

FIVE NEW SPECIES OF *UROCLEIDOIDES* (MONOGENOIDEA) (MIZELLE AND PRICE 1964) KRITSKY, THATCHER, AND BOEGER, 1986, PARASITIZING THE GILLS OF PANAMANIAN FRESHWATER FISHES

Edgar F. Mendoza-Franco* and Ruth G. Reina

Smithsonian Tropical Research Institute, Apartado 0843-03092 Balboa, Ancon, Panama, Republic of Panama.
e-mail: mfranco@mda.cinvestav.mx

ABSTRACT: During an investigation of gill monogenoidean parasites from freshwater fishes in central Panama, 5 new species of *Urocleidoides* (sensu stricto) were found: *Urocleidoides cultellus* n. sp., *Urocleidoides visiofortatus* n. sp., and *Urocleidoides adenai* n. sp. from the gymnotiform *Brachyhypopomus occidentalis* (Hypopomidae); *Urocleidoides neotropicalis* n. sp. and *Urocleidoides piriatiu* n. sp. from the characiforms *Saccodon dariensis* (Parodontidae) and *Ctenolucius beani* (Ctenoluciidae), respectively. Our findings represent the first known species of *Urocleidoides* from these fishes in Central America and demonstrate that they are morphologically linked to their South American congeners.

Urocleidoides Mizelle and Price 1964 (Monogenoidea: Dactylogyridae) (as amended by Kritsky et al., 1986), accommodates species possessing overlapping or tandem gonads, a coiled male copulatory organ with counterclockwise rings, a sinistral vaginal sclerite, unmodified anchors, and similar hooks with dilated shanks, and hooks pairs 1, 5, usually reduced in size. According to this diagnosis, 6 species of *Urocleidoides* (*Urocleidoides anops* Kritsky and Thatcher, 1974, from *Characidium caucanum* Eigenman 1912 [Characidae]; *Urocleidoides curimatae* Molnar, Hanek and Fernando, 1974 from *Curimata argentea*, Gill 1858 [Curimatidae]; *Urocleidoides eremitus* Kritsky, Thatcher and Boeger, 1986, from *Hoplias malabaricus* (Bloch, 1794) [Erythrinidae]; *Urocleidoides hypopomi* Suriano, 1997 from *Hypopomus brevirostris* Steindachner, 1868 [syn. *Brachyhypopomus brevirostris* [Hypopomidae] [as Rhamphichthyidae in Suriano, 1997]; *Urocleidoides paradoxus* Kritsky, Thatcher and Boeger, 1986, from *Rhytiodus microlepis* Kner, 1858 [Anostomidae]; and *Urocleidoides reticulatus* Mizelle and Price, 1964, from *Poecilia reticulata* Peters 1859 [Poeciliidae]) have been reported from South American fishes (Brazil, Trinidad, Argentina, and Colombia) (Kritsky et al., 1986; Suriano, 1997). Additionally, 3 other species (*Urocleidoides flegomai* Mendoza-Franco, Aguirre-Macedo and Vidal-Martinez, 2007 from *Piabucina panamensis* Gill, 1877 [Lebiasinidae]; *Urocleidoides similuncus* Mendoza-Franco, Aguirre-Macedo and Vidal-Martinez, 2007, from *Poecilia gillii* [Kner, 1863] [Poeciliidae]; and *Urocleidoides vaginoclastrum* Jogunoori, Kritsky and Venkatanarasiah, 2004, from *Xiphophorus helleri* Heckel 1848 [Poeciliidae]) of this parasite genus have been described from the Neotropics (Jogunoori et al., 2004; Mendoza-Franco et al., 2007). Herein, 3 and 2 new species of *Urocleidoides* from the gills of *Brachyhypopomus occidentalis* (Regan, 1914) (Hypopomidae) and the characiforms *Saccodon dariensis* Meek and Hildebrand, 1913 (Parodontidae) and *Ctenolucius beani* (Fowler, 1907) (Ctenoluciidae), respectively, are described.

MATERIALS AND METHODS

Fishes were collected with the use of electrofishing and trammel nets from Aguas Claras River at its confluence with the Bayano Lake (09°15'05.1"N, 78°41'11.2"W) and Rio Piriati River (09°03'36"N, 78°39'57"W) at its confluence with the Chagres River Basin in central Panama. Methods of collection, preparation of helminths for study, and measurement and illustration follow Mendoza-Franco et al. (2007). To study sclerotized structures, some specimens were mounted unstained in glycerin jelly. Measurements, all in micrometers (μm), represent straight-line distances between extreme points and are expressed as the mean followed by the range and number (n) of structures measured in parentheses; body length includes the haptor. Numbering (distribution) of hook pairs follows Mizelle (1936; see Mizelle and Price, 1963). Type and vouchers specimens are deposited in the United States National Parasite Collection, Beltsville, Maryland (USNPC) and in the National Helminthological Collection of Mexico (CNHE), Institute of Biology, National Autonomous University of Mexico, Mexico, as indicated in the respective descriptions. Names and hosts follow those provided in FishBase (Froese and Pauly, 2004).

DESCRIPTION

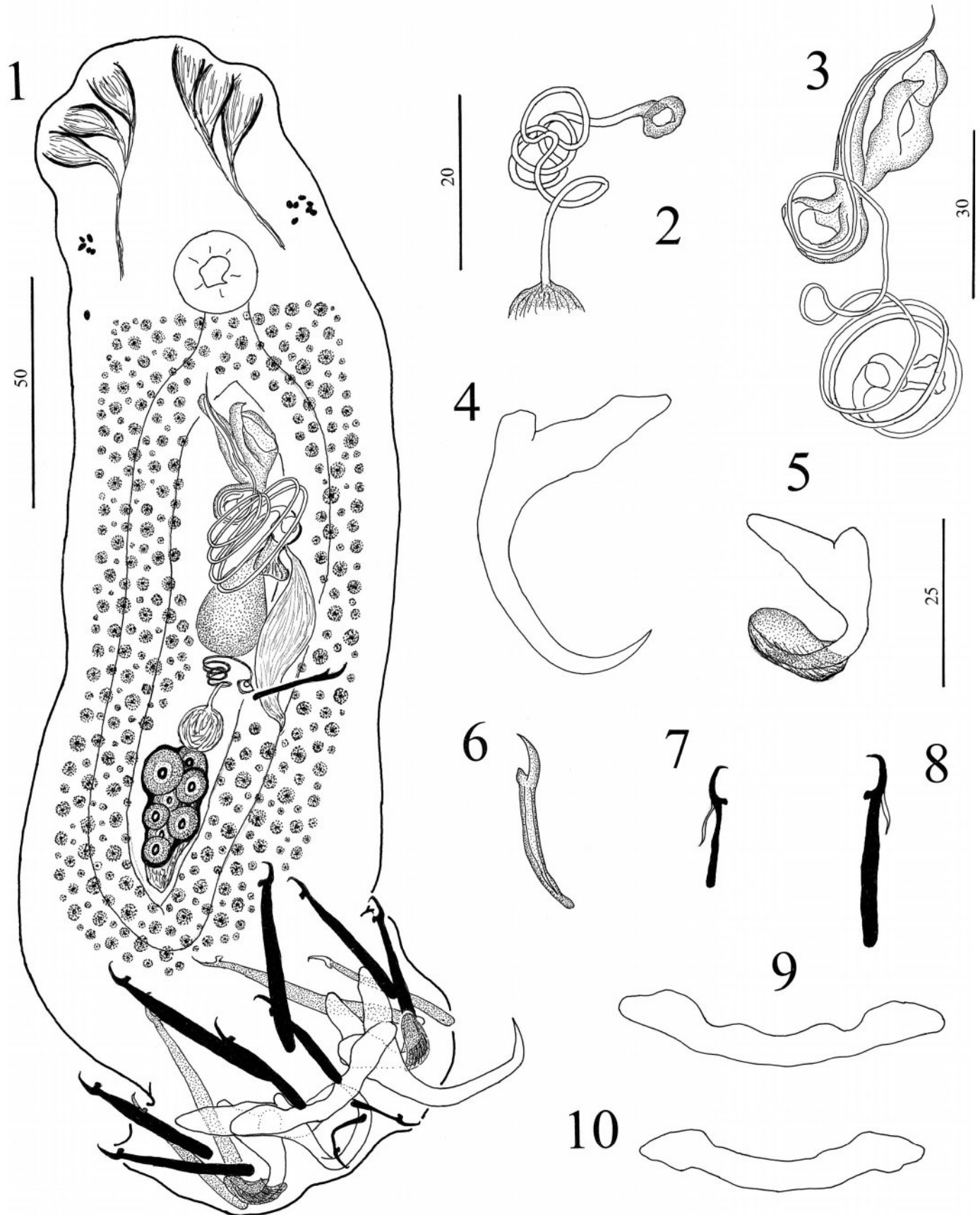
Urocleidoides cultellus n. sp.

(Figs. 1–10)

Diagnosis: Body fusiform 385 (165–712; n = 4) long, robust; greatest width 64 (41–76; n = 5) usually at level of testis. Cephalic margin broad; cephalic lobes moderately developed; 3 bilateral pairs of head organs; cephalic glands indistinct. Eyespots absent; accessory granules scattered in cephalic region and anterior trunk. Pharynx spherical 13 (12–18; n = 4) in diameter; esophagus moderately long. Peduncle broad; haptor subrectangular, 72 (65–85; n = 3). Ventral anchor 40 (39–43; n = 10) long, with elongate tapered superficial root, short deep root, proximally bent shaft, short point; base 23 (23–24; n = 5) wide. Dorsal anchor 24 (23–25; n = 7) long, poorly differentiated deep root, curved shaft, with bifurcate points; base 15 (15–16; n = 7) wide. Ventral bar 44 (42–47; n = 6) long, wide U-shaped with enlarged terminations; dorsal bar 37 (35–42; n = 4) long, with enlarged ends. Hooks similar, each with recurved point, depressed thumb, dilated shank; hook pairs 1, 5 reduced in size; filamentous hooklet (FH) loop half shank length (pairs 1, 5), one-quarter shank length (pairs 2, 3, 4, 6, 7); hook pair 1—27 (26–29; n = 4) long; hook pair 2—45 (45–46; n = 4) long; hook pairs 3, 4 and 6—37 (36–37; n = 10) long; hook pair 5—17 (n = 4) long; hook pair 7—52 (51–52; n = 4) long. Male copulatory organ a coil of about 5 counterclockwise rings, base with lateral flange, 22 (n = 2) diameter of the first ring. Accessory piece tripartite, 35 (n = 2) long. Vagina ventral, a convoluted tube opening at the level of left intestinal caecum; seminal receptacle midventral, small. Gonads overlapping, 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 grooved rod distally hooked. Vitellaria scattered throughout trunk, absent in regions of reproductive organs.

Received 22 August 2007; revised 14 January 2008; accepted 14 January 2008.

* Also at: Laboratory of Parasitology, Centro de Investigación y de Estudios Avanzados (CINVESTAV, Unidad Mérida), Carretera Antigua a Progreso Km. 6, Apartado Postal 73 “Cordemex”, C.P. 97310 Mérida, Yucatán, México.



Taxonomic summary

Type host: Knifefish *B. occidentalis* (Regan, 1914) (Gymnotiformes: Hypopomidae).

Site of infection: Gills.

Type locality/collection date: Aguas Claras River at its confluence with the Bayano Lake (09°15'05.1"N, 78°41'11.2"W), Republic of Panama, September 2006.

Specimens deposited: Holotype, CNHE 6019; 4 paratypes, CNHE 6020; 3 paratypes, USNPC 100679.

Etymology: The specific name is from Latin (*cultellus* = a little knife) and refers to the common name of its host, the knifefish.

Remarks

Based on comparisons of the haptor, reproductive organs, and copulatory complex morphology, *U. cultellus* n. sp. most closely resembles *Urocleidoides carapus* Mizelle and Kritsky, 1969, and *Urocleidoides gymnotus* Mizelle, Kritsky and Crane, 1968 from *Gymnotus carapo* (Linnaeus, 1758) (Gymnotiformes: Gymnotidae) from the Amazon River in Brazil (both considered by Kritsky et al. [1986] as being members of the *Urocleidoides* sensu lato group) and *U. hypopomi* from *H. brevirostris* (syn. *B. brevirostris*) (Hypopomidae) in Argentina (see Mizelle et al., 1968; Suriano, 1997). *Urocleidoides cultellus* n. sp. differs from these 3 latter monogenoidean species by having a coiled male copulatory organ with 5 rings (ranging from 2 to 3 rings and from 7 to 9 rings in *U. carapus* and *U. gymnotus*, respectively), dorsal bar with enlarged ends (arched posteriorly with hooked ends in *U. gymnotus*), and dorsal anchors with bifurcate points (absent in *U. gymnotus* and *U. hypopomi*). Additionally, it differs in the size of its hooks; hook pair 2 (length 45–46 vs. 31–36 in *U. carapus* and 26–30 in *U. gymnotus*), and hook pair 7 (length 51–52 vs. 42–44 in *U. carapus* and 26–30 in *U. gymnotus*) (see Mizelle et al., 1968; Suriano, 1997; present study).

Urocleidoides neotropicalis n. sp.

(Figs. 11–19)

Diagnosis: Body fusiform 202 (150–275; n = 16) long; greatest width 73 (57–85; n = 12) at various points along the trunk. Cephalic margin broad; cephalic lobes moderately developed; 3 bilateral pairs of head organs; cephalic glands distinct, posterolateral to pharynx. Eyespots absent; accessory granules scattered in cephalic region and anterior trunk. Pharynx spherical, 14 (9–15; n = 19) in diameter; esophagus moderately long. Peduncle broad; haptor globose, 49 (41–56; n = 14) wide. Ventral anchor 29 (28–30; n = 18) long, with well-differentiated roots, elongate superficial root, distally round deep root, curved shaft, elongate point; base 16 (15–17; n = 19) wide. Dorsal anchor 26 (25–27; n = 11) long, with poorly differentiated deep root, straight shaft, elongate point; base 13 (12–13; n = 7) wide. Ventral bar 24 (21–27; n = 14) long, broadly U-shaped with enlarged terminations and a slight indentation; dorsal bar 28 (26–32; n = 16) long, broadly U- or V-shaped, with posteromedial projection. Hooks similar, each with protruding thumb, delicate shaft and point, dilated shank; hook pairs 1, 5 reduced in size; filamentous hooklet (FH) loop of hook extending to union of shank subunits; hook pairs 2, 3, 4, 6, 7—16 (14–17; n = 19) long; hook pairs 1, 5—10 (10–11; n = 12) long. Male copulatory organ a coil of about 5½ counterclockwise rings, bulbous base with lateral flange, tube delicate, first ring 17 (13–19; n = 11) in diameter. Accessory piece simple, 30 (29–33; n = 4) long, terminating in a perpendicular opening. Vagina sinistral, a corrugated, bulb shaped, slightly sclerotized connected to small medial seminal receptacle anterior to germarium. Gonads overlapping, germarium 25 (19–31; n = 7) long, 18 (15–30; n = 6) 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 34 (33–36; n = 12) long, robust, a grooved rod distally hooked. Vitellaria scattered throughout trunk, except absent in regions of reproductive organs.

Taxonomic summary

Type host: Dormilón *Saccodon dariensis* Meek and Hildebrand, 1913 (Characiformes: Parodontidae).

Site of infection: Gills.

Type locality/collection date: Piriati River at its confluence with the Chagres River Basin (09°03'36"N, 78°39'57"W), Republic of Panama, September 2006.

Specimens deposited: Holotype, CNHE 6021; 18 paratypes, CNHE 6022; 10 paratypes, USNPC 100680.

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

Remarks

This species is easily differentiated from other congeneric species by having a male copulatory organ with 5½ rings (ranging from 2 to 2¼ rings in *U. piriatiu* n. sp., *U. eremitus*, *U. visiofortatus* n. sp., and *U. paradoxus*), a corrugated bulb shaped of the sinistral vaginal aperture (convoluted vaginal tube in *U. cultellus* n. sp. and as a short tube in midventral position in *U. visiofortatus* n. sp.) and by having a robust vaginal sclerite (length 34 vs. 24 and 23 in *U. cultellus* n. sp. and *U. visiofortatus* n. sp., respectively).

Urocleidoides piriatiu n. sp.

(Figs. 20–29)

Diagnosis: Body 258 (215–307; n = 9) long, broad, robust, foliform; greatest width 95 (87–105; n = 8) usually at level of gonads. Cephalic margin broad; cephalic lobes moderately developed; 3 bilateral pairs of head organs; cephalic glands indistinct. Eyespots absent; small accessory granules present in cephalic region. Pharynx spherical 15 (13–18; n = 9) in diameter; esophagus inconspicuous. Haptor hexagonal, 53 (48–65; n = 8). Ventral anchor 32 (30–34; n = 8) long, with depressed superficial root, distally tapered deep root, proximally bent shaft, short recurved point; base 15 (14–16; n = 6) wide. Dorsal anchor 25 (23–26; n = 10) long, with well-differentiated roots, curved shaft, moderately elongate point; base 12 (11–12; n = 6) wide. Ventral bar 28 (26–30; n = 5) long, rod-shaped with enlarged extremities; dorsal bar 27 (26–29; n = 5) long, broadly V-shaped with posteromedial projection. Hooks similar, each with depressed thumb, delicate shaft and point, dilated shank composed of two subunits; hook pairs 1, 5 reduced in size; filamentous hooklet (FH) loop ½ shank length (pairs 2, 3, 4, 6, 7), ½ shank length (pair 1); hook pairs 2, 3, 4, 6—17 (n = 3) long; hook pair 7—21 (20–21; n = 8) long; hook pairs 1, 5—15 (14–15; n = 5) long. Male copulatory organ a coil of about 2 rings, base with lateral flange, tube delicate, first ring 20 (19–22; n = 3) in diameter. Accessory piece, 24 (20–29; n = 5) long, comprising 2 subunits; dextral subunit terminally acute; sinistral subunit bottle-shaped. Vagina sinistral, a delicate tube with a distal ovate bulb guarding aperture; seminal receptacle midventral, anterior to germarium. Gonads overlapping, germarium 52 (50–62; n = 5) long, 22 (20–23; n = 5) 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 31 (29–32; n = 3) long, delicate, slender with distal hook, subterminal short projection. Vitellaria scattered throughout trunk, absent in regions of reproductive organs.

Taxonomic summary

Type host: *Ctenolucius beani* (Fowler, 1907) (Characiformes: Ctenoluciidae).

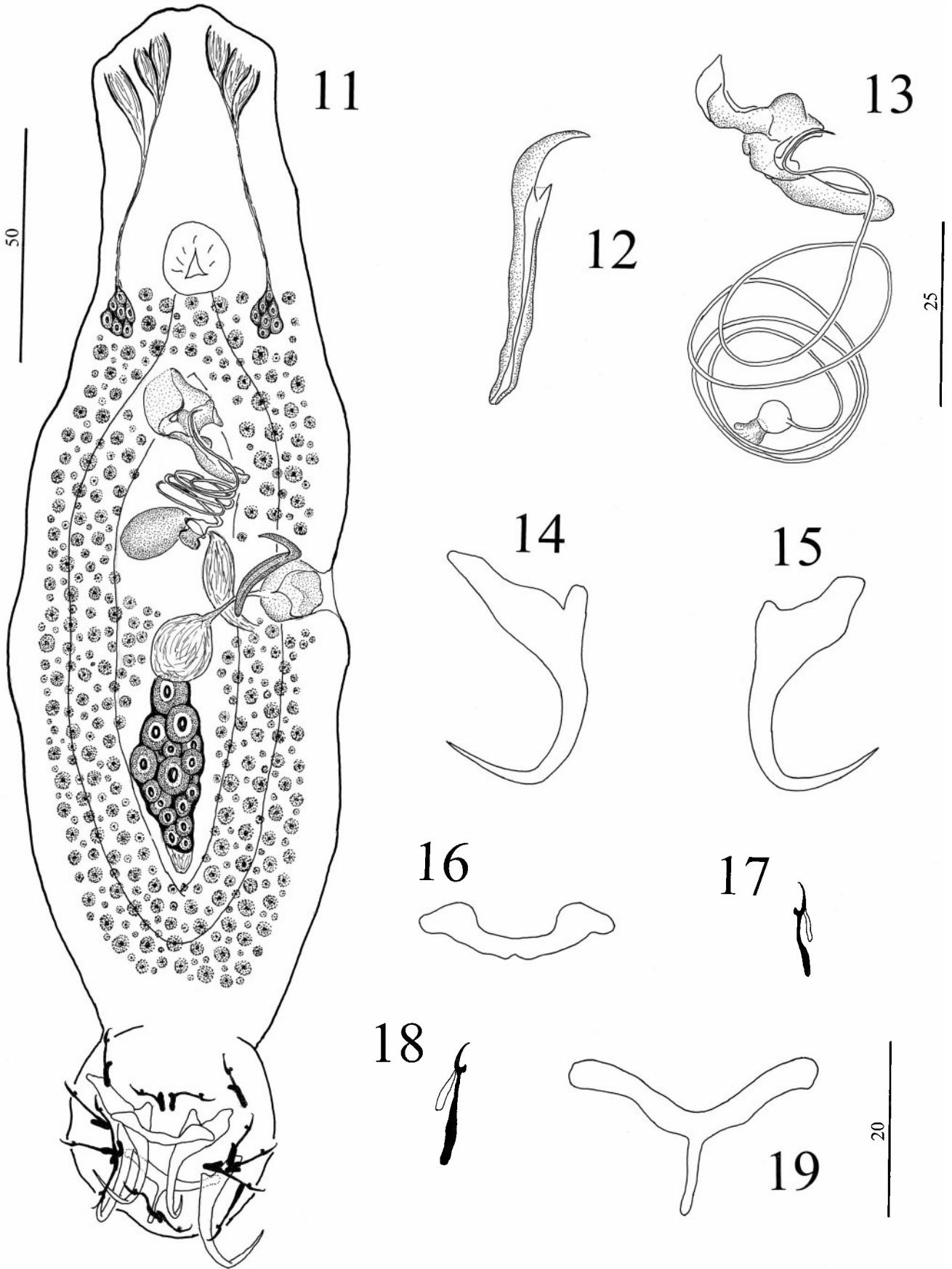
Site of infection: Gills.

Type locality/collection date: Piriati River at its confluence with the Chagres River Basin (09°03'36"N, 78°39'57"W), Republic of Panama, September 2006.

Specimens deposited: Holotype, CNHE 6023; 8 paratypes, CNHE 6024; 6 paratypes, USNPC 100681.

←

FIGURES 1–10. *Urocleidoides cultellus* n. sp. (1) Whole mount (composite, ventral view). (2) Vagina. (3) Copulatory complex (ventral). (4) Ventral anchor. (5) Dorsal anchor. (6) Vaginal sclerite. (7) Hook (pair 5). (8) Hook (pair 7). (9) Ventral bar. (10) Dorsal bar. All figures are drawn to the 25-µm scale, except 1 (50-µm), 2 (20-µm), and 3 (30-µm).



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

Remarks

This species resembles *U. neotropicalis* n. sp. from *S. dariensis* in the general morphology of its bars, especially by the presence of a posteromedial projection on dorsal bar. *Urocleidoides piriatiu* n. sp. differs from *U. neotropicalis* n. sp. in having a coiled male copulatory organ with 2 rings ($4\frac{1}{2}$ in *U. neotropicalis* n. sp.) and by having ventral anchors with depressed superficial roots (tapered superficial root in *U. neotropicalis* n. sp.). These are the only described species of *Urocleidoides* possessing a medial projection on posterior margin of its dorsal bars.

Urocleidoides visiofortatus n. sp.

(Figs. 30–38)

Diagnosis: Body fusiform 208 (175–238; n = 8) long, with irregular margins; greatest width 63 (52–75; n = 8) usually at level of testis. Cephalic margin broad; cephalic lobes moderately developed; 3 bilateral pairs of head organs; cephalic glands indistinct. Eyespots absent; accessory granules present in cephalic region and anterior trunk. Pharynx spherical 13 (11–15; n = 7) in diameter; esophagus moderately long. Peduncle almost inconspicuous; haptor subrectangular, 52 (48–58; n = 6). Ventral anchor 40 (37–44; n = 17) long, strong, with prominent superficial root, distally rounded deep root, evenly curved shaft, elongate point; base 19 (18–22; n = 9) wide. Dorsal anchor 25 (23–26; n = 5) long, strongly tapered superficial root, poorly developed deep root, curved shaft, elongate point; base 12 (n = 2) wide. Ventral bar 34 (30–38; n = 9) long, with bulbous extremities, a slight anteromedial indentation; dorsal bar 17 (16–19; n = 6) long, slightly V-shaped. Hooks similar, each with protruding thumb, delicate shaft and point, dilated shank; filamentous hooklet (FH) loop of hook extending to union of shank subunits; hooks 1, 2, 3, 4, 6, 7—20 (20–22; n = 11) long; hook pair 5—16 (15–17; n = 5). Male copulatory organ a delicate tube of about $1\frac{1}{2}$ rings, base with subrectangular flange, 21 (18–23; n = 4) diameter of the first ring. Accessory piece, an arched grooved rod, 19 (19–20; n = 3) long. Vagina ventral, a shorter delicate tube opening in a sclerotized atrium at level of a small bulb lying left to intestinal cecum; seminal receptacle midventral, small, anterior to germarium. Gonads overlapping, germarium 26 (20–30; n = 3) long, 16 (15–17; n = 3) 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 23 (20–25; n = 4) long, composed of grooved rod with distal hook. Vitellaria scattered throughout trunk, absent in regions of reproductive organs.

Taxonomic summary

Type host: Knifefish *B. occidentalis* (Regan, 1914) (Gymnotiformes: Hypopomidae).

Site of infection: Gills.

Type locality/collection date: Aguas Claras River at its confluence with the Bayano Lake (09°15′05.1″N, 78°41′11.2″W), Republic of Panama, September 2006.

Specimens deposited: Holotype, CNHE 6025; 4 paratypes, CNHE 6026; 4 paratypes, USNPC 10682.

Etymology: The specific name is from Latin (*visio* = appearance + *fortis* = robust) and refers to the robust ventral anchors of this species.

Remarks

This species differs significantly from other congeneric forms by the relative size of the ventral and dorsal anchors and by having an arched rod-shaped accessory piece. *Urocleidoides visiofortatus* n. sp. resembles *U. cultellus* n. sp. in having a vagina in midventral position but it differs from this latter species by having shorter vaginal tube (a convoluted

tube in *U. cultellus* n. sp.) and a wider vaginal aperture (small opening in *U. cultellus* n. sp.).

Urocleidoides advenai n. sp.

(Figs. 39–45)

Description: Body fusiform 185 (128–242; n = 12) long, with parallel lateral margins; greatest width 48 (27–60; n = 10) usually at level of testis. Cephalic margin broad; cephalic lobes moderately developed; 3 bilateral pairs of head organs; cephalic glands indistinct. Eyespots absent. Pharynx spherical 10 (9–15; n = 12) in diameter; esophagus short to nonexistent. Peduncle inconspicuous; haptor hexagonal, 39 (35–47; n = 7). Ventral anchor 11 (10–12; n = 15) long, with elongate slightly depressed superficial root, short deep root, curved shaft, elongate point; base 7 (6–8; n = 6) wide. Dorsal anchor 25 (23–26; n = 7) long, with poorly differentiated deep root, evenly curved shaft, point; base 10 (n = 3) wide. Ventral bar 19 (17–22; n = 11) long, usually straight, rod shaped with slightly enlarged ends; dorsal bar 16 (14–18; n = 7) long, rod shaped with slight terminal enlargements. Hooks similar, each with protruding thumb, delicate shaft and point, dilated shank; filamentous hooklet (FH) loop of hook extending to union of expanded shank; hooks 11 (9–12; n = 8) long. Male copulatory organ a delicate tube of about 1 ring, base with subrectangular flange, 15 (13–17; n = 6) diameter of the first ring. Accessory piece 14 (13–15; n = 4) long, comprising delicate sheath enclosing distal portion of the copulatory organ. Vagina sinistral, submarginal, a delicate tube leading to medial seminal receptacle anterior to germarium. Gonads overlapping, germarium 24 (20–30; n = 3) long, 10 (9–12; n = 3) 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. Vitellaria scattered throughout trunk, except absent in regions of reproductive organs.

Taxonomic summary

Type host: Knifefish *B. occidentalis* (Regan, 1914) (Gymnotiformes: Hypopomidae).

Site of infection: Gills.

Type locality/collection date: Aguas Claras River at its confluence with the Bayano Lake (09°15′05.1″N, 78°41′11.2″W), Republic of Panama, September 2006.

Specimens deposited: Holotype, CNHE 6027; 6 paratypes, CNHE 6028; 6 paratypes, USNPC 100683.

Etymology: The specific name is from Latin (*advena* = a stranger, foreigner) and refers to the fact that this species lives with 2 species of *Urocleidoides* (*U. cultellus* n. sp. and *U. visiofortatus* n. sp.) on the gills of same host species.

Remarks

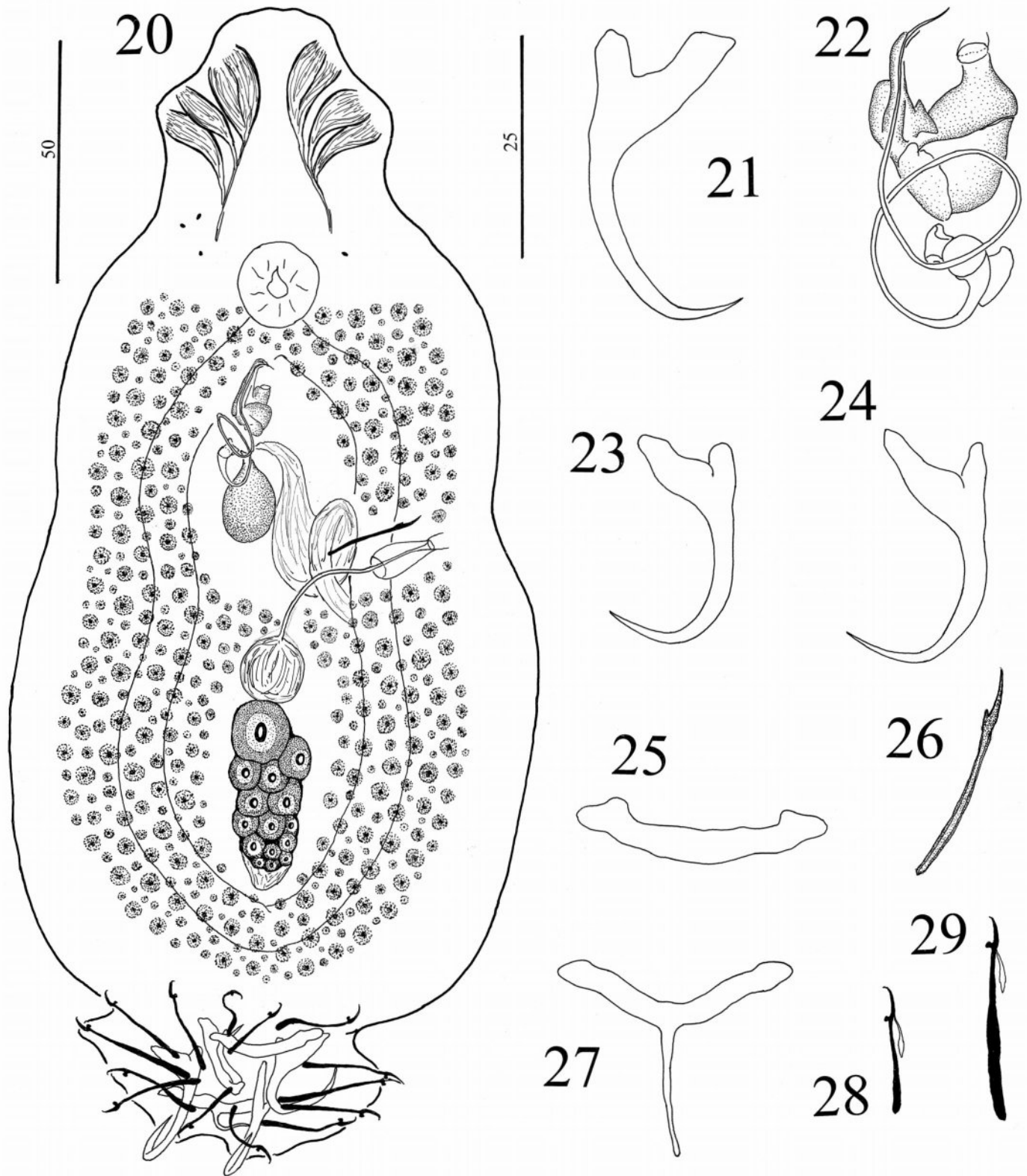
Urocleidoides advenai n. sp. differs from all congenitors in lacking a vaginal sclerite. In all other features this species resembles notably, in some details, the morphology of the species of *Urocleidoides* being described herein. All species share the unusual morphology of the base (i.e., with presence of a flange) of the MCO, the general morphology of the MCO itself and of the accessory piece; the general distribution of organs and even the morphology of the hook. The only major difference is the absence, in this species, of the vaginal sclerite and does not support proposal of a new genus for this unique species.

DISCUSSION

The present study represents the first report of species of *Urocleidoides* (sensu stricto) (*U. cultellus* n. sp., *U. neotropicalis* n. sp., *U. piriatiu* n. sp., *U. visiofortatus* n. sp., and *U. advenai* n. sp.) parasitizing freshwater fishes (*B. occidentalis*

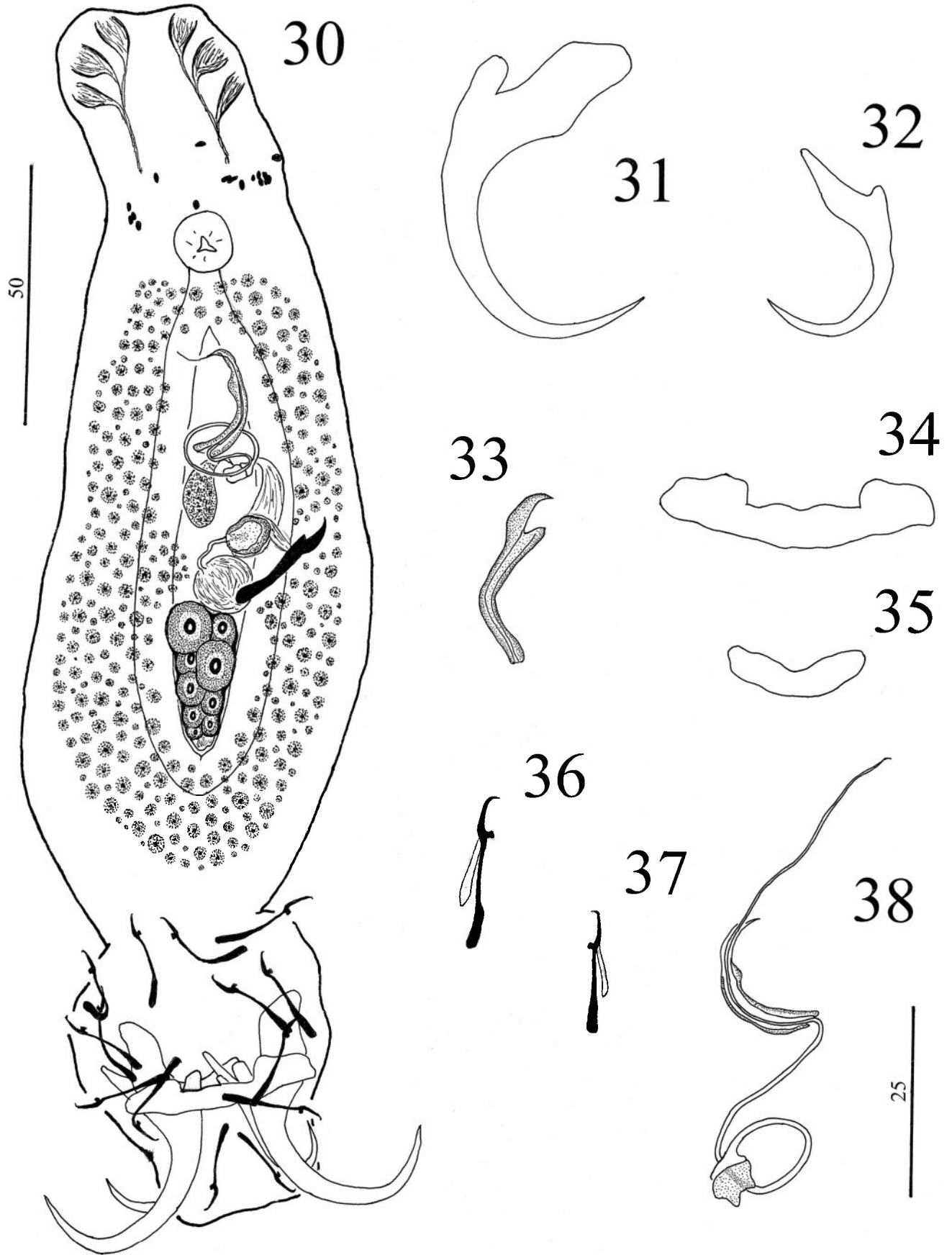
←

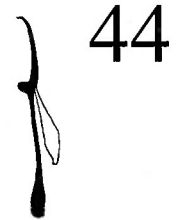
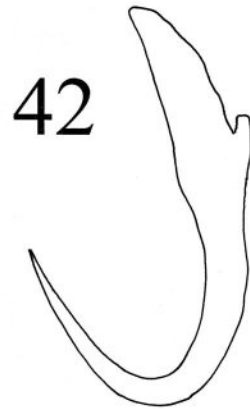
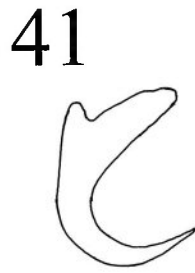
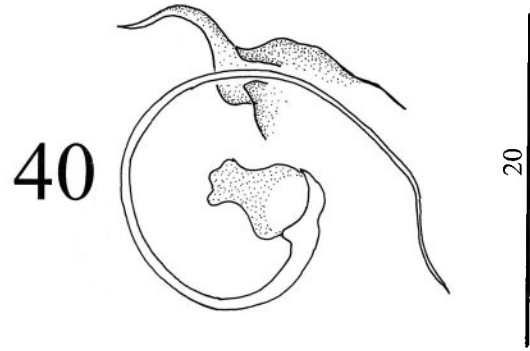
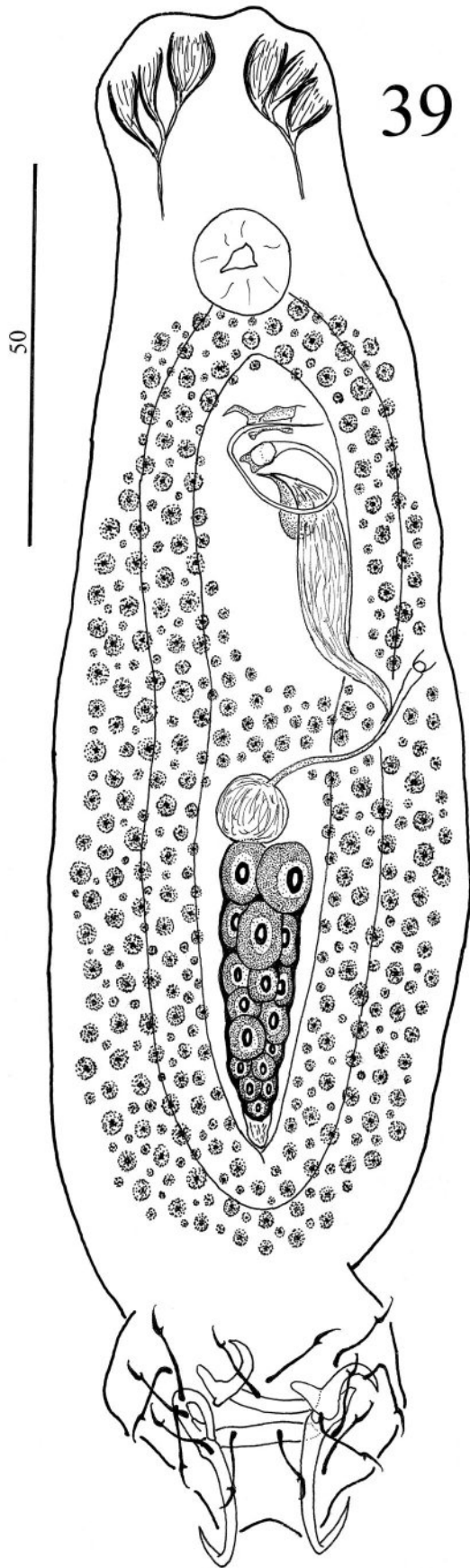
FIGURES 11–19. *Urocleidoides neotropicalis* n. sp. (11) Whole mount (composite, ventral view). (12) Vaginal sclerite. (13) Copulatory complex (ventral). (14) Ventral anchor. (15) Dorsal anchor. (16) Ventral bar. (17) Hook (pair 5). (18) Hook (pair 2). (19) Dorsal bar. All figures are drawn to the 20- μ m scale, except 11 (50- μ m) and 13 (25- μ m).



FIGURES 20–29. *Urocleidoides piriatu* n. sp. (20) Whole mount (composite, ventral view). (21) Ventral anchor. (22) Copulatory complex (ventral). (23–24) Dorsal anchors. (25) Ventral bar. (26) Vaginal sclerite. (27) Dorsal bar. (28) Hook (pair 5). (29) Hook (pair 2). All figures are drawn to the 25- μ m scale, except 20 (50- μ m).

FIGURES 30–38. *Urocleidoides visiofortatus* n. sp. (30) Whole mount (composite, ventral view). (31) Ventral anchor. (32) Dorsal anchor. (33) Vaginal sclerite. (34) Ventral bar. (35) Dorsal bar. (36) Hook (pair ?). (37) Hook (pair 5). (38) Copulatory complex (dorsal). All figures are drawn to the 25- μ m scale, except 30 (50- μ m).





[Gymnotiformes], *S. dariensis*, and *C. beani* [Characiformes]) from Central America. Gymnotiformes includes 5 tropical families (Apterontidae, Gymnotidae, Hypopomidae, Rhamphichthyidae, and Sternopygidae) (see Albert and Crampton, 2005; Loureiro and Silva, 2006) and the current knowledge on diversity of the Monogonoidea (5 species [present study] plus 3 considered incertae sedis in *Urocleidoides* and 1 species of *Gyrodactylus*) (Mizelle and Price, 1968; Vianna et al., 2007; present study), on fishes from these families is undoubtedly insufficient to understand the parasite diversification in this region. *Urocleidoides* (sensu stricto) includes a group of 9 tropical (South and Central America [Panama]) species, generally more displayed on a wide range of Characiformes (Characidae, Anostomidae, Curimatidae, Erythrinidae, and Lebiasinidae) compared to those fishes within Cyprinodontiformes (Poeciliidae) and Gymnotiformes (Hypopomidae) (Kritsky et al., 1986; Suriano, 1997; Jogunoori et al., 2004; Mendoza-Franco et al., 2007). In the present study, 5 new species of *Urocleidoides* were found on host species within Characiformes and Gymnotiformes. A phylogenetic analysis of otophysan fishes using morphological and molecular data has suggested that Characiformes is a sister group of Gymnotiformes (Briggs, 2005). However, the parasite data is still incipient to support if divergence between these 2 latter fish groups in South America may also represent the earliest phylogenetic split of *Urocleidoides* in the tropics. Alternatively, fossil evidence suggests that gymnotiforms spread into Central America from South America during late Miocene (5 mya) (Saitoh et al., 2003; Briggs, 2005). Our morphological evidence strongly suggests a morphological link between the monogonoidean fauna of *Urocleidoides* from South American freshwater fishes and that from Central America on gymnotiforms, probably as a result of the dispersal history of these fishes. Morphological similarities that support a clade of these monogonoidean species on gymnotiforms from Central and South America include: (1) ventral anchors with elongate tapered superficial roots and bent shaft; (2) dorsal anchors with bifurcate points (present in *U. carapus* and *U. cultellus* n. sp.); (3) hooks with robust shanks; (4) absence of eye-spots; and (5) vaginal aperture in midventral position (present in *U. cultellus* n. sp., *U. gymnotus*, *U. visiofortatus*, and *U. hypopomi*) (see Mizelle et al., 1968; Suriano, 1997; present study). Additionally, this hypothesis is supported by the fact that *U. cultellus* n. sp. from *B. occidentalis* (present study) most closely resembles *U. hypopomi* from *H. brevirostris* (syn. *B. brevirostris*) and 2 species currently considered incertae sedis in *Urocleidoides* Mizelle and Price, 1964: *U. gymnotus* and *U. carapus* from the gymnotiform *G. carapo* (Gymnotidae) from Brazil. *Urocleidoides gymnotus* and *U. carapus* are in incertae sedis because available specimens of these species are highly cleared and flattened, which precluded verification of the diagnostic features, i.e., presence of a vaginal sclerite, of *Urocleidoides* (sensu stricto) to be included within it (see Kritsky et al., 1986). However, comparisons of the haptor and copulatory complex morphology from the original descriptions of these species showed that they are markedly similar to those of

U. cultellus n. sp. On the basis of this strong resemblance, we consider that the taxonomic position of *U. gymnotus* and *U. carapus* from the South American gymnotiform fishes may be accepted within *Urocleidoides* (sensu stricto). In fact, *U. advenai* n. sp. from *B. occidentalis* (present study), as a unique species by lacking a vaginal sclerite (this character not reported in the original description of the former South American species), may be part of *Urocleidoides* group species lacking a vaginal sclerite. Furthermore, *U. advenai* n. sp. exhibit some similarity to another species currently considered incertae sedis in *Urocleidoides* Mizelle and Price, 1964, i.e., *Urocleidoides virescens* Mizelle, Kritsky and Crane, 1968, from the gymnotiform *Eigenmannia virescens* (Valenciennes, 1842) (Sternopygidae) from Brazil (Mizelle et al., 1968; Kritsky et al., 2000). Similarly, the original description of this latter monogonoidean species is insufficient to consider it within the current boundaries of *Urocleidoides* (see Mizelle et al., 1968; present study). Considering all the above, an emendation on *Urocleidoides* and/or a phylogenetic analysis, i.e., cladistic, is pending in order to include members lacking a vaginal sclerite. In conclusion, the absence of a phylogenetic hypothesis for all known species of *Urocleidoides* also limits our ability to determine satisfactorily if species of *Urocleidoides* on species of Hypopomidae in Central America could have originated from an invasion of parasites along with their hosts from South America.

ACKNOWLEDGMENTS

The authors are grateful to A. Castillo, A. Terrero, C. Schloeder, and E. Thompson for field and laboratory assistance during this study. Mark E. Torchin (Smithsonian Tropical Research Institute—STRI) provided useful comments on this manuscript prior to submission for publication. This study was financially supported by the STRI. This work was conducted while EFMF was Postdoctoral Fellowship at the STRI.

LITERATURE CITED

- ALBERT, J. S., AND W. G. R. CRAMPTON. 2005. Diversity and phylogeny of Neotropical electric fishes (Gymnotiformes). In *Electroreception*, T. H. Bullock, C. D. Hopkins, A. N. Popper, and R. R. Fay (eds.), Springer Handbook of Auditory Research, Philadelphia, Pennsylvania, p. 360–409.
- BRIGGS, J. C. 2005. The biogeography of otophysan fishes (Ostariophysi): A new appraisal. *Journal of Biogeography* **32**: 287–294.
- FROESE, R., AND D. PAULY. 2004. FishBase. World Wide Web electronic publication. www.fishbase.org, version (08/2007).
- JOGUNOORI, W., D. C. KRITSKY, AND J. VENKATANARASIAH. 2004. Neotropical Monogonoidea. 46. Three new species from the gills of introduced aquarium fishes in India, the proposal of *Heterotylus* n. g. and *Diaphorocleidus* n. g., and the reassignment of some previously described species of *Urocleidoides* Mizelle & Price, 1964 (Polyonchoinea: Dactylogyridae). *Systematic Parasitology* **58**: 115–124.
- KRITSKY, D. C., V. E. THATCHER, AND W. A. BOEGER. 1986. Neotropical. 8. Revision of *Urocleidoides* (Dactylogyridae, Ancyrocephalinae). *Proceedings of the Helminthological Society of Washington* **53**: 1–37.
- _____, E. F. MENDOZA-FRANCO, AND T. SCHOLZ. 2000. Neotropical Monogonoidea. 36. Dactylogyrids from the gills of *Rhamdia guatemalensis* (Siluriformes: Pimelodidae) from cenotes of the Yucatan Peninsula, Mexico with proposal of *Ameloblastella* gen. n. and

←

FIGURES 39–45. *Urocleidoides advenai* n. sp. (39) Whole mount (composite, ventral view). (40) Copulatory complex. (41) Ventral anchor. (42) Dorsal anchor. (43) Ventral bar. (44) Hook. (45) Dorsal bar. All figures are drawn to the 20- μ m scale, except 39 (50- μ m).

- Aphanoblastella* gen. n. (Dactylogyridae, Ancyrocephalinae). Comparative Parasitology **67**: 76–84.
- LOUREIRO, M., AND A. SILVA. 2006. A new species of *Brachyhypopomus* (Gymnotiformes, Hypopomidae) from northeast Uruguay. Copeia **4**: 665–673.
- MENDOZA-FRANCO, E. E., M. L. AGUIRRE-MACEDO, AND V. M. VIDAL-MARTINEZ. 2007. New and previously described species of Dactylogyridae (Monogeneoidea) from the gills of Panamanian freshwater fishes (Teleostei). Journal of Parasitology **93**: 761–771.
- MIZELLE, J. D. 1936. New species of trematodes from the gills of Illinois fishes. American Midland Naturalist **17**: 785–806.
- , AND C. E. PRICE. 1963. Additional haptor hooks in the genus *Dactylogyrus*. Journal of Parasitology **49**: 1028–1029.
- , D. C. KRITSKY, AND J. W. CRANE. 1968. Studies on monogenetic Trematodes. XXXVIII. Ancyrocephalinae from South America with the proposal of *Jainus* gen. n. American Midland Naturalist **80**: 186–198.
- SAITOH, K., M. MIYA, J. G. INOUE, N. B. ISHIGURO, AND M. NISHIDA. 2003. Mitochondrial genomics of Ostariophysan fishes: Perspectives on phylogeny and biogeography. Journal of Molecular Evolution **56**: 464–472.
- SURIANO, D. M. 1997. The genus *Urocleidoides* Mizelle and Price, 1964 (Monogenea: Ancyrocephalidae) parasitizing characoidei fishes in Argentina. Physis (Buenos Aires), Section B **53**: 1–6.
- VIANNA, R. T., W. A. BOEGER, AND A. D. M. DOVE. 2007. Neotropical Monogeneoidea. 51. *Scutalatus magniancoratus* gen. et sp. n. (Gyrodactylidae) from the South American electric eel, *Electrophorus electricus* (Gymnotidae, Gymnotiformes), and redescription of *Mormyrogyrodactylus gemini* from the African bulldog *Marcusenius macrolepidotus* (Mormyridae, Osteoglossiformes). Acta Zoologica (Stockholm) **88**: 89–94.