this species were found, we definitely consider them to represent a new species of *Urocleidoides* (sensu stricto) because they possess the primary characters, e.g., vaginal sclerite, distinguishing the genus. This species is easily separated from all other species of the genus based on the general morphology of anchors and by the presence of a conspicuous pad surrounding the copulatory complex on the right side of the body midline.

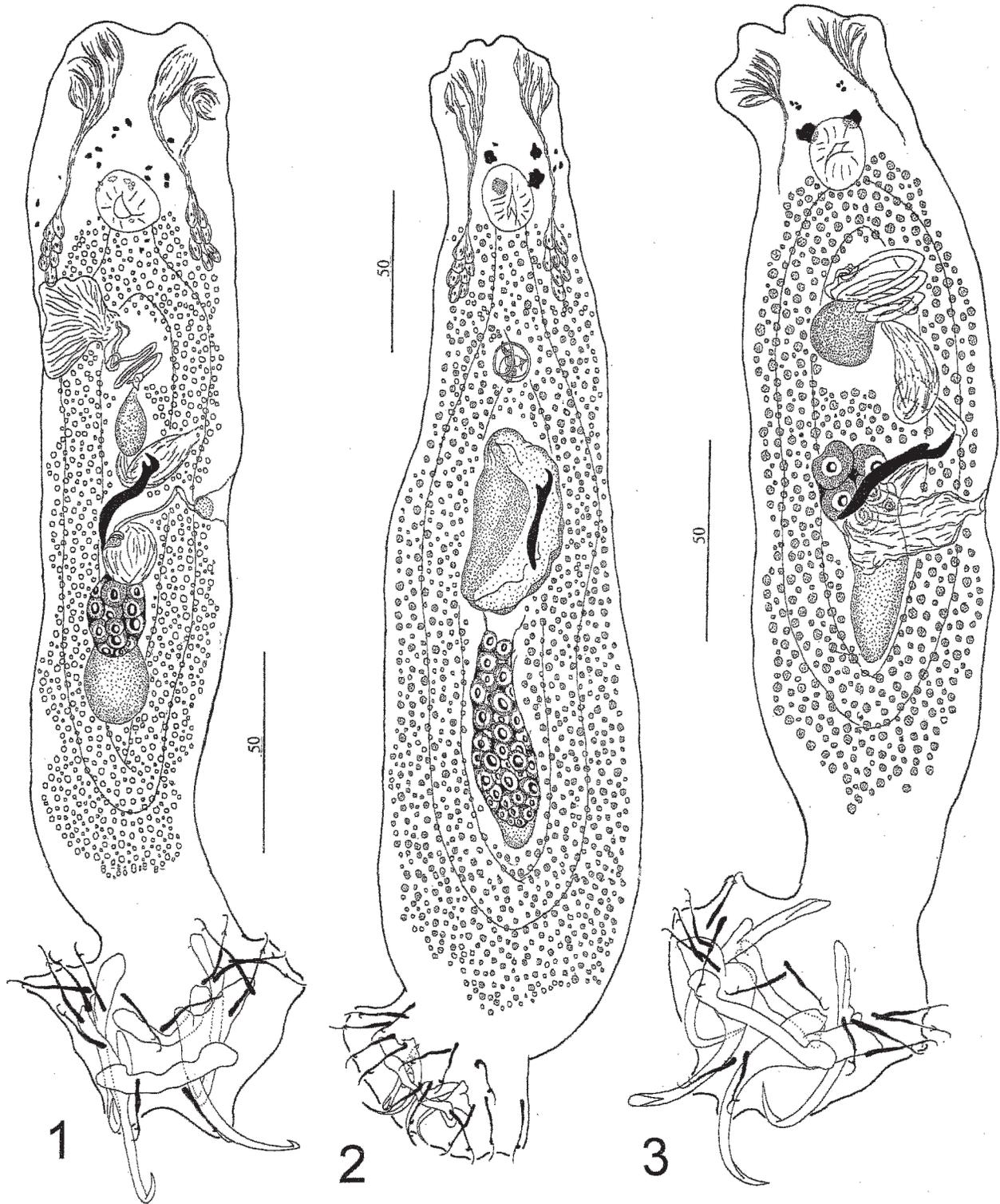
***Urocleidoides naris* n. sp.**

(Figs. 2, 13–20)

Diagnosis (based on 23 stained specimens and on 3 and 9 specimens mounted in Gray and Wess's medium and GAP, respectively): Body 282 (200–450; n = 16) long, fusiform, robust; greatest width 76 (40–105; n = 19), usually at level of gonads. Cephalic margin narrow; cephalic lobes moderately developed; 3 bilateral pairs of head organs; cephalic glands distinct, posterolateral to pharynx. Eyespots 4, subequal; members of posterior pair slightly closer together; accessory eye granules few in cephalic region. Pharynx subovate, 16 (14–19; n = 9) in diameter; esophagus long. Peduncle broad; haptor with semicircular posterior margin, 50 (37–63; n = 17) wide. Ventral anchor 25 (23–29; n = 32) long, with protruding superficial root, short deep root, elongate curved shaft, and point extending past level of superficial anchor root; base 14 (13–15; n = 20) wide. Dorsal anchor 23 (20–26; n = 24) long, with protruding superficial root, short deep root, straight shaft, and elongate point extending past level of superficial anchor root; base 14 (12–16; n = 19) wide. Ventral bar 31 (26–40; n = 20) long, with expanded ends laterally oriented. Dorsal bar 31 (25–37; n = 6) long, rod-shaped, slightly arced on its medial portion. Hooks similar in shape and size, each 18 (16–21; n = 33) long, with straight shaft and point, slightly flattened thumb, dilated shank; filamentous hooklet (FH) loop one-third shank length. MCO 26 (17–37; n = 17) long, a coil of about 1–2 rings, base with sclerotized marginal flap, 14 (12–17; n = 10) diameter of the first ring of the MCO. Accessory piece 17 (15–24; n = 15) long, distally bifurcate. Vagina not observed, apparently unsclerotized. Seminal receptacle not observed, apparently covered by egg. Gonads overlapping, germarium 59 (55–63; n = 3) long, 19–20 wide; testis dorsal, 50 long, 14 wide, slightly visible at end of germarium. Seminal vesicle, prostatic reservoir, oviduct, ootype, and uterus not observed. Vaginal sclerite 31 (21–52; n = 24) long, composed of grooved rod distally hooked. Vitellaria scattered throughout trunk, absent in regions of reproductive organs.

Taxonomic summary

Type host: *Hoplias malabaricus* (Bloch, 1794) (Characiformes: Erythrinidae).



FIGURES 1–3. Whole-mount drawings of species of *Urocleidoides* (ventral views). (1) *Urocleidoides malabaricus* n. sp. (2) *Urocleidoides naris* n. sp. (3) *Urocleidoides cuiabai* n. sp.

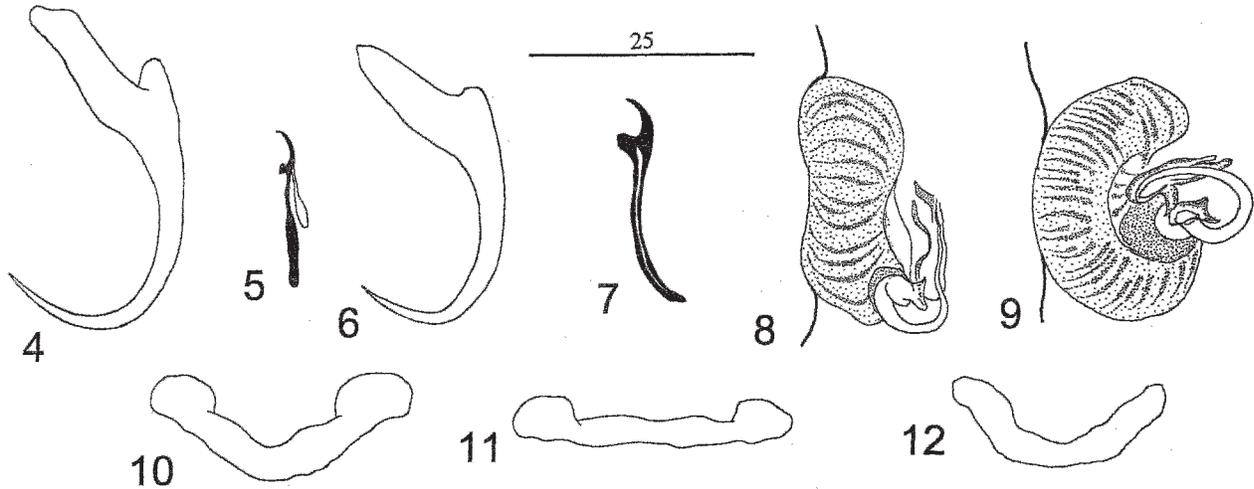
Site of infection: Nasal cavities.

Type locality/collection date: Cuiabá (16°58'N, 56°25'W), May 2007.

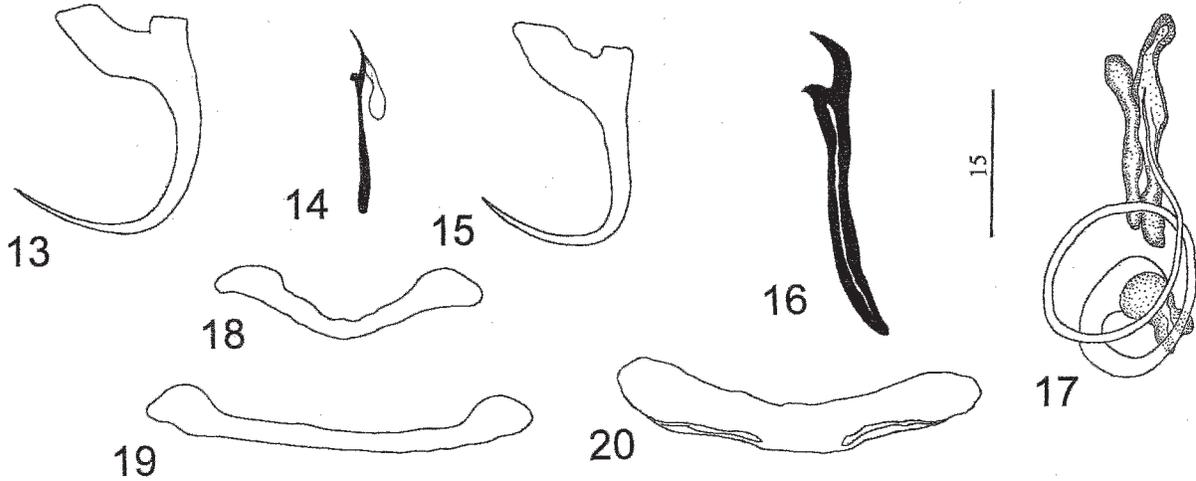
Other localities/collection dates: Guandu (22°48'N, 43°37'W), May 2006 and 2007; Jaguari-Mirim (22°28'N, 43°37'W), May 2007; and Machado (21°26'N, 45°50'W), October 2006 (see Table I).

Specimens deposited: Holotype and 10 paratypes in CHIOC (37468); 12 paratypes CNHE (7668); 12 vouchers specimens USNPC (104431).

Etymology: The specific name is a noun derived from Latin (*naris* = the nostrils, nose) and refers to the site of infection of this monogenoidean species.



Urocleidoides malabaricus n. sp.



Urocleidoides naris n. sp.

FIGURES 4–20. Haptoral and copulatory sclerites of species of *Urocleidoides*. (4–12) *Urocleidoides malabaricus* n. sp. (4) Ventral anchor. (5) Hook. (6) Dorsal anchor. (7) Vaginal sclerite. (8, 9) Copulatory complexes. (10, 11). Ventral bars. (12) Dorsal bar. (13–20) *Urocleidoides naris* n. sp. (13) Ventral bar. (14) Hook. (15) Dorsal anchor. (16) Vaginal sclerite. (17) Copulatory complex. (18, 19). Ventral bars. (20) Dorsal bar. All figures are drawn to the 25-µm scale, except 16 (15 µm).

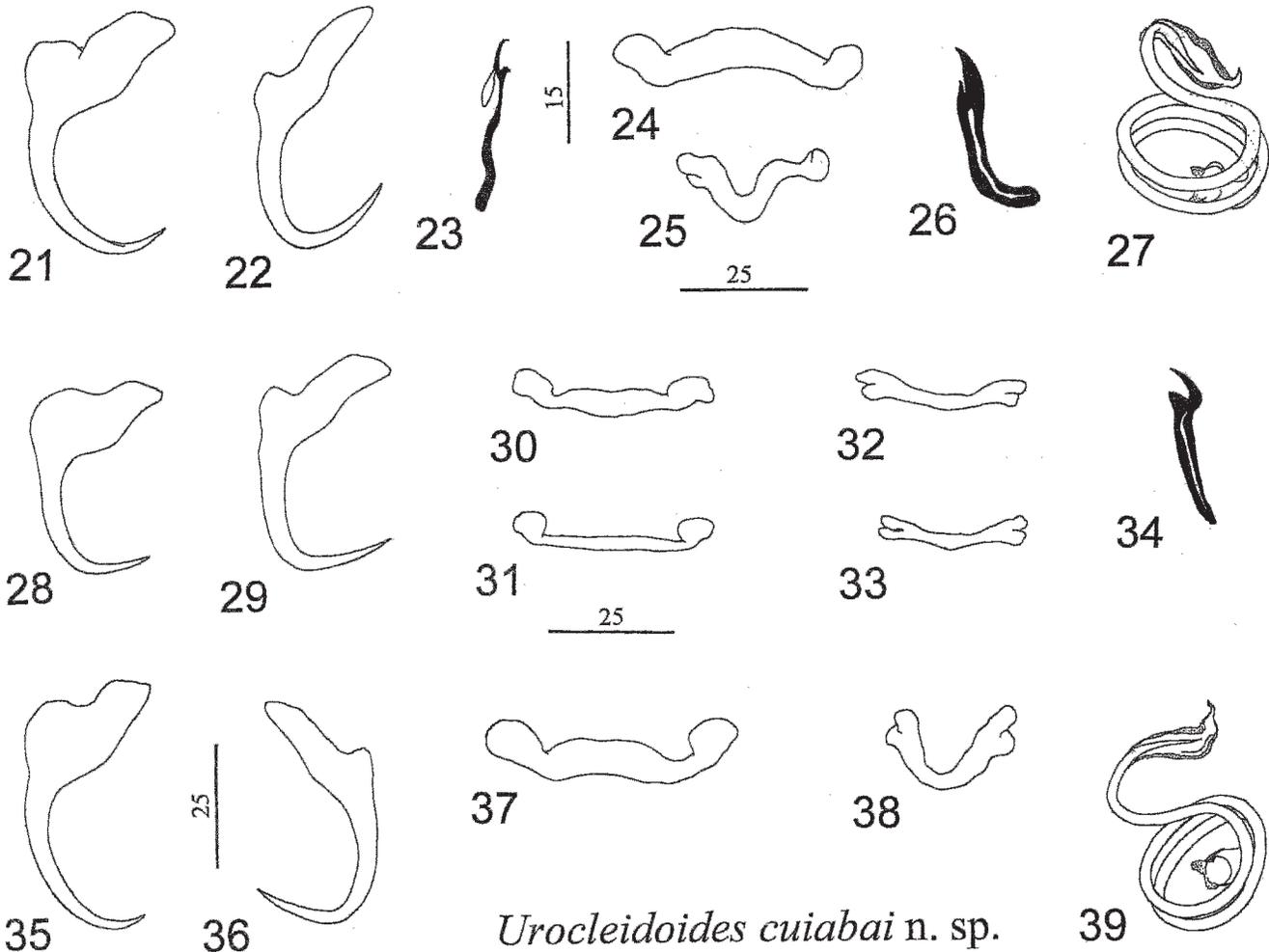
Remarks

Based on morphology of anchors, this species resembles *Urocleidoides flegomai* Mendoza-Franco, Aguirre-Macedo, and Vidal-Martínez, 2007, from *Piabucina panamensis* (Lebiasinidae) in Panama, Central America, and *Urocleidoides vaginoclastrum* Jogunoori, Kritsky, and Venkatanarasaiah, 2004, from an introduced host *Xiphophorus hellerii* Heckel, 1848, in India. These monogenoideans possess anchors with curved shaft and elongate point extending past level of superficial anchor root (see Jogunoori et al., 2004; Mendoza-Franco et al., 2007). It differs from these latter in having a coiled MCO with 1–2 rings (ranging from 4 to 5 rings in *U. flegomai* and *U. vaginoclastrum*) and by the shape (distally hooked vs. slightly hooked distally and “sickle-shaped end” in *U. flegomai* and *U. vaginoclastrum*, respectively) of the vaginal sclerite. This is the only described species of *Urocleidoides* infecting the nasal cavity of its host.

***Urocleidoides cuiabai* n. sp.**
(Figs. 3, 21–34)

Diagnosis (based on 6 stained specimens and on 4 mounted in GAP): Body 304 (180–453; n = 7) long, fusiform, robust; greatest width 61 (53–

76; n = 6), at level of gonads. Cephalic margin broad; cephalic lobes moderately developed; 3 bilateral pairs of head organs; cephalic glands indistinct. Eyespots 2; few accessory granules in anterior position of the eyespots. Pharynx subovate, 15 (12–17; n = 5) in diameter; esophagus absent. Peduncle moderately elongated; haptor subtrapezoidal, 64 (57–70; n = 5) wide. Ventral anchor 46 (40–52; n = 19) long, variable in shape, with poorly differentiated roots, elongate curved shaft, short and open point; base 29 (26–32; n = 4) wide. Dorsal anchor 48 (42–52; n = 21) long, with elongate tapered superficial root, almost inconspicuous deep root, straight shaft, moderately long point; base 30 (26–33; n = 9) wide. Ventral bar 41 (38–48; n = 9) long, straight to slightly arched on its medial portion with prominent extremities directed anteriorly. Dorsal bar 31 (28–35; n = 7) long, straight to U-shaped with bifurcated ends. Hooks similar in shape, each with evenly curved shaft, short point, depressed thumb, dilated shank; hook pairs 1, 5 reduced in size (pair 5 not measured); filamentous hooklet (FH) loop one-quarter shank length; hook pair 1, 18 (17–19; n = 3) long; hook pairs 2, 3, 4, 6, and 7, 24 (22–28; n = 8) long. MCO 42 (33–70; n = 9) long, coil of about 2–3 rings, base with lateral flange, 20 (19–22; n = 3) diameter of the first ring of the MCO. Accessory piece 41 (38–48; n = 9) long, variable, distally hooked. Vagina corrugated bag opening on left side of body margin leading to undifferentiated seminal receptacle on



Urocleidoides cuiabai n. sp.

FIGURES 21–39. Haptor and copulatory sclerites of *Urocleidoides cuiabai* n. sp. (21–34) from Cuiabá. (21) Ventral anchor. (22) Dorsal anchor. (23) Hook. (24) Ventral bar. (25) Dorsal bar. (26) Vaginal sclerite. (27) Copulatory complex. (28) Ventral anchor. (29) Dorsal anchor. (30, 31) Ventral bars. (32, 33) Dorsal bars. (34) Vaginal sclerite. (35–39) Haptor and copulatory complex from Jaguari-Mirim. (35) Ventral anchor. (36) Dorsal anchor. (37) Ventral bar. (38) Dorsal bar. (39) Copulatory complex. All figures are drawn to the 25- μ m scale, except 23 (15 μ m).

midventral position. Gonads overlapping, germarium 20–23 long, 16 wide; testis dorsal, 28 (17–38; n = 3) long, 13–14 wide. Seminal vesicle a distal enlargement (expansion) of vas deferens; 1 prostatic reservoir; oviduct, ootype, and uterus not observed. Vaginal sclerite 45 (34–48; n = 10) long, composed of grooved rod with distal hook at acute or tapered subterminal projection. Vitellaria scattered throughout trunk, absent in regions of reproductive organs.

Taxonomic summary

Type host: *Hoplias malabaricus* (Bloch, 1794) (Characiformes: Erythrinidae).
Site of infection: Gill lamellae.

Type locality/collection date: Cuiabá (16°58'N, 56°25'W), May 2007.

Other localities/collection date: Guandu (22°48'N, 43°37'W), May 2006 and 2007; Jaguari-Mirim (22°28'N, 43°37'W), May 2007; Paraná (22°45'N, 53°16'W), October 2006; and Araguaia (13°23'N, 50°39'W), August 2007 (see Table I).

Specimens deposited: Holotype and 9 paratypes in CHIOC (37469), and CNHE (7669).

Etymology: This species is named for the locality from which it was collected.

Remarks

This species is distinguished from all other congeners of the genus in having a straight to U-shaped dorsal bar with bifurcated ends. The new

species resembles *Urocleidoides piriatu* Mendoza-Franco and Reina, 2008, from *Ctenolucius beani* (Fowler, 1907) (Ctenoluciidae) in Panama, *U. eremitus* from *H. malabaricus* and *Urocleidoides paradoxus* Kritsky, Thatcher, and Boeger, 1986, from *Rhytiodus microlepis* (Kner, 1858) (Anostomidae) from Brazil, and *Urocleidoides hypopomi* Suriano, 1997, from *Brachyhypopomus brevisrostris* (Steindachner, 1868) (Hypopomidae) in Argentina (Kritsky et al., 1986; Suriano, 1997; Mendoza-Franco and Reina, 2008). All these monogenoideans possess a coiled MCO ranging from 2 to 3 rings. *Urocleidoides cuiabai* showed notable morphological variation of its haptor structures, probably as result of the geographical distance of individual localities, i.e., Cuiabá vs. Jaguari-Mirim (see Figs. 21–39, 92).

***Urocleidoides brasiliensis* n. sp.**

(Figs. 40–49)

Diagnosis (based on 6 stained specimens from Cuiabá and on 5 from Cristalino [brackets]): Body 565 (520–618; n = 5) (504 [373–585; n = 3]) long, fusiform; greatest width 79 (66–97; n = 5) (70 [54–102; n = 3]), usually at level of germarium. Cephalic margin broad; cephalic lobes moderately developed; 3 bilateral pairs of head organs; cephalic glands indistinct. Eyespots 2; accessory granules not observed. Pharynx spherical, 20 (17–22; n = 5) (17 [16–18; n = 3]) in diameter; esophagus absent. Peduncle elongate; haptor subhexagonal, 71 (66–75; n = 3) (73 [60–88; n = 3]) wide. Ventral anchor 50 (48–52; n = 6) (55 [54–58; n = 6]) long, with elongate superficial root, rounded deep root, evenly curved shaft, short

point; base 35 (34–37; n = 4) (43 [41–45; n = 3]) wide. Dorsal anchor 37 (36–47; n = 10) (38 [34–41; n = 6]) long, with tapered superficial root, poorly developed deep root, short shaft, moderately long point; base 26 (23–30; n = 4) (28 [25–30; n = 4]) wide. Ventral bar 39 (32–49; n = 4) (45 [36–55; n = 5]) long, variable in size, straight, with dilated ends directed anteriorly. Dorsal bar 37 (32–46; n = 4) (32–45) long, variable in shape, straight to slightly curved ends. Hooks similar in shape, each with straight shaft, short point, depressed thumb, dilated shank; hook pairs 1, 5 reduced in size; filamentous hooklet (FH) loop one-third shank length; hook pair 1, 19 (18–22; n = 4) (23) long; hook pairs 2, 3, 4, 6, and 7, 24 (21–26; n = 9) (24 [23–26; n = 6]) long; hook pair 5, 18 (n = 2). MCO 44 (40–55; n = 6) (43 [35–48; n = 4]) long, coil of about 3 rings, base with lateral flange, 18 (17–19; n = 3) (18–25) diameter of first ring of MCO. Accessory piece 30 (25–33; n = 5) (32 [30–36; n = 4]) long, grooved, distally bent, and rounded. Vagina irregular bag opening on left side of the body margin leading to an undifferentiated seminal receptacle on midventral position. Gonads overlapping, germarium 44–68 (44) long, 23 (n = 2) (44) wide; testis dorsal, 42–72 long, 18 wide. Seminal vesicle a distal enlargement of vas deferens; 1 prostatic reservoir; oviduct, ootype, and uterus not observed. Vaginal sclerite 17 (15–18; n = 5) (16 [16–17; n = 3]) long, composed of grooved rod with distal hook, subterminal short projection. Vitellaria scattered throughout trunk, absent in regions of reproductive organs.

Taxonomic summary

Type host: *Hoplias malabaricus* (Bloch, 1794) (Characiformes: Erythrinidae).

Site of infection: Gill lamellae.

Type locality/collection date: Cuiabá (16°58'N, 56°25'W), May 2007.

Other localities/collection date: Guandu (22°48'N, 43°37'W), May 2006 and 2007; Paraná (22°45'N, 53°16'W), October 2006; and Cristalino (13°22'N, 50°52'W), August 2007 (see Table I).

Specimens deposited: Holotype and 5 paratypes in CHIOC (37470), and 6 vouchers in CNHE (7670-7671).

Etymology: This species is named for the country from which it was collected.

Remarks

This species differs from all other species of the genus in having ventral anchors with an elongate superficial root, a rounded deep root, an evenly curved shaft, and short point. The new species resembles *Urocleidoides visiofortatus* Mendoza-Franco and Reina, 2008, from *Brachyhyppopomus occidentalis* (Regan, 1914) (Hypopomidae) from Panama and *U. cuiabai* (present study) in the general morphology of their haptor structures. For example, all these monogenoideans possess ventral anchors with a prominent superficial root, a distally rounded deep root, and an evenly curved shaft (present in *U. brasiliensis* and *U. visiofortatus*) and vaginal opening consisting of an irregular bag on left side of body midline (present in *U. brasiliensis* and *U. cuiabai*). *Urocleidoides brasiliensis* differs from *U. visiofortatus* and *U. cuiabai* in having 2 eyespots (absent in *U. visiofortatus*), a short point of the ventral anchor (elongate point in *U. visiofortatus*), and by the size of the vaginal sclerite (length 15–18 vs. 20–25 and 34–48 in *U. visiofortatus* and *U. cuiabai*, respectively) and ventral anchors (length 48–52 vs. 37–44 in *U. visiofortatus*) (see Mendoza-Franco and Reina, 2008; present study). Similar to *U. cuiabai*, specimens of this new species showed some morphological differences between Cuiabá and Paraná Rivers (see Figs. 43–53).

EMENDED DESCRIPTION

Urocleidoides eremitus Kritsky, Thatcher, and Boeger, 1986 (Figs. 54–61, 64–65)

Supplemental observations: Measurements from different hosts and localities are provided in Table II.

Taxonomic summary

Host: *Hoplias malabaricus* (Bloch, 1794) (Characiformes: Erythrinidae).

Site of infection: Gill lamellae.

Locality/collection date: Guandu (22°48'N, 43°37'W), May 2006 and 2007.

Other localities/collection date: Jaguari-Mirim (22°28'N, 43°37'W), May 2007; Machado (21°26'N, 45°50'W), October 2006; and Cuiabá (16°58'N, 56°25'W), May 2007 (Table I).

Specimens deposited: 37 voucher specimens CHIOC (37471), CNHE (7672), and USNPC (104432).

Remarks

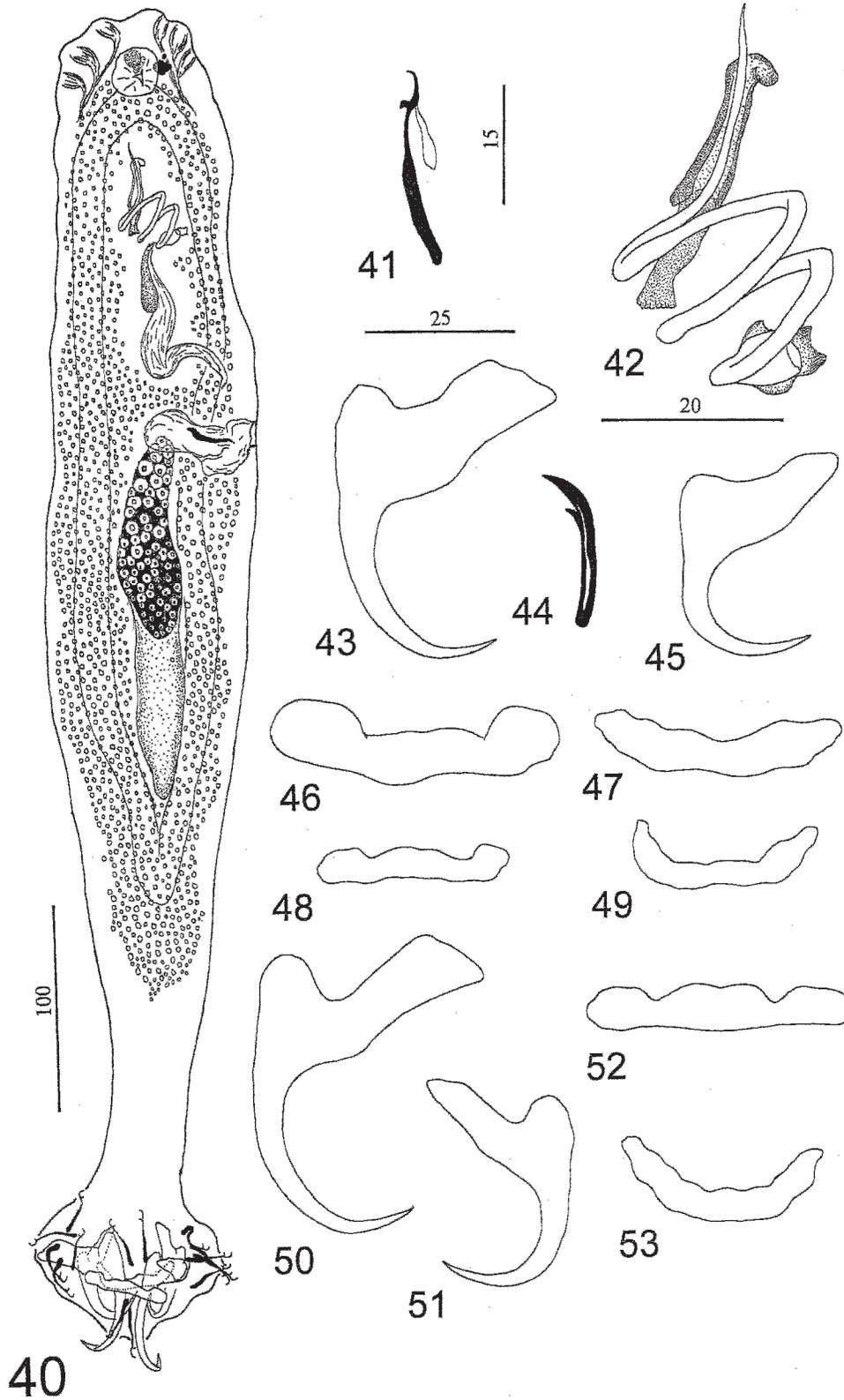
At the beginning of this research, we considered that present specimens would require the description of a new species of *Urocleidoides* because of the presence of a character not previously described in species of this genus, i.e., distal tip of the vaginal sclerite that emerges from a conspicuous pad on the left side of the body midline, at the level of the anterior trunk (see Figs. 54, 55). However, morphometric comparison of all other sclerotized structures, as well as distribution of internal organs of present specimens, and those from the original description of the only other previously described species of this genus, *U. eremitus*, from the same host species, *H. malabaricus* in Brazil (see Kritsky et al., 1986), indicated that new specimens are conspecific with this latter monogenoid. In addition to this character mentioned above, the only metric difference between present specimens and those of *U. eremitus* as originally described is in the length of the MCO, i.e., 17–30 vs. 136. While these 2 latter characters are distinctive in present specimens, the shape and size of all other features, i.e., accessory piece, diameter of the first ring of the MCO, anchors, vaginal sclerite, etc., fit well into the diagnosis of *U. eremitus*. Therefore, in order to avoid synonymies in the future, we consider that these 2 characters are not sufficient to warrant erection of a new species of *Urocleidoides* and so designate the present specimens to be conspecific with *U. eremitus*. Furthermore, based on further examination, present specimens from southeastern and midwestern Brazil do not differ significantly in detail from the type specimens of *U. eremitus* (USNPC 78764) from northern Brazil, i.e., Janaúacá Lake, near Manaus, Amazonas (see map in Fig. 92). Thus, we did not observe a conspicuous pad in the unstained type specimens. Based on all of these features, this latter character, as well as the length of the MCO in present specimens, we would suggest that a semidistinct morph of *U. eremitus* occurs in the southeastern and midwestern areas of Brazil.

In the present study, *U. eremitus* specimens from different localities occur on the same host species, and these noted shape and size differences might be considered intraspecific variation, probably attributable to geographical distance, i.e., northern vs. southeastern and midwestern Brazil. A more plausible explanation for these morphological differences, mainly the presence of a pad of *U. eremitus* from southeastern and midwestern Brazil, compared to those from northern Brazil, requires further study of living specimens to verify this character. To date, *U. eremitus* has been reported from Janaúacá Lake, Brazil (type locality), Madre de Dios River from southeastern Peru, and Chascomús Lake from Buenos Aires, Argentina (Kritsky et al., 1986; Suriano, 1997; Kohn and Cohen, 1998). The Guandu, Jaguari-Mirim, Machado, and Cuiabá Rivers in Brazil (present study) represent new locality records for *U. eremitus*. Interestingly, *U. eremitus* does not occur in the Paraná River (see Table I). This is consistent with earlier parasitological studies conducted on this river for 7 yr of collection (from 2000 to 2007), which also noted the absence of *U. eremitus* in *H. malabaricus* (see Takemoto et al., 2009). Similar to *U. cuiabai* and *U. brasiliensis*, present specimens of *U. eremitus* showed intraspecific variability among Jaguari-Mirim (Figs. 62–63), Machado (Figs. 66–69), and Cuiabá Rivers (Figs. 70–74).

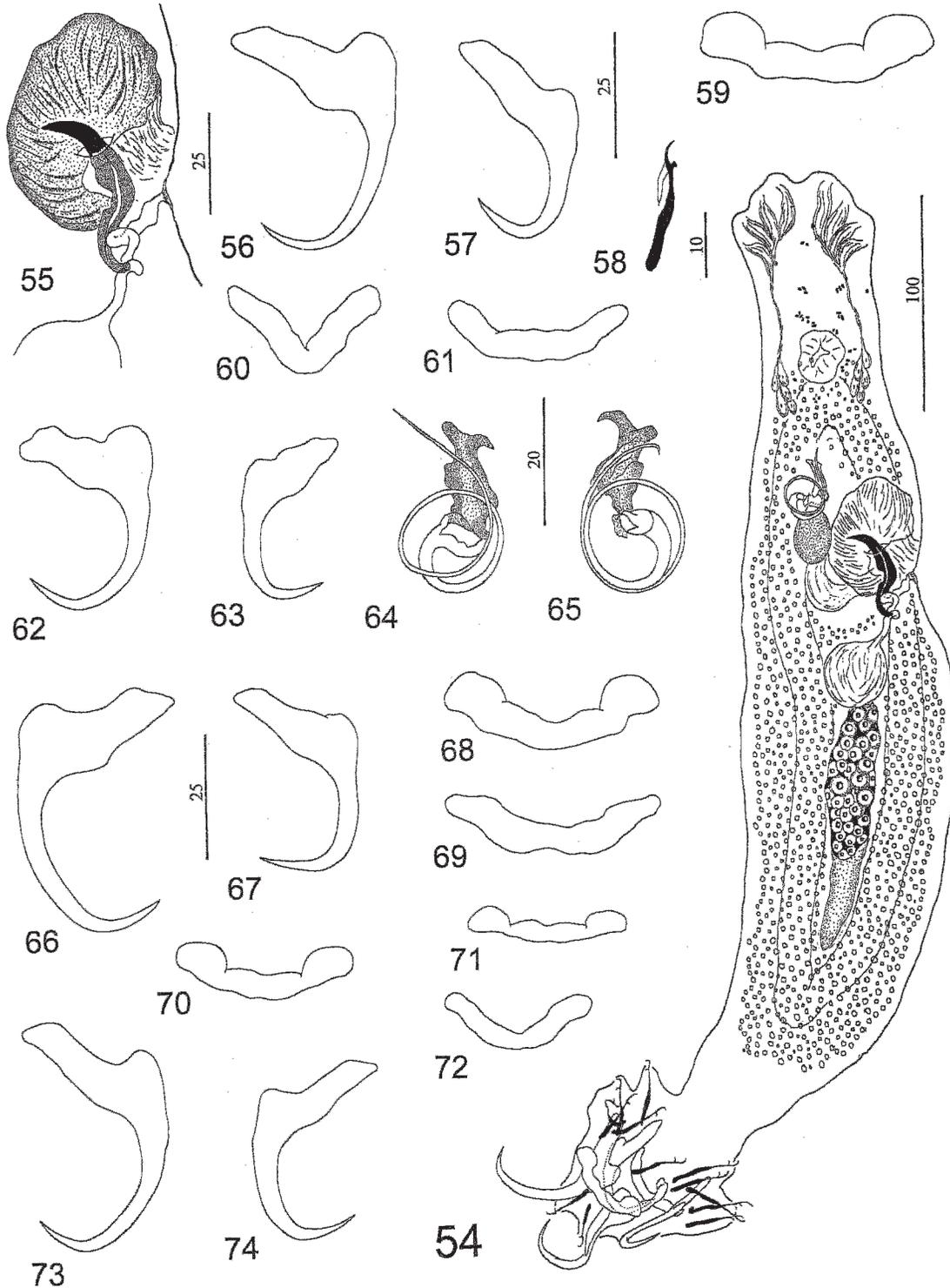
Dactylogyridae gen. sp.

(Figs. 75–82)

Diagnosis (based on 15 stained specimens): Body fusiform, robust; greatest width usually at level of gonads. Cephalic margin narrow; cephalic lobes moderately developed; 3 bilateral pairs of head organs; cephalic glands distinct, posterolateral to pharynx. Eyespots 4; accessory granules not observed. Pharynx spherical; esophagus moderately long. Peduncle elongate; haptor subtrapezoidal. Ventral anchor with tapered superficial root, rounded deep root, evenly bent shaft, and moderately long point. Dorsal anchor with depressed superficial root, expanded deep root, curved shaft and point. Ventral bar variable, rod-shaped to slightly arched on its medial portion with slightly enlarged terminations. Dorsal bar rod-shaped with slightly enlarged ends. Hooks similar in shape, each with recurved point, depressed thumb, dilated shank; hook pair 1 reduced in



FIGURES 40–53. *Urocleidoides brasiliensis* n. sp. (40–49) from Cuiabá. (40) Composite illustration of entire specimen (ventral). (41) Hook. (42) Copulatory complex. (43) Ventral anchor. (44) Vaginal sclerite. (45) Dorsal anchor. (46, 48) Ventral bars. (47, 49) Dorsal bars. (50–53) Anchors and bars from Paraná. (50) Ventral anchor. (51) Dorsal anchor. (52) Ventral bar. (53) Dorsal bar. All figures are drawn to the 25-µm scale, except 40 (100 µm), 41 (15 µm), and 42 (20 µm).



FIGURES 54–74. *Urocleidooides eremitus* (54–61) from Guandu. (54) Composite illustration of entire specimen (ventral). (55) Vaginal sclerite. (56) Ventral anchor. (57) Dorsal anchor. (58) Hook. (59) Ventral bar. (60, 61) Dorsal bars. (62, 63) Anchors from Jaguari-Mirim. (62) Ventral anchor. (63) Dorsal anchor. (64, 65) Copulatory complexes from Guandu. (66–69) Anchors and bars from Machado. (66) Ventral anchor. (67) Dorsal anchor. (68) Ventral bar. (69) Dorsal bar. (70–74) Anchors and bars from Cuiabá. (70, 71) Ventral bars. (72) Dorsal bar. (73) Ventral anchor. (74) Dorsal anchor. All figures are drawn to the 25- μ m scale, except 54 (100 μ m), 55 (30 μ m), 58 (10 μ m), and 64–65 (20 μ m).

TABLE II. Measurements of *Urocleidoides eremitus* Kritsky, Thatcher, and Boeger, 1986 (Dactylogyridae), from the gill lamellae of *Hoplias malabaricus* (Characiformes) from 4 rivers of Brazil.

	Localities			
	Guandu	Jaguari-Mirim	Machado	Cuiabá
Body length	489 (345–590; n = 38)	303 (245–360; n = 3)	563 (262–725; n = 7)	379 (280–520; n = 16)
Greatest width	66 (50–82; n = 36)	45 (38–50; n = 4)	62 (47–75; n = 7)	51 (40–58; n = 14)
Pharynx	18 (15–24; n = 26)	12 (12–13; n = 4)	17 (15–19; n = 7)	15 (11–16; n = 10)
Haptor width	67 (53–87; n = 29)	59 (53–70; n = 4)	68 (n = 2)	61 (50–75; n = 16)
Ventral anchor length	51 (38–58; n = 49)	42 (38–48; n = 11)	49 (43–58; n = 18)	46 (41–53; n = 34)
Base width	32 (27–37; n = 22)	27 (25–30; n = 7)	32 (29–33; n = 7)	30 (27–35; n = 18)
Dorsal anchor length	43 (35–49; n = 50)	34 (31–38; n = 10)	42 (38–46; n = 23)	40 (37–46; n = 38)
Base width	27 (23–31; n = 18)	21 (19–23; n = 4)	26 (23–27; n = 11)	25 (20–27; n = 24)
Ventral bar length	34 (31–36; n = 22)	35 (29–34; n = 5)	35 (30–33; n = 6)	36 (28–49; n = 19)
Dorsal bar length	30 (26–38; n = 26)	29 (25–28; n = 4)	32 (27–44; n = 6)	29 (25–37; n = 13)
Hook pair 1	20 (18–22; n = 15)	17 (15–18; n = 3)	19 (18–20; n = 4)	21 (19–24; n = 6)
Hook pairs 2, 3, 4, 6, 7	25 (23–28; n = 41)	23 (20–24; n = 9)	25 (23–25; n = 15)	24 (20–27; n = 26)
Hook pair 5	18 (17–20; n = 12)	–	19	18 (17–20; n = 13)
MCO length	23 (17–30; n = 30)	26 (22–35; n = 6)	24 (21–29; n = 11)	26 (21–30; n = 16)
First ring of MCO	16 (13–20; n = 34)	19 (16–22; n = 7)	17 (15–19; n = 6)	19 (13–22; n = 12)
Accessory piece	18 (15–20; n = 19)	20–25	20 (14–24; n = 3)	22 (15–28; n = 3)
Germarium length	67 (50–93; n = 20)	28	70–90	–
Germarium width	17 (10–23; n = 13)	–	8	–
Testis length	55 (45–75; n = 5)	–	–	–
Testis width	12 (10–14; n = 5)	–	–	–
Sclerite length	32 (26–41; n = 20)	31 (27–34; n = 4)	25 (21–28; n = 6)	29 (24–35; n = 11)

size (pair 5 not measured); filamentous hooklet (FH) loop one-half shank length. Male copulatory organ a coil of about 1–1.5 rings, base with slightly sclerotized flange. Accessory piece sigmoid, distally hooked. Vagina not observed, apparently unsclerotized. Seminal receptacle, vas deferens, and seminal vesicle not observed. Gonads overlapping, testis dorsal. Prostatic reservoir, oviduct, ootype, and uterus not observed. Vitellaria scattered throughout trunk, absent in regions of reproductive organs. Measurements from different localities are provided in Table III.

Taxonomic summary

Host: *Hoplias malabaricus* (Bloch, 1794) (Characiformes: Erythrinidae).
Site of infection: Gill lamellae.

Locality/collection date: Jaguari-Mirim (22°28'N, 43°37'W), May 2007.

Other localities/collection date: Paraná (22°45'N, 53°16'W), October 2006; Machado (21°26'N; 45°50'W), October 2006; and Cuiabá (16°58'N, 56°25'W), May 2007 (Table I).

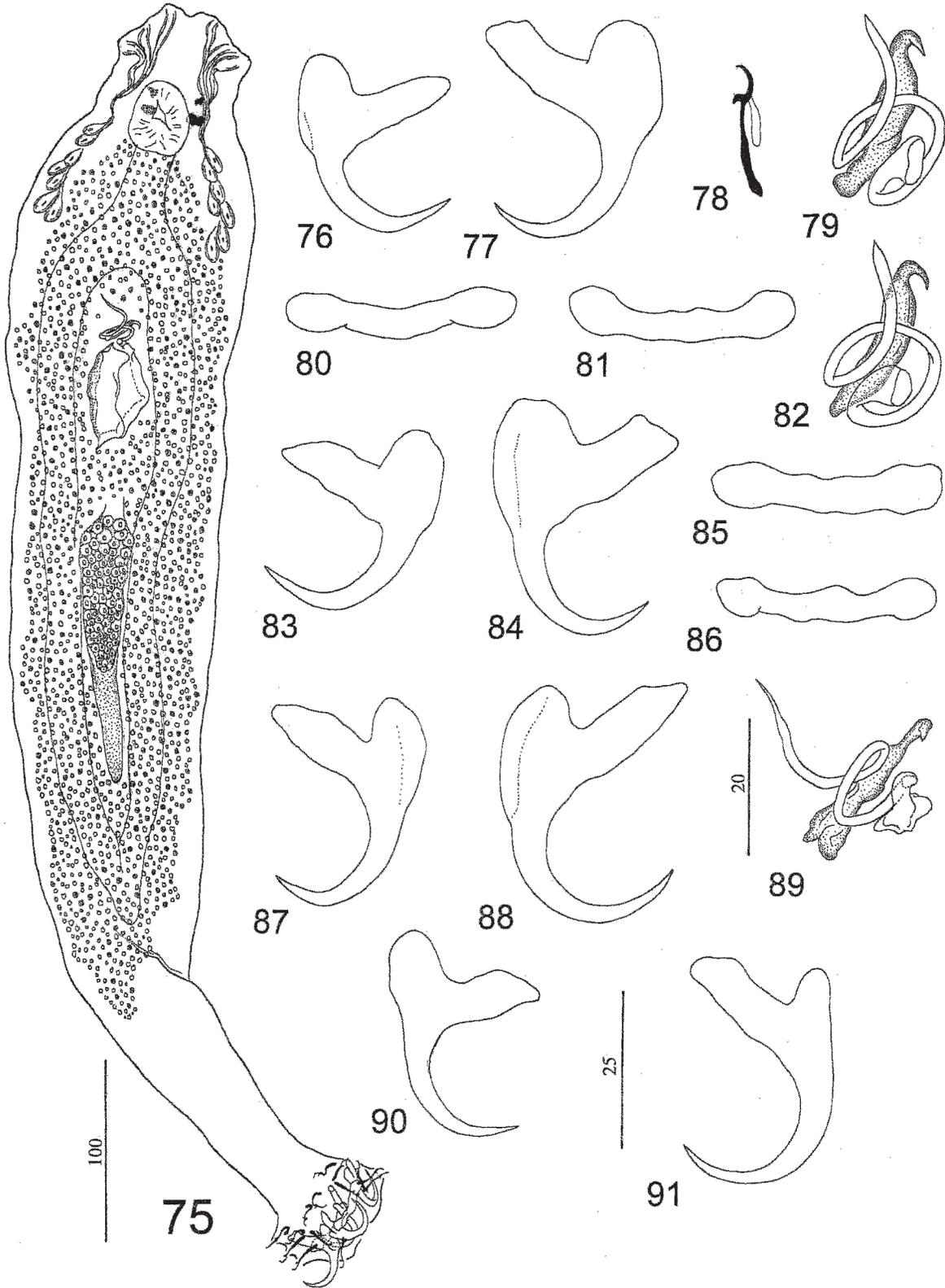
Specimens deposited: 15 reference specimens CHIOC (37472), CNHE (7673), and USNPC (104433).

Remarks

Present specimens exhibit diagnostic features, some of which are also present in other dactylogyrids. However, the suite of features does not fit with the diagnosis of currently known dactylogyrid genera with species infecting Brazilian or tropical freshwater fishes. Our posture here is conservative and denotes the need for a comparative morphology analysis based on new collections of additional forms of this group from new geographical areas and host species to formally establish a new genus of the Dactylogyridae to accommodate present specimens. For example, the 7 rivers sampled for monogenoids in the present study are embedded in 4 (see Table I; Fig. 92) from a total of 12 hydrographic zones in Brazil (Porto and Porto, 2008). Unless new information about monogenoidean specimens from new areas and hosts become available, we consider present specimens from *H. malabaricus* as Dactylogyridae. Similar to the previously described species in this paper, present specimens exhibited some morphologic differences among locations, i.e., differences in the anchors/bars of specimens from Paraná (Figs. 83–86), anchors/copulatory complex from Machado (Figs. 87–89), and anchors from Cuiabá (Figs. 90–91).

DISCUSSION

Prior to the present investigation, *Urocleidoides* consisted of 14 accepted species infecting tropical freshwater fish species from a wide spectrum of 9 host families, i.e., Characidae, Ctenoluciidae, Curimatidae, Erythrinidae, Hypopomidae, Lebiasinidae, Poeciliidae, Anostomidae, and Parodontidae. The species described and/or reported (4 new, 1 known, and 1 at the status of Dactylogyridae) herein expand our knowledge of the monogenoidean fauna on the erythrinid species of *H. malabaricus*. Previous monogenoideans described on this host species are *U. eremitus* (Dactylogyridae) and *Gyrodactylus trairae* Boeger and Popazoglo, 1995 (Gyrodactylidae) from Brazil (see Kritsky et al., 1986; Boeger and Popazoglo, 1995). Based on current available information, diversification of *Urocleidoides* in the tropics could be high because of the opportunity to colonize and speciate on members of a wide number of piscine families. Species of this genus occur on their native hosts (some of them introduced to new areas) from the Chascomús Lake in Argentina (see Suriano, 1997) to northern Mexico, i.e., *Urocleidoides vaginoclastrum* from the tropical native host *Xiphophorus hellerii* (Poeciliidae), which have been introduced into northern Mexico, and *Urocleidoides* sp. from the native *Profundulus* sp. (Profundulidae) (Mendoza-Palmero and Aguilar-Aguilar, 2008). Comparatively, speciation of other tropical (mainly from South America) dactylogyrid genera is currently evident on host species representing a few families. For example, 19 species of *Sciadicleithrum* Kritsky, Thatcher, and Boeger, 1989, 14 species of *Gussevia* Kohn and Paperna, 1964, and 1 species of *Trinidadactylus* Hanek, Molnar, and Fernando, 1974, occur on representatives of the Cichlidae; ~65 species of *Anacanthorus* Mizelle and Price, 1965, occur on members of Characidae and Serrasalminidae; 4 species of *Ameloblastella* Kritsky, Mendoza-Franco, and Scholz, 2000, and 4



FIGURES 75-91. Dactylogyridae gen. sp. (75-82) from Jaguari-Mirim. (75) Composite illustration of entire specimen (ventral). (76) Ventral anchor. (77) Dorsal anchor. (78) Hook. (79) Copulatory complex. (80) Ventral bar. (81) Dorsal bar. (82) Copulatory complex. (83-86) Anchors and bars from Paraná. (83) Ventral anchor. (84) Dorsal anchor. (85) Ventral bar. (86) Dorsal bar. (87-89) Anchors and copulatory complex from Machado. (87) Ventral anchor. (88) Dorsal anchor. (89) Copulatory complex. (90, 91) Anchors from Cuiabá. (90) Ventral anchor. (91) Dorsal anchor. All figures are drawn to the 25- μ m scale, except 75 (100 μ m), 79, 82, and 89 (20 μ m).

TABLE III. Measurements of Dactylogyridae gen. sp. from the gill lamellae of *Hoplias malabaricus* (Characiformes) from 4 rivers of Brazil.

	Localities			
	Jaguari-Mirim*	Paraná	Machado	Cuiabá
Body length	623 (534–738; n = 15)	–	714 (570–880; n = 5)	676 (575–720; n = 6)
Greatest width	104 (85–132; n = 17)	112	120 (102–133; n = 3)	117 (110–130; n = 5)
Pharynx	30 (22–38; n = 16)	27–28	33 (32–35; n = 4)	35 (33–42; n = 6)
Haptor width	62 (53–68; n = 13)	65	68 (60–82; n = 3)	64 (60–70; n = 4)
Ventral anchor length	28 (25–32; n = 14)	27 (26–28; n = 4)	32 (30–35; n = 4)	29 (28–31; n = 3)
Base width	24 (22–26; n = 14)	25 (25–26; n = 3)	26	–
Dorsal anchor length	35 (30–39; n = 18)	37 (36–37; n = 3)	40 (38–41; n = 3)	34 (28–39; n = 7)
Base width	26 (25–27; n = 6)	27 (27–28; n = 3)	26	22–29
Ventral bar length	34 (29–37; n = 4)	35 (32–36; n = 3)	31–36	32 (29–37; n = 3)
Dorsal bar length	36 (32–44; n = 5)	34–35	34 (32–35; n = 3)	33 (32–35; n = 4)
Hook pair 1	–	–	–	–
Hook pairs 2, 3, 4, 6, 7	19 (18–20; n = 11)	18 (18–19; n = 5)	18 (18–19; n = 3)	–
Hook pair 5	14	14–15	–	–
MCO length	29 (25–33; n = 17)	31 (27–35; n = 3)	29 (26–34; n = 3)	30 (25–33; n = 4)
First ring of MCO	14 (12–15; n = 3)	–	–	–
Accessory piece	25 (20–28; n = 13)	24–28	25 (22–28; n = 4)	26 (24–25; n = 3)
Germarium length	67 (53–84; n = 4)	–	77 (46–115; n = 3)	73 (45–100; n = 4)
Germarium width	26 (22–30; n = 5)	–	32 (20–40; n = 4)	26 (20–34; n = 3)
Testis length	70	–	–	57–80
Testis width	–	–	–	17–184

* Present description.

species of *Aphanoblastella* Kritsky, Mendoza-Franco, and Scholz, 2000, are found on members of Pimelodidae and Heptapteridae; 19 species of *Demidospermus* Suriano, 1983 (Kritsky and Gutierrez, 1998) occur on members of Loricariidae, Pimelodidae, and Auchenipteridae; 6 species of *Diaphorocleidus* occur on members of Characidae; 3 species of *Palombitrema* (Price and Busing, 1968) Suriano, 1997, occur on members of Curimatidae and Characidae; and 15 species of *Amphithecium* Boeger and Kritsky, 1998, occur on members of Serrasalminidae, among many other genera containing dactylogyrids on hosts of other families (Kritsky et al., 1992, 1997, 2000; Mendoza-Franco and Vidal-Martínez, 2005; Mendoza-Franco and Scholz, 2009; Mendoza-Franco et al., 2009; Cepeda and Luque, 2010; Ferrari-Hoinghaus et al., 2010; Monteiro et al., 2010). While many host families have been extensively studied for parasites, e.g., cichlids and serrasalmids, others are still poorly known, e.g., the 9 families mentioned here to contain potential hosts of species of *Urocleidoides*. The absence of a phylogenetic hypothesis for species of *Urocleidoides* also limits our ability to determine potential co-evolutionary relationships of these parasites and their hosts in the tropics.

In the present study, specimens of the same monogenoidean species from different localities showed some differences in shape of their anchors and bars, i.e., *U. brasiliensis*. Therefore, these morphologic differences should be seriously taken with caution in future parasitological studies to delimit morphological boundaries of each species or recognize intermediate forms of the same species from *H. malabaricus*. Herein, we consider specimens from 4 rivers to be conspecific with *U. eremitus* until further study of living specimens can be conducted to clarify the morphologic differences found between type and present specimens of this species. The generic characters, e.g., vaginal sclerite, used to identify present specimens are in agreement with those provided by Kritsky et al. (1986). A noteworthy observation is that the ventral bar with enlarged ends appeared to be consistent in



FIGURE 92. Map of South America showing localities from Brazil, Peru, and Argentina from which current and previous monogenoidean species on *Hoplias malabaricus* (Characiformes) have been described and/or reported: (1) Janauacá Lake, Amazonas, Brazil (Kritsky et al., 1986). (2) Madre de Dios River from southeastern Peru (Kohn and Cohen, 1998). (3) Cristalino River. (4) Araguaia River. (5) Cuiabá River. (6) Chascomús Lake from Buenos Aires, Argentina (Suriano, 1997). (7) Paraná River. (8) Jaguari-Mirim River. (9) Machado River. (10) Guandu River.

present collections as well as in the original descriptions of previous species of this genus. Thus, this character could be considered as a generic character for *Urocleidoides*.

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