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Monogenoidea (Polyonchoinea: Dactylogyridae) parasitizing the gills of marine catfish (Siluriformes: Ariidae) inhabiting the Atlantic Amazon Coast of Brazil

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Abstract

A parasitological survey of monogenoids infesting the gills of marine catfish (Ariidae) captured from the Atlantic coastal region of the Amazon Basin was carried out during the 2011–2013 period. The gills of 448 specimens involving twelve ariid species (29 *Amphiarius rugispinis* (Valenciennes), 52 *Aspistor quadriscutis* (Valenciennes), 74 *Bagre bagre* (Linnaeus), 16 *Cathorops arenatus* (Valenciennes), 13 *Cathorops agassizii* (Eigenmann & Eigenmann), 17 *Cathorops spixii* (Agassiz), 3 *Cathorops* sp., 13 *Notarius grandicassis* (Valenciennes), 14 *Sciades couma* (Valenciennes), 64 *Sciades herzbergii* (Bloch), 48 *Sciades parkeri* (Traill), 13 *Sciades passany* (Valenciennes), 92 *Sciades proops* (Valenciennes) were sampled. No monogenoids were found in *Cathorops agassizi*, *Cathorops arenatus*, *Cathorops spixii*, *Cathorops* sp. and *Sciades parkeri,* but the gills of the other sampled species were parasitized by at least one species of monogenoid. We identified four new species of *Chauhanellus* and one new species of *Hamatopeduncularia*: *Chauhanellus hamatopeduncularoideum* **n. sp.** from *Amphiarius rugispinis* and *Sciades couma*; *Chauhanellus hypenocleithrum* **n. sp.** from *Sciades proops*; *Chauhanellus susamlimae* **n. sp.** from *Sciades herzbergii* and *Sciades passany*; *Chauhanellus velum* **n. sp.** from *Sciades couma, Sciades herzbergii* and *Sciades passany*; and *Hamatopeduncularia cangatae* **n. sp.** from *Aspistor quadriscutis* and *Notarius grandicassis*. Four previously described species were reported for the first time parasitizing ariids from Atlantic Amazon: *Chauhanellus neotropicalis* Domingues & Fehlauer, 2006 from *Amphiarius rugispinis*, *Aspistor quadriscutis*, *Notarius grandicassis* and *Sciades passany*; *Chauhanellus boegeri* Domingues & Fehlauer, 2006 from *Sciades couma* and *Sciades herzbergii*; *Hamatopeduncularia bagre* Hargis, 1955 from *Bagre bagre*; and *Neomurraytrematoides proops* Zambrano & Añez 1993 from *Sciades passany.* The monotypic *Neomurraytrematoides* Zambrano & Añez 1993 was placed in synonymy with *Neotetraonchus* Bravo-Hollis, 1968 and its type-species, *Neomurraytrematoides proops* Zambrano & Añez 1993 was transferred to *Neotetraonchus* as *Neotetraonchus proops* (Zambrano & Añez 1993) **n. comb.** The morphology of the haptoral structures supports the transfer of *Rhamnocercus seenghali* Kumar, 2013 to *Chauhanellus* as *Chauhanellus seenghali* (Kumar, 2013) **n. comb.**

Key words: Parasites, Atlantic Amazon coast, Monogenoidea, Dactylogyridae, *Chauhanellus*, *Hamatopeduncularia*, *Neotetraonchus*, Ariidae

Introduction

Marine catfish from Ariidae represent the most widely distributed siluriform group, and occur in tropical and temperate zones around the world. This family includes 135 species, which are predominantly marine and brackish water inhabitants, with a few species occurring in freshwaters (Marceniuck & Menezes 2007). Current estimates suggest that there are about 250 species of metazoan parasites infesting ariids around the world. Although this diversity suggests that a wide range of parasites have used these organisms as hosts, only 30% of the ariid species have been examined for parasites. The current knowledge on the diversity of parasites taken from marine catfish shows representatives of the major lineages of Metazoa, where the phylum Platyhelminthes represents more than half of this diversity (~54%) with monogenoids representing ~25% of this total (63 species). There are 20 species of marine catfish inhabit Brazilian waters (Menezes *et al.* 2003), however, very little is known about monogenoids

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from this host family in Brazil. With the exception of the parasitic fauna from ariids from South and Southeastern Brazilian coasts (Brandes 1894; Domingues & Fehlauer 2006), no information is available from the Atlantic Amazon, and this includes the coasts of the states of Amapá and Pará, where 65% of Ariidae diversity occurs in Brazilian waters (13 species).

Here, we address the fauna of monogenoidean parasites taken from the gills of ariids from the Atlantic Amazon coast and describe five new species of dactylogyrids (1 of *Hamatopeduncularia* and 4 of *Chauhanellus*). *Chauhanellus neotropicalis* Domingues & Fehlauer, 2006, *Chauhanellus boegeri* Domingues & Fehlauer, 2006, *Hamatopeduncularia bagre* Hargis, 1955 and *Neomurraytrematoides proops* Zambrano & Añez, 1993 are reported for the first time parasitizing ariids from Atlantic Amazon. *Neomurraytrematoides* Zambrano & Añez, 1993 is transferred to *Neotetraonchus* as *Neotetraonchus proops* (Zambrano & Añez, 1993) **n. comb.** *Rhamnocercus seenghali* Kumar, 2013 is transfer to *Chauhanellus* as *Chauhanellus seenghali* (Kumar, 2013) **n. comb.**

Material and methods

Fish hosts were collected by fish weir and gill net or purchased at local fish markets during the period 2011–2013. Specimens purchased at local fish markets had its gills removed and place in vials containing formalin 5%. For other specimens, gill arches were removed and placed in vials containing solution heated 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 helminths were removed from the gills or sediment using small probes. Some specimens were stained with Gomori's trichrome (Humason 1979) and mounted in Canada balsam to determine internal soft structures while others were mounted in Gray & Wess medium (Humason 1979), Hoyer's medium (Humason 1979), and a few specimens were prepared with ammonium picrate-glycerine (GAP) (Justine 2005) for the study of sclerotized structures. The measurements, all in micrometers, were taken according to the procedures of Mizelle & Klucka (1953). The dimensions of organs and other structures represented here were measured for the most part in dorsoventral view. The lengths of curved or bent structures (anchors, bars, accessory piece) were measured by the straight-line distances between extreme ends; while the length of the coiled male copulatory organ was obtained through the analysis of digital images processed using the software ImageJ 1.43m (rsb.info.nih.gov/ij/). The average measurement is followed by the ranges 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 using differential interference contrast and phase contrast optics. The definitions of prevalence and mean intensity follow the definition of Bush *et al.* (1997). Type specimens and vouchers were deposited in the following collections: Invertebrate Collection of the Museu Paraense Emílio Goeldi (MPEG), Belém, State of Pará, Brazil; Helminthological Collection of the Instituto Oswaldo Cruz (CHIOC), Rio de Janeiro, RJ, Brazil; and Invertebrate Collection of the Instituto Nacional de Pesquisas da Amazônia (INPA), Manaus, AM, Brazil. A CD containing images of the holotype of *Hamatopeduncularia bagre* Hargis, 1955 was sent by the manager of the United States National Parasite Collection Beltsville, Maryland, USA (USNPC 49339). These images were used for comparative purposes. Host scientific names were validated according to Marceniuk & Menezes (2007), Marceniuk & Betancur-R (2008) and Betancur-R *et al.* (2008). Historical review of species containing relevant taxonomic contributions, such as description (descr), diagnose (diag), redescription (redes), synonymization (synon), new record (recor), citation (citat) and Figure (Fig) were included after the valid species name.

Results

From the 448 host specimens analyzed in the present work, no monogenoids were found on the gills of *Cathorops agassizi*, *Cathorops arenatus*, *Cathorops spixii*, *Cathorops* sp. and *Sciades parkeri* (Table 1). However, the gills of the other eight species of Ariidae studied herein were parasitized by at least one species of monogenoid. The host-parasite list is presented in the taxonomic summary, as presented below.

TABLE 1. List of hosts for which no parasites were recorded.

Host	N	Locality
Cathorops agassizii	7	Fish market, Municipality of Bragança, State of Pará, Brazil
	5	Bombom Village, Municipality of Viseu, State of Pará, Brazil (01°11’48”N, 46°08’24” W).
	1	Fishing village of Ajuruteua, Municipality of Bragança, State of Pará, Brazil (0°49’31”N, 46°36'29"W).
Cathorops arenatus	1	Fish market, Municipality of Bragança, State of Pará, Brazil
	1	Bombom Village, Municipality of Viseu, State of Pará, Brazil
	14	Fishing village of Ajuruteua, Municipality of Bragança, State of Pará, Brazil
Cathorops spixii	8	Fish market, Municipality of Bragança, State of Pará, Brazil
	6	Bombom Village, Municipality of Viseu, State of Pará, Brazil
	3	Fishing village of Ajuruteua, Municipality of Bragança, State of Pará, Brazil
Cathorops sp.	1	Bombom Village, Municipality of Viseu, State of Pará, Brazil
	2	Fishing village of Ajuruteua, Municipality of Bragança, State of Pará, Brazil
Sciades parkeri	1	Fish market, Municipality of Bragança, State of Pará, Brazil
	47	Atlantic coast, State of Amapá, Brazil (02°14'87,5"N,: 50°26'72,8"W).

Class Monogenoidea Bychowsky, 1937

Subclass Polyonchoinea Bychowsky, 1937

Order Dactylogyridea Bychowsky, 1937

Dactylogyridae Bychowsky, 1933

Chauhanellus Bychowsky & Nagibina, 1969

Chauhanellus hamatopeduncularoideum n. sp.

(Figs. 1–7)

Type-host: *Amphiarius rugispinis* (Valenciennes)

Site of infection: Secondary lamellae of the gills.

Type locality: Fishing village of Ajuruteua, Municipality of Bragança, State of Pará, Brazil (0°49’31”N, 46°36'29"W).

Other records: *Amphiarius rugispinis*, Bombom Village, Municipality of Viseu, State of Pará, Brazil (01°11’48”N, 46°08’24”W); *A. rugispinis*, Fish market, Municipality of Bragança, State of Pará, Brazil. *Sciades couma* (Valenciennes), Fish market, Municipality of Bragança, State of Pará, Brazil.

Prevalence of infection: 23 of 29 *Amphiarius rugispinis* (79%); 13 of 14 *Sciades couma* (92%).

Specimens deposited: Holotype, CHIOC 38240a; 16 paratypes, CHIOC 38240b–h, INPA 666, MPEG 044–047; 35 vouchers, CHIOC 38241a–f, 38242, 38243a–c, 38244a–b, 38245a–b, 38246a–c, INPA 667–669, MPEG 048–056.

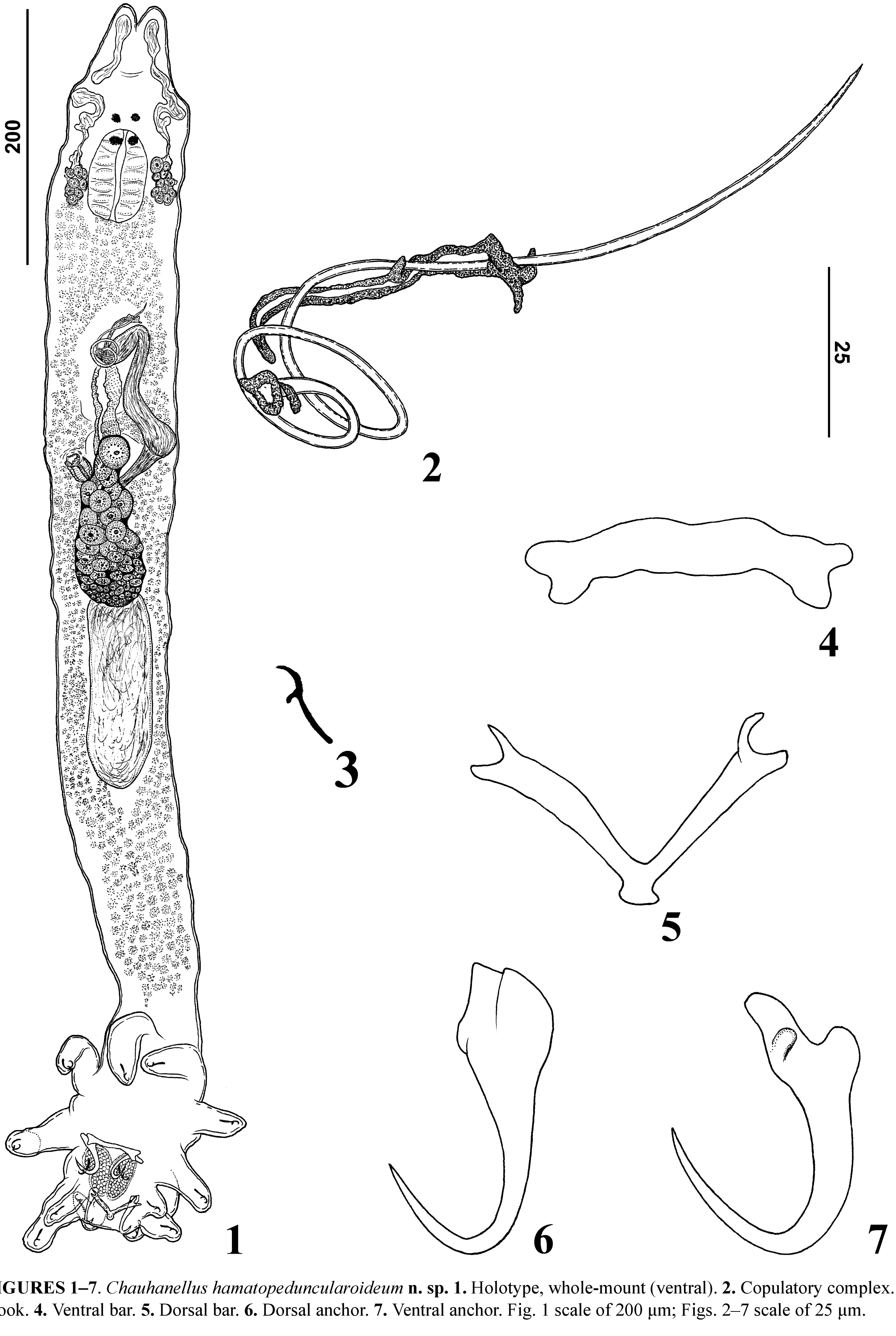
Etymology: The specific name refers to the superficial resemblance of the species of *Hamatopeduncularia*, mainly by possessing hooks located on haptoral digits and absence of expanded deep roots on the ventral anchors.

Comparative measurements: Table 2.

Description: Based on 25 adult specimens; 10 mounted in Gomori’s trichrome, 15 mounted in Hoyer’ medium. Body fusiform (Fig. 1), total length excluding haptor 754 (710–810; n=5) long, 121 (90–160; n=7) wide at level of germarium. Tegument smooth with a tapered cephalic margin with moderately developed terminal lobes. Three bilateral pairs of head organs with rod-shaped secretion; unicellular cephalic glands lying lateral to pharynx. Equidistant eyes present (4); accessory granules absent. Mouth subterminal, midventral; pharynx ovate, 84 (64–

110; n=5) long, 81 (73–88; n=5) wide; oesophagus, intestinal caeca obscured by vitellaria. Genital pore opening midventral, anterior to copulatory complex; muscular genital atrium. Testis post-germarial, dorsal to germarium, bacilliform, 143 (n=1) long, 71(n=1) wide. Vas deferens apparently looping left of intestinal cecum; seminal vesicle a dilatation of vas deferens, sigmoid. Prostatic reservoir not observed. Copulatory complex comprising male copulatory organ, accessory piece; male copulatory organ, coiled sclerotized tube 206 (185–227; n=11) long, with two clockwise rings, distal aperture acute; base with sclerotized margin. Accessory piece sclerotized, non-articulated with male copulatory organ comprising sheath along last ring and medial portion of male copulatory organ; distal portion of accessory piece bifurcated, which serves as a guide to male copulatory organ (Fig. 2). Germarium 123 (119–127; n=3) long, 57 (50–63; n=3) wide, saccate. Vagina comprises vaginal aperture with dextroventral opening, submarginal: vaginal vestibule with soft tissue; vaginal canal elongate, sclerotized, cup-shaped. Seminal receptacle, ootype, Mehlis' glands not observed. Vitellaria dense throughout trunk except in region of reproductive organs. Eggs not observed. Peduncle elongate. Haptor digitate, 170 (n=2) long, 90 (80–100; n=2) wide. Anchors dissimilar. Ventral anchor (Fig. 7), base 10 (8–13; n=10) long, with divergent roots; superficial root 33 (31–37; n=12) long, deep root 28 (24–30; n=12) long, not expanded; with knob shaped expansion for articulation with ventral bar; slightly curved shaft, elongate point extending well past level of tip of superficial root. Dorsal anchor (Fig. 6) 41 (38–43; n=6) long, base 14 (11–16; n=7) long, robust, with inconspicuous roots, slightly expanded outer base, slightly curved shaft, elongated point extending well past level of tip of inner base; anchor spine blunt. Ventral bar (Fig. 4) 6 (4–10; n=9) long, 48(38–52; n=7) wide, dumbbell shaped, with protuberances at each end for articulation with ventral anchor. Dorsal bar (Fig. 5) 7 (5–8; n=8) long, 50 (43–65; n=7) wide, V-shaped, with bifurcation on both ends, elongated posteromedial process. Hooks similar in shape (Fig. 3), 14 (11–16; n = 12) long, shank without inflation, depressed thumb, lightly curved long shaft, and delicate point. Filamentous hook loop not observed.

Remarks: *Chauhanellus hamatopeduncularoideum* **n. sp.** is characterized by having a combination of *Hamatopeduncularia*-like features (*i.e.,* haptoral digits, absence of expanded deep roots on the ventral anchors) and *Chauhanellus*-like features (*i.e.,* spine on dorsal anchor, dumbbell-shaped ventral bar, dorsal bar with posteromedial process). Lim (1996) reported eight species of monogenoids (4 of *Hamatopeduncularia* and 4 of *Chauhanellus*) that possess a combination of features of both genera, and although there are strictly no unique characteristics (synapomorphies), each species could be assigned to either of the genera based on those combinations (see Lim 1994, 1996). Although the presence of haptoral digits is a diagnostic feature for *Hamatopeduncularia* (Yamaguti 1953, 1963; Lim 1996), it is also reported for some species of *Chauhanellus*: *C. australis* (Young, 1967), *C. pedunculatus* Paperna, 1977, *C. digitalis* Lim, 1994, and the two new species described herein (*i.e., C. hamatopeduncularoideum* **n. sp.** and *C. susamlimae* **n. sp.**). Kearn & Whittington (1994) considered that the presence of extensible haptoral digits observed in *Hamatopeduncularia* might be a valid distinction between this genus and *Chauhanellus*. However, Lim (1996) suggests that haptoral digits should not be considered as a distinguishing feature between *Hamatopeduncularia* and *Chauhanellus*. The presence of haptoral digits is also reported for species of *Trinigyrus* Hanek, Molnar & Fernando 1974 from loricariids (Siluriformes, Loricariidae) from Central America and South America. Kritsky *et al.* (1986) suggested that *Hamatopeduncularia* and *Trinigyrus* are closed related mainly by sharing some haptoral elements (*i.e.,* haptoral digits, posteromedial projections in the bar and conspicuous glandular reservoirs), and by parasitizing Siluriformes fishes. However, only a cladistic analysis will indicate the real relationship between these genera with other dactylogyrids, and whether those shared characters are phylogenetically informative. Other important diagnostic characteristic used to discriminate both genera is the presence of expanded deep roots on the ventral anchors, as well as, the presence of ventral bar with bifurcated ends (dumbbell shaped) which occurs in all species of *Chauhanellus* (Bychowsky & Nagibina 1969; Lim 1994). Kearn & Whittington (1994) considered the flange on the shaft of the ventral anchor of *Hamatopeduncularia pearsoni* Kearn & Whittington, 1994 similar to the expanded deep roots on the ventral anchors found on species of *Chauhanellus*. However, these authors considered that this species belongs to *Hamatopeduncularia* because it possesses, among other features, extensible haptoral digits. With the exception of *Chauhanellus intermedius* Lim, 1994 and *C. aspinous* Lim, 1994, the presence of a spine on the dorsal anchor is the common characteristic for species of *Chauhanellus*. We decided to accommodate the new species in *Chauhanellus* as C. *hamatopeduncularoideum* **n. sp.** mainly because it possesses a spine on the inner base of the dorsal anchor, as well as a dumbbell-shaped ventral bar and dorsal bar with spines at both ends and a posteromedial process.



FIGURES 1–7. *Chauhanellus hamatopeduncularoideum* **n. sp. 1.** Holotype, whole-mount (ventral). **2.** Copulatory complex. **3.** Hook. **4.** Ventral bar. **5.** Dorsal bar. **6.** Dorsal anchor. **7.** Ventral anchor. Fig. 1 scale of 200 µm; Figs. 2–7 scale of 25 µm.

TABLE 2. Comparative measurements (in µm) of specimens of *Chauhanellus hamatopeduncularoideum* **n. sp.** from the gills of *Amphiarius rugispinis* and *Sciades couma* . MCO= male copulatory organ.

	A. rugispinis	N	*S. couma*	N
Body				
Length	754 (710–810)	5	527(420–600)	3
Width	121 (90–160)	7	97(60–120)	3
Haptor				
Length	170 (170–170)	2	145(140–150)	2
Width	90 (80–100)	2	155(140–170)	2
Pharynx				
Length	84 (64–110)	5	58(57–58)	2
Width	81 (73–88)	5	51(50–53)	2
MCO length	206 (185–227)	11	182(163–198)	3
MCO ring	20 (18–23)	11	26(25–27)	3
Ventral Bar				
Length	6 (4–10)	9	7(6–8)	3
Width	48 (38–52)	7	48(48–49)	2
Dorsal Bar				
Length	7 (5–8)	8	8(8–10)	4
Width	50 (43–65)	7	51(48–54)	2
Ventral Anchor				
Inner	28 (24–30)	12	31 (29–32)	4
Outer	33 (31–37)	12	33 (32–33)	4
Base	10 (8–13)	10	13 (13–14)	4
Dorsal Anchor				
Inner	40 (38–43)	5	41 (40–41)	5
Outer	41 (38–43)	6	43 (41–43)	5
Base	14 (11–16)	7	14 (13–14)	5
Hooks	14 (11–16)	12	15	2
Germarium				
Length	123 (119–127)	3	74 (71–76)	2
Width	57 (49–63)	3	40 (32–48)	2
Testis				
Length	123 (119–127)	3	74 (71–76)	2
Width	57 (49–63)	3	40(32–48)	2

Chauhanellus hypenocleithrum **n. sp.**

(Figs. 8–14)

Type-host: *Sciades proops* (Valenciennes).

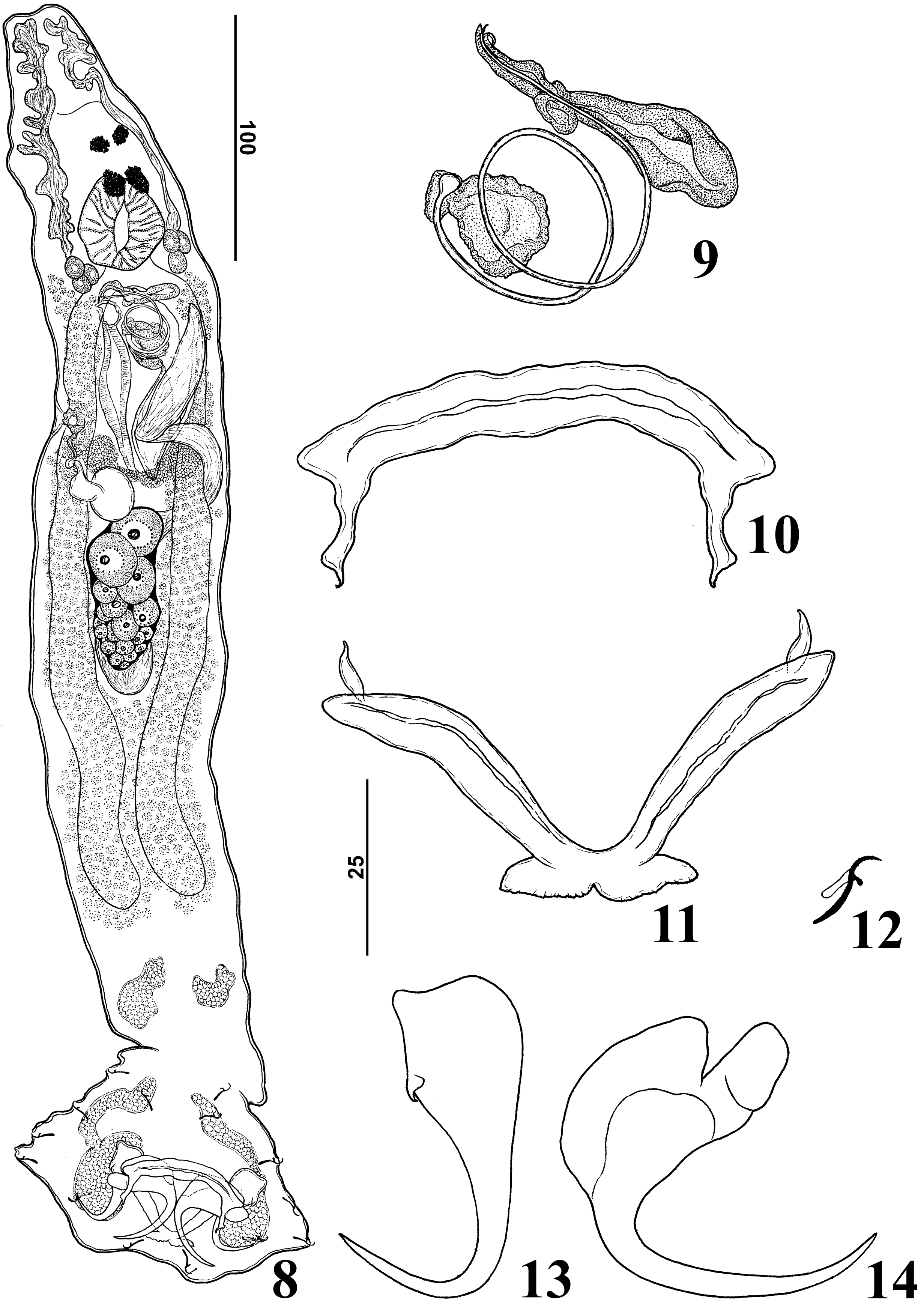
Site of infection: Secondary lamellae of the gills.

Type locality: Fishing village of Ajuruteua, Municipality of Bragança, State of Pará, Brazil (0°49'31"N, 46°36'29"W).

Prevalence of infection: 11 of 11 (100%).

Specimens deposited: Holotype, CHIOC 38247; 13 paratypes, CHIOC 38248a–b, 38249a–b, 38250a–b, INPA 678, MPEG 057–058.

Etymology: The specific name is from Greek (*hypen* = moustache; *kleithron*= bar) and refers to the shape of the posterior protuberances of the dorsal bar.



FIGURES 8–14. *Chauhanellus hypenocleithrum* **n. sp. 8.** Holotype, whole-mount (ventral). **9.** Copulatory complex. **10.** Ventral bar. **11.** Dorsal bar. **12.** Hook. **13.** Dorsal anchor. **14.** Ventral anchor. Fig. 8 scale of 100 µm; Figs. 9–14 scale of 25 µm.

Description: Based on 12 adult specimens; 3 mounted in Gomori's trichrome, 9 mounted in Hoyer' medium. Body fusiform (Fig. 8), total length excluding haptor 339 (250–435; n=4) long, 63 (30–95; n=4) wide at level of germarium. Tegument smooth. Cephalic margin tapered; poorly developed terminal lobes; three bilateral pairs of head organs with rod-shaped secretion; cephalic glands unicellular, posterolateral to pharynx. Eyes 4, posterior pair larger than anterior pair; accessory granules absent or few in cephalic area, spherical. Mouth subterminal, midventral; pharynx subovate, 37(35–40; n=4) long, 32 (27–38; n=4) wide; oesophagus short, intestinal caeca two, non-confluent posteriorly, lacking diverticula. Genital pore opening mid-ventral; genital atrium muscular. Gonads overlapping; testis dorsal to germarium. Testis elongate, 43(n=1) long, 30 (n=1) wide. Vas deferens looping left intestinal cecum; seminal vesicle a dilatation of vas deferens, sigmoid. One prostatic reservoir, pyriform, lying ventral lateral to copulatory complex. Copulatory complex comprising male copulatory organ, accessory piece; male copulatory organ, sclerotized, a coiled tube with 2 counterclockwise rings, base with an expanded sclerotized cap, 188 (148–199; n=7) long, distal aperture acute. Accessory piece sclerotized, non-articulated with male copulatory organ comprising an elongated sheath with bifurcated distal portion (Fig. 9). Germarium 64 (63–65; n=2) long, 25 (24–27; n=2) wide, elongated. Vagina comprising vaginal aperture with dextroventral opening, marginal; vaginal vestibule, vaginal canal; vaginal canal sclerotized, elongated, sigmoid, with distal portion expanded before entering into seminal receptacle. Seminal receptacle ovate; Mehlis' glands, ootype not observed. Vitellaria dense throughout trunk, except in region of reproductive organs. Eggs not observed. Peduncle elongate. Haptor subhexagonal, 19 (14–30; n=4) long, 23 (14–40; n=4) wide. Anchors dissimilar. Ventral anchor (Fig. 14), base 33 (30–35; n=8) long, with divergent roots, truncate superficial root, 35 (33–40; n=8) long, expanded deep root, 46 (43–49; n=8) long; short shaft, elongated point; point extending beyond of tip of superficial root. Dorsal anchor (Fig. 13) 46 (45–48; n=8) long, base 17 (16–17; n=8) long, robust, with inconspicuous roots, evenly curved shaft, point; point extending well past level of tip of inner base; anchor spine blunt. Ventral bar (Fig. 10) 10 (8–14; n=7) long, 65 (57–75; n=7) wide, curved in posterior direction with longitudinal groove; protuberances at each end for articulation with ventral anchor, posterior protuberance elongated with hook shaped termination at distal portion. Dorsal bar (Fig. 11) 8 (6–10; n=6) long, 42 (38–48; n=8) wide, V-shaped, with rounded ends; donkey-ear like protuberance on both ends; short posteromedial process with medial constriction (moustache-like). Hooks similar in shape (Fig. 12), 12(10–13; n = 8) long, shank without inflation, depressed thumb, lightly curved long shaft, delicate point, filamentous hook loop about half of shank length.

Remarks: *Chauhanellus hypenocleithrum* **n. sp.** is morphologically closer to *C. hamatopeduculoideum* **n. sp.** due to the presence of coiled male copulatory organ and also by having a sclerotized vaginal vestibule and canal; hooks with shank without inflation. It differs from *C. hamatopeduculoideum* **n. sp.** by possessing a haptor without digits, ventral anchor with expanded deep root, and ventral bar with an elongate posterior protuberance. The new species also differs from all other congeneric species by possessing a dorsal bar with a short posteromedial process with medial constriction (moustache-like).

Chauhanellus susamlimae n. sp.

(Figs. 15–21)

Type-host: *Sciades herzbergii* (Bloch).

Site of infection: Secondary lamellae of the gills.

Type locality: Fishing village of Ajuruteua, Municipality of Bragança, State of Pará, Brazil (0°49'31"N, 46°36'29"W).

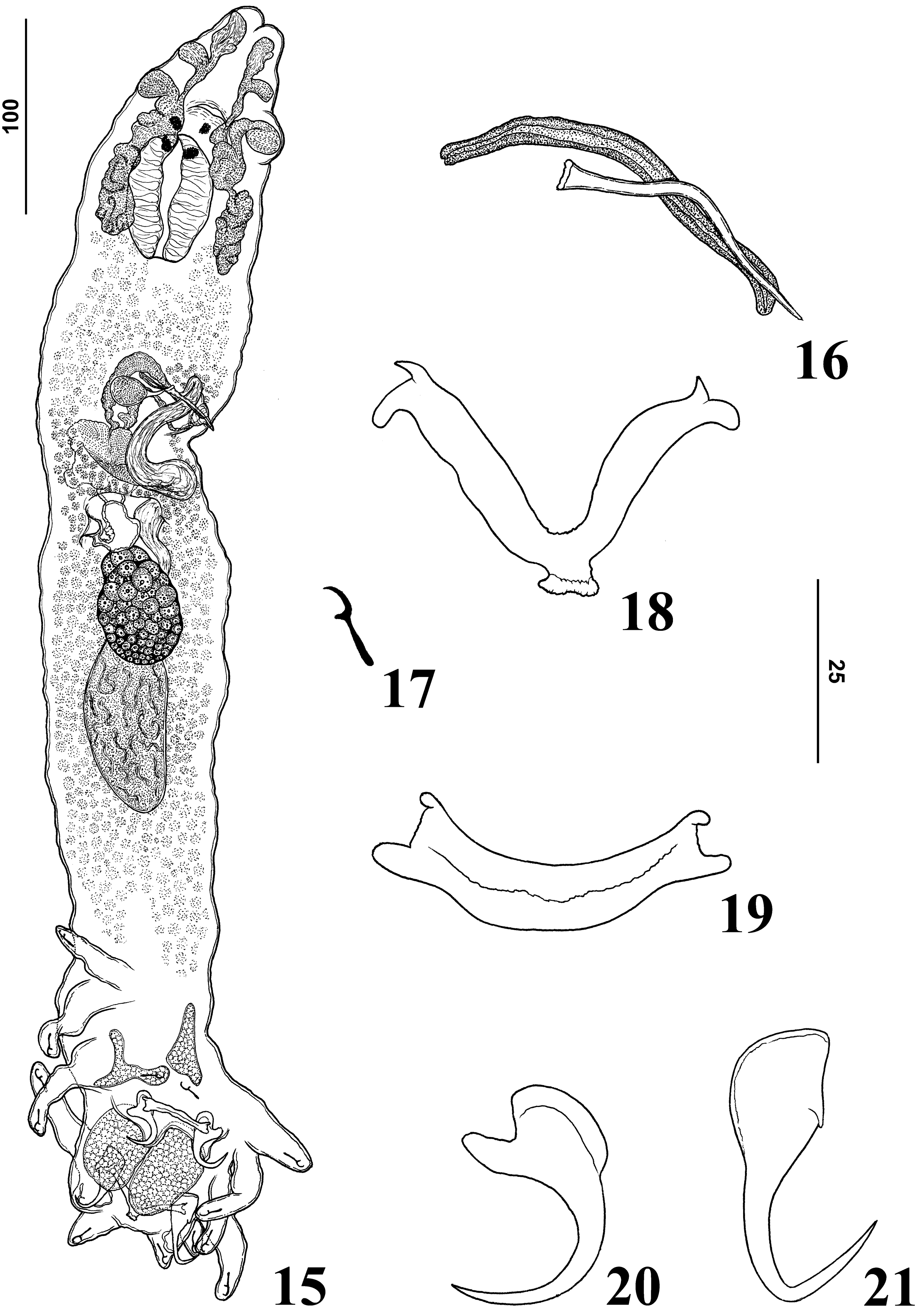
Other records: *Sciades herzbergii,* Bombom Village, Municipality of Viseu, State of Pará, Brazil (01°11'48"N, 46°08'24"W); *S. herzbergii*, Fish market, Municipality of Bragança, State of Pará, Brazil; *S. herzbergii*, Furo da Ostra (0°38' 59"S, 47°53'22,89917"W) municipality of Curuça, State of Pará, Brazil; *S. herzbergii*, Japerica Village (0°51'28"S, 47°10' 41,69"W), municipality of São João de Pirabas, State of Pará, Brazil; *Sciades passany* (Valenciennes)*,* Fish market, Municipality of Bragança, State of Pará, Brazil.

Prevalence of infection: 12 of 13 (92%).

Specimens deposited: Holotype, CHIOC 38251a; 13 paratypes, CHIOC 38251b–h, INPA 684, MPEG 073–074; 26 vouchers, CHIOC 38252–38260, INPA 685–686, MPEG 075–079.

Etymology: the species is dedicated to Prof. L.H.S. Lim in recognition for her work on monogenoids from Ariidae.

Comparative measurements: Table 3.



FIGURES 15–21. *Chauhanellus susamlimae* **n. sp. 15.** Holotype, whole-mount (ventral). **16.** Copulatory complex. **17.** Hook. **18.** Dorsal bar. **19.** Ventral bar. **20.** Ventral anchor. **21.** Dorsal anchor. Fig. 15 scale of 100 µm; Figs. 16–21 scale of 25 µm.

TABLE 3. Comparative measurements (in µm) of specimens of *Chauhanellus susamlimae* **n. sp.** from the gills of *Sciades herbergii* and *S. passany*. MCO= male copulatory organ.

	S. herbergii	N	*S. passany*	N
Body				
Length	435(330–520)	4	648(497–913)	5
Width	85(70–90)	4	115(95–153)	4
Haptor				
Length	116(100–145)	4	135(132–138)	2
Width	124(95–175)	4	86(79–94)	2
Pharynx				
Length	68(62–75)	4	51	1
Width	46(34–54)	4	40	1
MCO length	47(43–55)	6	28	1
Ventral Bar				
Length	6(5–8)	9	5(2–7)	6
Width	40(35–44)	8	40(36–49)	6
Dorsal Bar				
Length	7(6–8)	8	5(5–7)	7
Width	42(38–48)	8	39(29–50)	6
Ventral Anchor				
Inner	23(22–24)	11	23(22–25)	5
Outer	28(25–32)	11	30(28–33)	4
Base	14(10–19)	11	13(12–16)	4
Dorsal Anchor				
Inner	37 (35–40)	9	35(33–37)	5
Outer	35 (35–38)	9	35(34–37)	5
Base	12(11–14)	9	11(10–14)	5
Hooks	13(12–15)	6	12(12–13)	5
Germarium				
Length	66(63–74)	4	76	1
Width	35(24–41)	4	64	1
Testis				
Length	100(79–117)	4	116(91–142)	2
Width	44(40–48)	4	59(55–64)	2

Description: Based on 15 adult specimens; 4 mounted in Gomori's trichrome, 11 mounted in Hoyer' medium. Body fusiform (Fig. 15), total length excluding haptor 435(330–520; n=4) long, 85 (70–90; n=4) wide at level of germarium. Tegument smooth. Cephalic margin tapered; moderately developed terminal lobes; three bilateral pairs of head organs with rod-shaped secretion; cephalic glands unicellular, lateral to pharynx. Eyes 4, posterior pair closer than anterior pair; accessory granules absent or few in cephalic area, spherical. Mouth subterminal, midventral; pharynx ovate, 68 (62–75; n=4) long, 46 (34–54; n=4) wide; oesophagus, intestinal ceca obscured by vitellaria. Genital pore opening ventral, moved to lateral margin of the body, lateral to copulatory complex; genital atrium muscular. Testis post-germarial; testis dorsal to germarium. Testis saccate, 100 (79–117; n=4) long, 44 (40–48; n=4) wide. Vas deferens apparently looping left of intestinal cecum, seminal vesicle a dilatation of vas deferens, sigmoid. One prostatic reservoir, pyriform, lying ventral lateral to copulatory complex. Copulatory complex comprising male copulatory organ, accessory piece; male copulatory organ, sclerotized tube, sigmoid 47 (43–55; n=6) long, distal aperture acute. Accessory piece sclerotized, non-articulated with male copulatory organ comprising an elongated sheath (Fig. 16). Germarium 66 (63–74; n=4) long, 35 (24–41; n=4) wide, subspherical. Vagina comprising vaginal aperture with dextroventral opening; vaginal vestibule with soft tissue; vaginal canal short, muscular, sigmoid. Seminal receptacle saccate, distal end ascendant; Mehlis' glands bilateral to ootype, some portions of Mehlis' glands obscured by transverse vitelline commissures and seminal vesicle. Vitellaria dense throughout trunk, except in region of reproductive organs. Eggs not observed. Peduncle elongate. Haptor digitate, 116 (100–145; n=4) long, 124 (95–175; n=4) wide. Anchors dissimilar. Ventral anchor (Fig. 20), base 14 (10–19; n=11) long, with divergent roots, truncate superficial root, 28 (25–32; n=11) long, expanded deep root, 23 (25–32; n=11) long; evenly curved shaft, point; point extending at level of tip of superficial root. Dorsal anchor (Fig. 21) 37 (35–40; n=9) long, base 12 (11–14; n=9) long, robust, with inconspicuous roots, slightly curved shaft, elongated point extending well past level of tip of inner base; anchor spine blunt. Ventral bar (Fig. 19) 6 (5–8; n=9) long, 40 (35–44; n=8) wide, broadly U-shaped, with short protuberances at each end for articulation with ventral anchor, anterior protuberance smaller than posterior protuberance. Dorsal bar (Fig. 18) 7 (6–8; n=8) long, 42 (38–48; n=8) wide, V-shaped, with bifurcation on both ends, acute anterior protuberance, rounded posterior protuberance; blunt posteromedial process. Hooks similar in shape (Fig. 17), 13 (12–15; n = 6) long, shank without inflation, erect thumb, lightly curved long shaft, delicate point, filamentous hook loop not observed.

Remarks: The new species seems to be closely related to *Chauhanellus boegeri* Domingues & Fehlauer, 2006 and *Chauhanellus neotropicalis* Domingues & Fehlauer, 2006 by having dorsal bar with posteromedial process, hooks not proximally inflated, and a muscular vagina (unsclerotized). However, *Chauhanellus susamlimae* **n. sp.** can be easily distinguished from these species because it possesses a haptor with digitations, ventral bar with short posterior protuberances (posterior protuberances foot-like in *C. boegeri* and *C. neotropicalis*), and dorsal bar with bifurcation on both ends (non-bifurcated in *C. boegeri* and *C. neotropicalis*).

***Chauhanellus velum* n. sp.**

(Figs. 22–29)

Type-host: *Sciades couma* (Valenciennes)

Site of infection: Internal borders of the primary lamellae of the gills.

Type locality: Fish market, Municipality of Bragança, State of Pará, Brazil.

Other records: *Sciades herzbergii,* Furo da Ostra (0°38’ 59”S, 47°53’22,89917”W) municipality of Curuça, State of Pará, Brazil; *Sciades passany*, Fish market, Municipality of Bragança, State of Pará, Brazil.

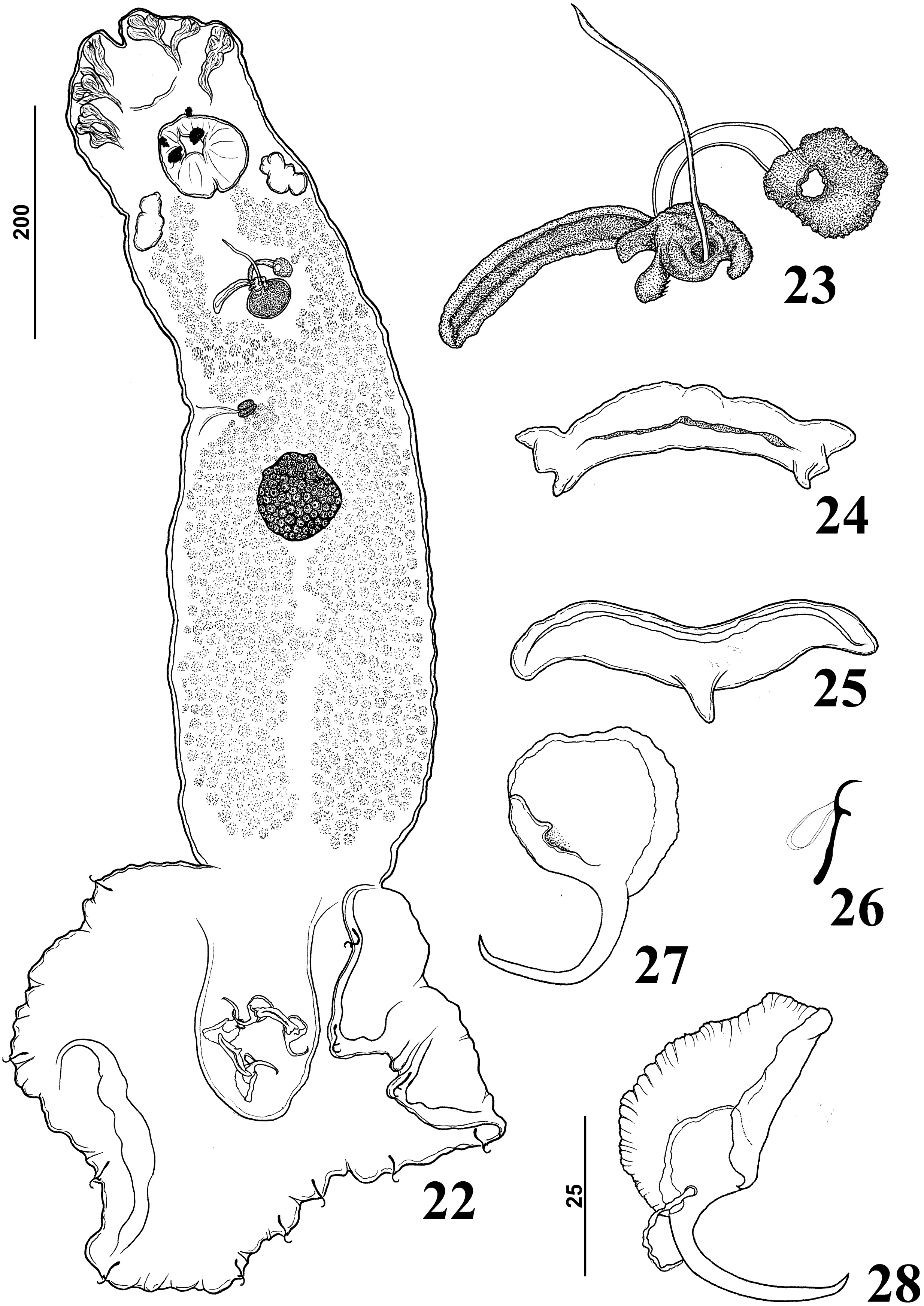
Prevalence of infection: 2 of 14 (14%) of *S. couma*; 1 of 79 (1%) of *S. herzbergii*; 3 of 13 (23 %) of *S. passany.*

Specimens deposited: Holotype, CHIOC 38261; 1 paratype, INPA 679; 4 vouchers, CHIOC 38261 –38262a–b, MPEG 060.

Etymology: The specific name (a noun) is from the Latin *velum* (a veil) and refers to the shape of the haptor.

Comparative measurements: Table 4.

Description: Based on 6 adult specimens; 3 mounted in Gomori’s trichrome, 3 mounted in GAP. Body fusiform (Fig. 22), total length excluding haptor 1025 (950–1100; n=2) long, 215 (180–250; n=2) wide at level of germarium. Tegument smooth. Cephalic margin tapered; moderately developed terminal lobes; three bilateral pairs of head organs with rod-shaped secretion; cephalic glands unicellular, lateral to pharynx. Eyes 4, posterior pair larger than anterior pair; accessory granules absent or few in cephalic area, spherical. Mouth subterminal, midventral; pharynx subspherical, 119 (n=1) long, 113 (n=1) wide; oesophagus, intestinal caeca obscured by vitellaria. Genital pore, genital atrium not observed. Testis post-germarial; testis dorsal to germarium. Testis spherical, 129 (100–158; n=2) long, 91 (58–125; n=2) wide. Vas deferens, seminal vesicle obscured by vitellaria. One prostatic reservoir, spherical, lying ventral posterior to copulatory complex. Copulatory complex comprising male copulatory organ, accessory piece; male copulatory organ, sclerotized, a coiled tube with 1 counterclockwise ring, base with an expanded sclerotized cap, 110 (n=1) long, distal aperture acute. Accessory piece sclerotized, non-articulated with male copulatory organ comprising two portions, proximal portion with three small projections (one projection serrated on inner margin) and duct throughout the male copulatory organ pass, distal portion an elongated sheath (Fig. 23). Germarium 158 (159–165; n=2) long, 90 (63–116; n=2) wide, spherical. Vagina comprising vaginal aperture with dextroventral opening, marginal; vaginal vestibule with soft tissue; vaginal canal short, sclerotized, knob shape. Seminal receptacle, Mehlis’ glands, ootype not observed. Vitellaria dense throughout trunk, except in region of reproductive organs. Eggs not observed. Peduncle short. Haptor subcircular, velum like, anchor/bar complex positioned at center of haptor in a small protuberance, margin of haptor delicate, armed with 12 evenly spaced marginal hooks. Anchors dissimilar. Ventral anchor (Fig. 27) 62(n=1) long, base 40(n=1) long, robust, base with expanded medial, posterior; inconspicuous roots, shaft bent at midpoint, forming



FIGURES 22–28. *Chauhanellus velum* **n. sp. 22.** Holotype, whole-mount (ventral). **23.** Copulatory complex. **24.** Ventral bar. **25.** Dorsal bar. **26.** Hook. **27.** Ventral anchor. **28.** Dorsal anchor. Fig. 22 scale of 200 µm; Figs. 23–28 scale of 25 µm.

angle of approximately 100°, short recurved point. Dorsal anchor (Fig. 28) robust, with inconspicuous roots, expanded margin, slightly curved shaft, short point; anchor spine blunt. Ventral bar (Fig. 24) 11(n=1) long, 46 (n=1) wide, curved in posterior direction with longitudinal groove; small protuberances at each end for articulation with ventral anchor. Dorsal bar (Fig. 25) 12 (n=1) long, 52(n=1) wide, open V-shaped, with longitudinal groove, rounded ends; short posteromedial process. Hooks similar in shape (Fig. 26), pairs 1–4, 6–7 at margin of the haptor, pair 5 not observed, 16 (n = 2) long, shank without inflation, depressed thumb, evenly curved shaft point, filamentous hook loop about 2/3 of shank length.

TABLE 4. Comparative measurements (in µm) of specimens of *Chauhanellus velum* **n. sp.** from the gills of *Sciades couma, S. herzbergii* and *S. passany*. MCO= male copulatory organ.

	S. couma	N	*S. herzbergii*	N	*S. passany*	N
Body						
Length	1025 (950–1100)	2	760	1	–	–
Width	215 (180–250)	2	210	1	–	–
Haptor						
Length	420	1	390	1	–	–
Width	470	1	410	1	–	–
Pharynx						
Length	119	1	71	1	–	–
Width	113	1	95	1	105 (88–122)	2
MCO length	110	1	104 (97–112)	2	85	1
Ventral Bar						
Length	11	1	10 (9–11)	2	14 (12–15)	2
Width	46	1	49 (46–52)	2	55 (52–57)	2
Dorsal Bar						
Length	12	1	14 (12–15)	2	15	2
Width	52	1	49 (41–57)	2	67 (64–69)	2
Ventral Anchor						
Inner	–		28 (25–31)	2	37	1
Outer	62	1	43 (41–44)	2	37	1
Base	40	1	29 (27–31)	2	45	1
Dorsal Anchor						
Inner	–	–	115	1	150	1
Outer	–	–	123	1	165	1
Base	–	–	75	1	63	1
Hooks	16	2	16 (15–17)	2	16	2
Germarium						
Length	158 (159–165)	2	125	1	–	–
Width	90 (63–116)	2	68	1	–	–
Testis						
Length	129(100–158)	2	–	–	–	–
Width	91(58–125)	2	–	–	–	–

Remarks: *Chauhanellus velum* **n. sp.** differs from its congeners by possessing a subcircular haptor, veil like, with anchor/bar complex positioned in a small protuberance in the center of the haptor, and hooks marginal. The shape of the haptor seems to be related to the site on the gills where this parasite attaches. While other species *Chauhanellus* occupy the secondary lamellae of the gills, *Chauhanellus velum* n. sp is able to attach itself to the internal borders of the primary lamellae by folding the haptor in its transverse axis (Fig. 29).

FIGURES 29. Photomicrograph of specimen of *Chauhanellus velum* **n. sp.** Arrow indicates the attachment point of the haptor to the internal borders of the primary lamellae. Scale of 50 µm.

Chauhanellus boegeri Domingues & Fehlauer, 2006

Chauhanellus boegeri: Domingues & Fehlauer (2006): 65–68, figs. 8–14 (descr); Cohen & Kohn (2008): 8, 32 (citat); Kohn *et al.* (2013): 39, 135, fig. 136 (citat).

Type-host: *Genidens barbus* (Lacepède).

Site of infection: Secondary lamellae of the gills.

Type-locality: Baía de Guaratuba, Municipality of Guaratuba, State of Paraná, Brazil.

Other records: *Genidens genidens* (Cuvier), Baía de Guaratuba, Municipality of Guaratuba, State of Paraná, Brazil; *Sciades couma*, Fish market, Municipality of Bragança, State of Pará, Brazil; *Sciades herzbergii*, Caratateua Village, Municipality of Bragança, State of Pará, Brazil (0°59' N, 46°44', 4644' W); *S. herzbergii*, Fishing village of Ajuruteua, Municipality of Bragança, State of Pará (0°49'31"N, 46°36'29"W)

Prevalence of infection: 14 of 14 (100%) of *S. couma*; 69 of 79 (88%) of *S. herzbergii.*

Remarks: Specimens of *Chauhanellus* parasitizing the gills of *Sciades couma* and *S. herzbergii* clearly are considered conspecific with *C. boegeri* mainly by sharing the general morphology of the male copulatory organ (a coiled tube of about 1¼ counterclockwise rings with flattened end).

Chauhanellus neotropicalis Domingues & Fehlauer, 2006

Chauhanellus neotropicalis: Domingues & Fehlauer (2006): 63–65, figs. 1–7 (descr); Cohen & Kohn (2008): 8, 32 (citat); Kohn *et al.* (2013): 39, 135, fig. 137 (citat).

Type-host: *Aspistor luniscutis* (Valenciennes).

Site of infection: Secondary lamellae of the gills.

Type-locality: Fish market, Municipality of Paranaguá, State of Paraná, Brazil.

Other records: *Aspistor quadriscutis*, Fish market, Municipality of Bragança, State of Pará, Brazil; *Amphiarius rugispinis*, Bombom Village, Municipality of Viseu, State of Pará, Brazil (01°11'48"N, 46º08'24" W); *A. rugispinis,* Fishing village of Ajuruteua, Municipality of Bragança, State of Pará, Brazil (0°49'31"N, 46°36'29"W); *A. rugispinis,* Fish market, Municipality of Bragança, State of Pará, Brazil; *Notarius grandicassis*, Bombom Village, Municipality of Viseu, State of Pará, Brazil; *N. grandicassis*, Fishing village of Ajuruteua, Municipality of Bragança, State of Pará, Brazil; *N. grandicassis*, Fish market, Municipality of Bragança, State of Pará, Brazil; *Sciades passany*, Fish market, Municipality of Bragança, State of Pará, Brazil; *Sciades proops*, Fishing village of Ajuruteua, Municipality of Bragança, State of Pará, Brazil; *S. proops*, Fish market, Municipality of Bragança, State of Pará, Brazil.

Prevalence of infection: 43 of 66 (65%) of *A. quadriscutis*; 23 of 28 (82%) of *A. rugispinis*; 17 of 19 (92%) of *N. grandicassis;* 100% of 84 *S. proops*; 12 of 13 (92%) of *S. passany.*

Remarks: The analysis of specimens of *Chauhanellus* parasitizing the gills of of *A. quadriscutis*, *A. rugispinis*, *N. grandicassis*, *S. proops* and *S. passany* indicated that they are conspecific with *C. neotropicalis*, based on the morphology of the male copulatory organ and haptoral structures. These specimens have a male copulatory organ with 1¼ counterclockwise rings and distal acute tip, ventral bar possessing postero-dorsal foot-like protuberances, and dorsal bar with V-shaped with spine-like ends. The specimens collected from those hosts did not differ morphometrically from the type-host collected from the Brazilian Southern Coast, extending the distribution of *C. neotropicalis* to the North coast of Brazil.

Hamatopeduncularia Yamaguti, 1953

Hamatopeduncularia cangatae n. sp.

(Figs. 30–36)

Type-host: *Aspistor quadriscutis* (Valenciennes)

Site of infection: Secondary lamellae of the gills.

Type locality: Fish market, Municipality of Bragança, State of Pará, Brazil.

Other records: *Aspistor quadriscutis*, Fishing village of Ajuruteua, Municipality of Bragança, State of Pará, Brazil (0°49'31"N, 46°36'29"W); *Notarius grandicassis* (Valenciennes), Bombom Village, Municipality of Viseu, State of Pará, Brazil (01°11'48"N, 46°08'24"W); *N. grandicassis*, Fishing village of Ajuruteua, Municipality of Bragança, State of Pará, Brazil; *N. grandicassis*, Fish market, Municipality of Bragança, State of Pará, Brazil.

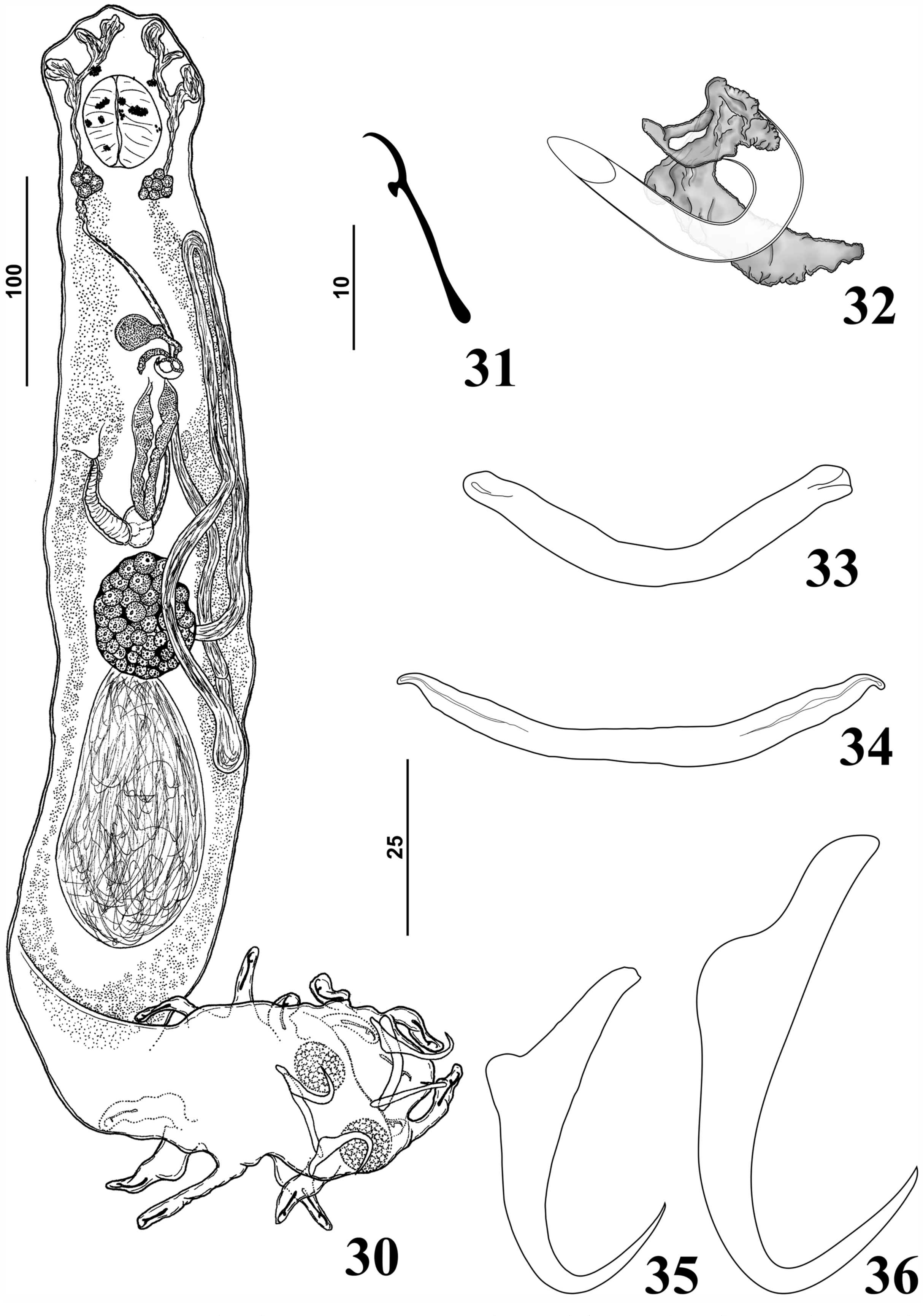
Prevalence of infection: 30 of 52 *Aspistor quadriscutis* (57%); 12 of 13 *Notarius grandicassis* (92%).

Specimens deposited: Holotype,CHIOC 38264; 5 paratypes, CHIOC 38265a–b, 38266, INPA 670–671; 22 vouchers, CHIOC 38267–38272, INPA 672–677, MPEG 063–067.

Etymology: The specific name is derived from the local name of the type host, bagre-cangatá or cangatã.

Comparative measurements: Table 5.

Description: Based on 12 adult specimens; 3 mounted in Gomori's trichrome, 9 mounted in Hoyer' medium. Body fusiform (Fig. 30), total length excluding haptor 682 (600–740; n = 5) long, 105 (90–140; n=6) wide at level of germarium. Tegument smooth. Cephalic margin tapered with moderately developed terminal lobes containing three bilateral pairs of head organs with rod-shaped secretion. Cephalic glands unicellular, posterolateral to pharynx. Eyes present (two pairs), with posterior pair closer together than anterior pair; accessory granules absent or few in cephalic area, spherical. Mouth subterminal, midventral; pharynx ovate to subspherical, 50 (40–62; n=3) long, 35 (27–45; n=3) wide; oesophagus short; intestinal ceca, nonconfluent, lacking diverticula. Genital pore opening midventral, anterior to copulatory complex, genital atrium muscular. Testis post-germarial, dorsal to germarium. Testis pyriform, 160 (n=1) long, 140 (127–152; n=2) wide. Vas deferens apparently looping left intestinal cecum; seminal vesicle a dilatation of vas deferens; seminal vesicle with extensive loops flanking left margin; proximal loop, ascendant, extend close to cephalic glands; medial loop, descendant, extend to anterior portion of testis and looping anteriorly originating distal loop that extend to the base of male copulatory organ. One prostatic reservoir, pyriform, lying dorsal anterior to copulatory complex. Copulatory complex comprising male copulatory organ, accessory piece; male copulatory organ sclerotized, arcuate 64(54–69; n=10) long, proximal portion bent, directed anteriorly; distal aperture subterminal; base with sclerotized margin. Accessory piece sclerotized, non-articulated with male copulatory organ, comprising a variable sheath (Fig. 32). Germarium 55 long



FIGURES 30–36. *Hamatopeduncularia cangatae* **n. sp. 30.** Holotype, whole-mount (ventral). **31.** Hook. **32.** Copulatory complex. **33.** Ventral bar. **34.** Dorsal bar. **35.** Ventral anchor. **36.** Dorsal anchor. Fig. 30 scale of 100 µm; Fig. 31 scale of 10 µm; Figs. 32–36 scale of 25 µm.

TABLE 5. Comparative measurements (in μm) of specimens of *Hamatopeduncularia cangatae* **n. sp.** from *Aspistor quadriscutis* and *Notarius grandicassis*. MCO= male copulatory organ.

	A. quadriscutis	N	*N. grandicassis*	N
Body				
Length	682 (600–740)	5	900	1
Width	105 (90–140)	6	145 (140–150)	2
Haptor				
Length	140	1	133 (100–150)	3
Width	90	1	85 (80–90)	2
Pharynx				
Length	50 (40–62)	3	55 (52–58)	5
Width	35 (27–45)	3	41 (35–47)	5
MCO length	65 (62–67)	3	64 (54–69)	10
MCO ring	21 (20–23)	4	19 (15–22)	10
Ventral Bar				
Length	15 (10–20)	3	6 (5–7)	12
Width	60	1	66 (49–74)	11
Dorsal Bar				
Length	8 (7–10)	3	5 (5–6)	13
Width	65 (62–67)	3	63 (56–76)	11
Ventral Anchor				
Inner	30 (25–32)	8	33 (29–35)	12
Outer	46 (42–50)	4	46 (43–49)	12
Base	22 (12–27)	4	14 (11–16)	12
Dorsal Anchor				
Inner	42 (38–44)	8	45 (41–48)	12
Outer	57 (50–65)	5	63 (59–67)	12
Base	26 (17–32)	5	16 (14–17)	12
Hooks	15 (14–16)	9	12 (10–16)	11
Germarium				
Length	55	1	84	1
Width	50	1	43	1
Testis				
Length	160	1	162 (124–195)	6
Width	140 (127–152)	2	74 (56–84)	6

(n = 1), 50 (n = 1) wide, oval. Vagina comprises a vaginal aperture with dextroventral opening, submarginal; vaginal vestibule with soft tissue, vaginal canal elongated, muscular. Seminal receptacle spherical. Unidentified tube, heavily sclerotized, running dorsally at midline of body and extends close to cephalic glands. Ootype not observed. Vitellaria coextensive with caeca. Eggs not observed. Peduncle elongate. Haptor digitate, 140(n=1) long, 90(n=1) wide. Anchors are similar, members of ventral pair larger than those of dorsal pair; each with moderately long depressed superficial root with short to nonexistent deep root, evenly curved shaft, point. Ventral anchor (Fig. 35) 46 (42–50; n=4) long, base 22 (12–27; n=4) long, superficial root 30 (25–32; n=8) long. Dorsal anchor (Fig. 36) 57 (50–65; n=5) long, base 26 (17–32; n=5) long, superficial root 42 (38–44; n=8) long. Ventral bar (Fig. 33) broadly U-shaped with longitudinal groove at both terminations, 15 (10–20; n=3) long, 60 (n=1) wide. Dorsal bar (Fig. 34) 8 (7–10; n=3) long, 65 (62–67; n=3) wide, elongate, with delicate tapered ends; longitudinal groove at both terminations. Hooks similar in shape (Fig. 31), 15 (14–16; n = 9) long, shank without inflation, depressed thumb, lightly curved long shaft, delicate point; filamentous hook loop not observed.

Remarks: *Hamatopeduncularia cangatae* **n. sp.** seems to be closely related to *H. isosimplex* Lim, 1996, *H. malayanus* Lim, 1996, and *H. simplex* Bychowsky & Nagibina, 1969 because they share ventral pair of anchors larger than those of dorsal pair, each with depressed moderately long superficial root and short to nonexistent deep root. These species also share a subterminal opening in the distal portion of the male copulatory organ. The new species can be easily distinguished from these species and other congeners by the combination of the following characters: (1) male copulatory organ arcuate "J"-shape; (2) hooks without shank inflation; (3) vas deferens long and convoluted; and (4) an unidentified sclerotized tube running dorsally at midline of the body, extending close to cephalic glands.

Hamatopeduncularia bagre Hargis, 1955

(Figures 37–46)

Syn. *Hamatopeduncularia bagrae* Hargis, 1955 (misspelling in Tripathi, 1959, page 59) *Hargitrema bagre* (Hargis, 1955) Tripathi 1959; *Hargitrema bagrae* (Hargis, 1955) Triparthi 1959 (misspelling in diagnosis).
Hamatopeduncularia bagre: Hargis (1955): 188–189, Figs 34–38 (descr); Lim *et al*. (2001): 174–176 (citat).
Hargitrema bagrae: Triparthi (1959): 60 (diag); Paperna (1977): 112, photo 2 (citat).
Hargitrema bagre: Yamaguti (1963) 69–70, pl. 13, Fig. 120 (citat.).

Type-host: *Bagre marinus* (Mitchill)

Site of infection: Secondary lamellae of the gills.

Type-locality: Alligator Harbor, Franklin County, Florida, USA.

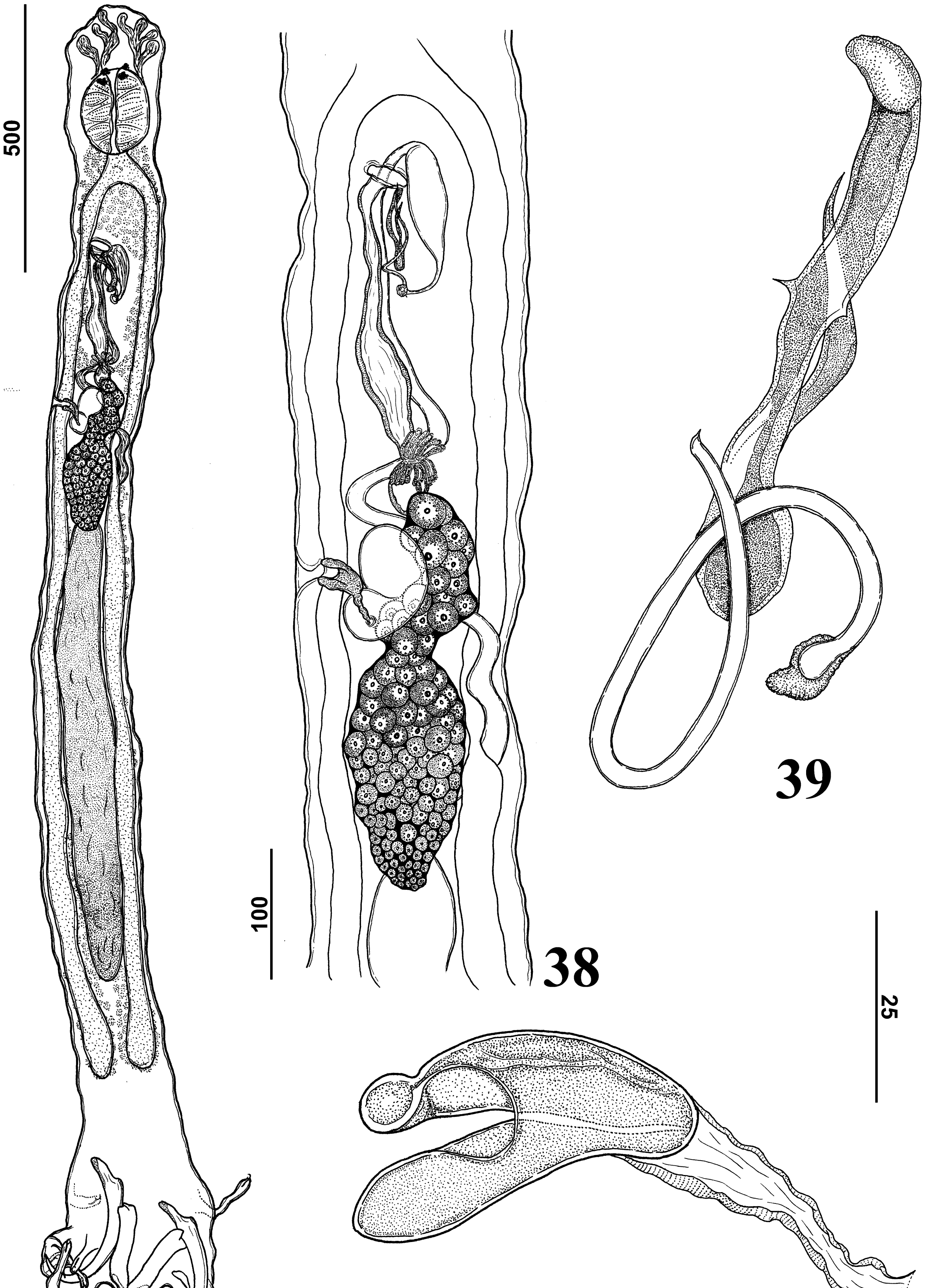
Other records: *Bagre bagre* (Linnaeus), Bombom Village, Municipality of Viseu, State of Pará, Brazil (01°11'48"N, 46º08'24" W); *B. bagre*, Caratateua Village, Municipality of Bragança, State of Pará, Brazil (0°59' N, 46°44', 46°44' W); *B. bagre*, Fishing village of Ajuruteua, Municipality of Bragança, State of Pará, Brazil (0°49'31"N, 46°36'29"W); *B. bagre*, Fish market, Municipality of Bragança, State of Pará, Brazil.

Specimens studied: 1 holotype USNPC 49339; 25 Vouchers, CHIOC 38273–38280, INPA 680–683, MPEG 061–062.

Prevalence of infection: 33 of 74 (45%) of *Bagre bagre.*

Comparative measurements: Table 6.

Redescription: Based on 21 adult specimens; 10 mounted in Gomori's trichrome, 11 mounted in Hoyer' medium. Body fusiform (Fig. 37), total length excluding haptor 1307 (1010–1560; n=3) long, fusiform, 256 (240–280; n = 5) wide, usually at level of germarium. 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. Eyes 4, equidistant; members of posterior pair of eyes larger than anterior pair; accessory granules absent or few in cephalic area, spherical. Mouth subterminal, midventral; pharynx subspherical, 136 (120–170; n = 7) long, 97 (90–115; n=5) wide; oesophagus short; intestinal caeca, nonconfluent, lacking diverticula. Genital pore opening midventral, anterior to copulatory complex; genital atrium muscular. Testis post-germarial; testis dorsal to germarium. Testis elongate fusiform, about 1/3 body length, 400 (350–450; n=2) long, 100 (100–200; n=3) wide. Vas deferens looping left intestinal cecum; seminal vesicle a dilatation of vas deferens; proximal portion of seminal vesicle sigmoid, crossing midline, dorsal to ootype, uterus; distal portion of seminal vesicle dilated, looping before connecting with male copulatory organ. Prostatic reservoir not observed. Copulatory complex comprising male copulatory organ, accessory piece; male copulatory organ, sclerotized, a coiled tube with 1 counterclockwise ring; distal aperture subterminal; base with sclerotized margin. Accessory piece sclerotized, non-articulated with male copulatory organ; proximal portion spoon shaped; distal portion with two branches, small branch with acute termination, large branch with spines at midpoint, rounded termination (Fig. 39). Germarium 100 (100–200; n=3) long, 50(50–100; n=3) wide, constricted at level of seminal receptacle; proximal portion subovate, distal portion elongate (Fig. 38). Vagina comprising vaginal aperture with dextroventral opening; vaginal vestibule with soft tissue at proximal portion; distal portion of vaginal vestibule sclerotized, cup shaped; vaginal canal sclerotized, short (Fig. 40). Seminal receptacle pyriform, distal end ascendant; Mehlis' glands bilateral to ootype. Vitellaria coextensive with caeca. Egg tetrahedral with short filament. Peduncle elongate. Haptor digitate, (usually 12), 342 (270–430; n = 6) long, 257 (220–290; n = 3) wide. Anchors dissimilar. Ventral anchor (Fig. 44), three times smaller than dorsal anchors, 60 (52–62; n = 6) long, base 17 (17; n = 4) long, inconspicuous roots, anterior tip covered with sclerotized cap; evenly curved shaft and point. Dorsal anchor (Fig. 41) 248 (270–315; n = 7) long, base 47 (42–62; n = 7) long, with elongate superficial root 228 (200–250; n=21) long, inconspicuous deep root, both root tips covered with sclerotized cap; evenly curved shaft and point; internal shaft with sclerotized cap shield shaped; external shaft with expansion keel shaped. Haptor with 3 (1 midventral, 2



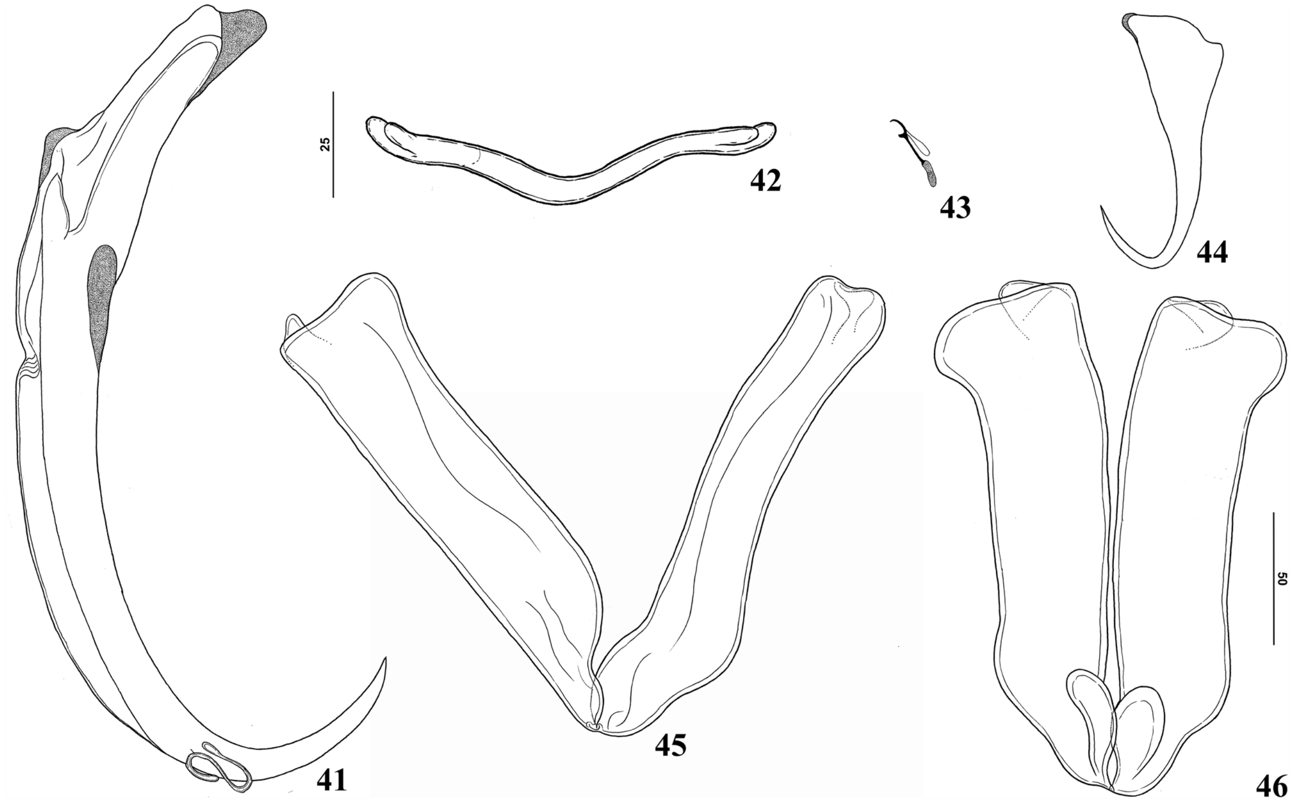
FIGURES 37–40. *Hamatopeduncularia bagre* Hargis, 1955**. 37.** Voucher, whole-mount (ventral). **38.** Ventral view of worm showing reproductive organs. **39.** Copulatory complex. **40.** Vagina. Fig. 37 scale of 500 µm; Fig. 38 scale of 100 µm; Figs. 39–40 scale of 25 µm.

TABLE 6. Comparative measurements (in µm) of specimens of *Hamatopeduncularia bagre* Hargis, 1955 from the gills of *Bagre marinus* (USNPC 49339) and *Bagre bagre*. MCO= male copulatory organ.

	B. bagre	N	*B. marinus*	N
Body				
Length	1307 (1010–1560)	3	1427	1
Width	256 (240–280)	5	238	1
Haptor				
Length	–	–	–	–
Width	–	–	–	–
Pharynx				
Length	136 (120–170)	7	92	1
Width	97 (90–115)	5	64	1
MCO length	–	–	–	–
MCO ring	–	–	–	–
Ventral Bar				
Length	45 (35–65)	9	–	–
Width	207 (183–256)	9	–	–
Dorsal Bar				
Length	5 (5–6)	4	–	–
Width	94 (68–112)	4	–	–
Ventral Anchor				
Inner	51 (50–52)	4	–	–
Outer	60 (52–62)	6	49)	1
Base	17 (17–17)	4	14	1
Dorsal Anchor				
Inner	284 (270–315)	7	199	1
Outer	228 (200–250)	21	–	–
Base	47 (42–62)	7	12	1
Hooks	17 (14–19)	16	–	–
Germarium				
Length	–	–	–	–
Width	–	–	–	–
Testis				
Length	–	–	–	–
Width	–	–	–	–

mid-dorsal) haptoral bars. Ventral bar (Fig. 42), broadly V shaped, with bifurcated ends 104 (92–120; n = 9) long, 7 (7–7; n = 20) wide. Paired dorsal bars with robust muscles connecting both bars, each dorsal bar with 204 (178–254; n = 10) long, 40 (29– 52; n = 10) wide, (Figs. 45–46), expanded ends with anterior projection twisted dorsally. Hooks (Fig. 43) similar, 17 (14–19; n = 16) long, erect thumb, lightly curved shaft, short point; shank divided into two subunits, proximal 1/3 of shank inflated; filamentous hook loop extending to near beginning of shank dilation.

Remarks: *Hamatopeduncularia bagre* Hargis, 1955 was proposed to accommodate a species from the gills of *Bagre marinus* collected from Alligator Harbor, Franklin County, Florida, USA. The species was characterized mainly by the possession of hooks on haptoral digits, two articulated dorsal bars, and dissimilarity in the size of anchors. Tripathi (1959) considered that *H. bagre* did not belong to *Hamatopeduncularia*, and proposed *Hargitrema* Tripathi, 1959 to accommodate it as *Hargitrema bagrae* (Hargis, 1955) Tripathi, 1959. The genus was defined as having two pairs of unequal anchors, three bars (one ventral, two dorsal), and intestinal caeca posteriorly united by an isthmus. Yamaguti (1963), Paperna (1977) and Lim (1996) accepted *Hargitrema* as a valid genus. However, Lim *et al*. (2001) re-assigned *Hamatopeduncularia bagre* and considered *Hargitrema* a junior synonym of *Hamatopeduncularia*. Comparison of the holotype of *H. bagre* (USNPC 49339) with specimens collected from the gills of *Bagre bagre* from Atlantic Amazon coast of Brazil allowed us to detect that Hargis (1955) erroneously identified the overlap of vitelline follicules posteriorly to testis as an isthmus uniting intestinal caeca.



FIGURES 41–46. Haptoral structures *Hamatopeduncularia bagre* Hargis, 1955**. 41.** Dorsal anchor. **42.** Ventral bar. **43.** Hook. **44.** Ventral anchor. **45–46.** Dorsal bar. Figs. 42–44 scale of 25 µm; Figs. 41, 45–46 scale of 50 µm.

The study of available specimens allowed us to confirm also that the dorsal bar is divided into two pieces, as proposed by Hargis (1955) in the description of *H. bagre*. Boeger & Kritsky (1997) found 1 ventral, 1 dorsal bars in the haptor to be a synapomorphy for the clade Dactylogyrinea+Tetraonchinea, while 1 ventral, 2 dorsal bars represented a synapomorphy for two independent clades in both suborders: Sundanonchidae + Tetraonchidae, and Diplectanidae + Pseudomurraytrematidae. Occurrences of 1 ventral, 2 dorsal bars in the haptor of some dactylogyrids species (*i.e.* species of *Curvianchoratus* Hanek, Molnar & Fernando, 1974, *Trinibaculocauda* Tripathi, 1959, *Trinibaculum* Kritsky, Thatcher & Kayton, 1980, *Thaparocleidus tengra* (Tripathi, 1959) Lim, 1996 and *Hamatopeduncularia bagre*) is apparently derived within the family and represents autapomorphies for those taxa.

Except for the presence of double dorsal bar, *Hamatopeduncularia bagre* shares features typically associated with the genus (*i.e.,* haptoral digits, absence of expanded deep roots on the ventral anchors), which supports the maintenance of this species in *Hamatopeduncularia.*

Neotetraonchus Bravo-Hollis, 1968

Neotetraonchus proops (Zambrano & Añez, 1993) n. comb.

(Figures 47–56)

Syn. *Neomurraytrematoides proops* Zambrano & Añez, 1993

Neomurraytrematoides proops: Zambrano & Añez (1993): 10–12, fig. 1 (descr); Kohn and Paiva (2000): 35 (citat); Kohn *et al.* (2013): 55, 135, fig. 245 (citat).

Type-host: *Sciades proops* (Valenciennes)

Site of infection: Secondary lamellae of the gills

Type-locality: Enseada de La Guardia, Ilha de Margarita, Venezuela.

Other records: *Sciades passany*, Fish market, Municipality of Bragança, State of Pará, Brazil.

Specimens studied: 5 Vouchers, CHIOC 38281–38282, INPA 687.

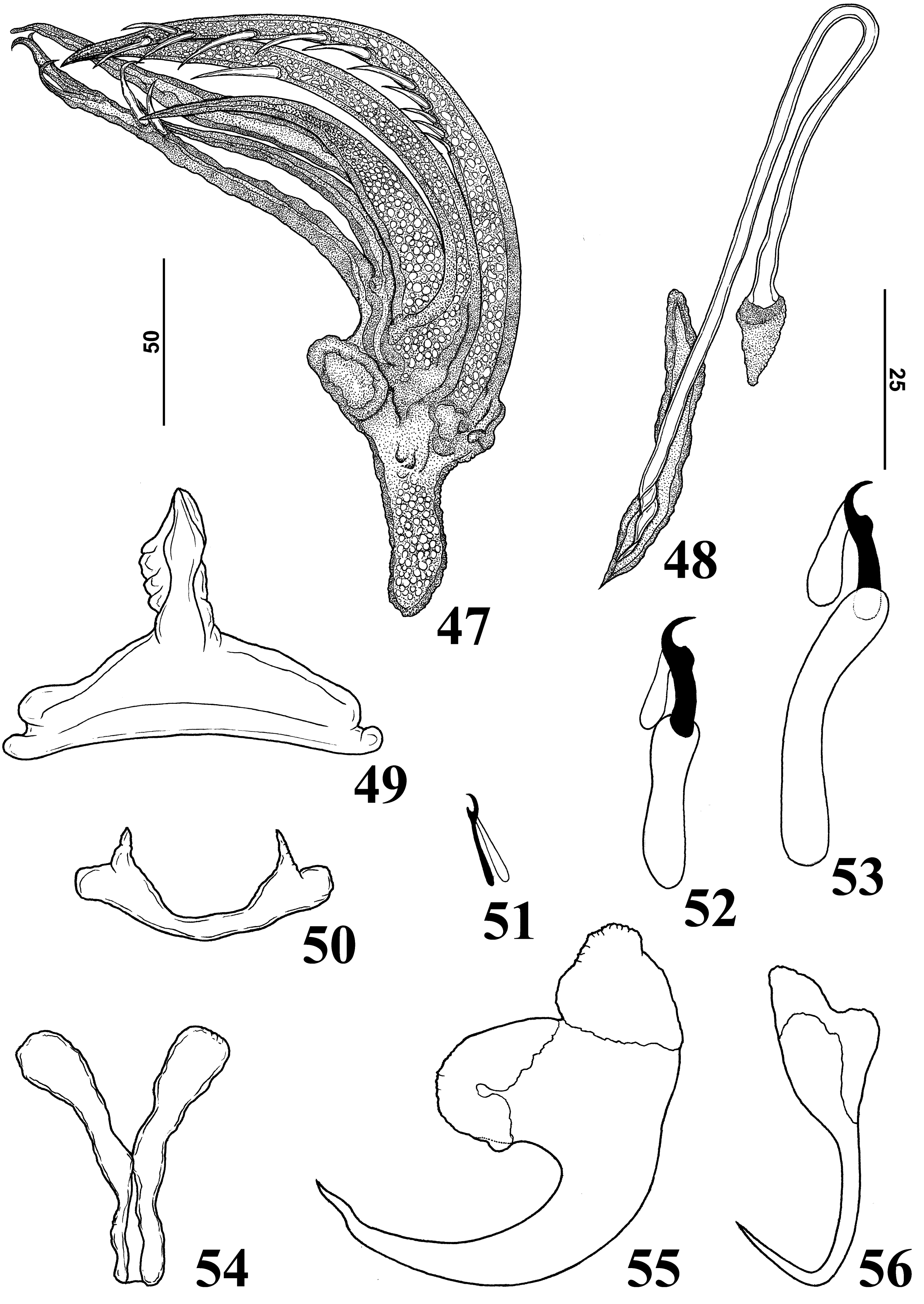
Prevalence of infection: 3 of 13(23 %) of *S. passany.*

Redescription: Based on 5 adult specimens; 4 mounted in Gomori's trichrome, 1 mounted in Hoyer' medium. Body fusiform, total length excluding haptor 2552 (2305–2800; n=2) long, fusiform, 700 (n = 2) wide, usually at level of germarium. 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. Eyes 4, equidistant; members of posterior pair of eyes larger than anterior pair; accessory granules absent. Mouth subterminal, midventral; pharynx subspherical, 102 (90–111; n = 2) long, 105(69–122; n=4) wide; oesophagus short; intestinal caeca, nonconfluent, lacking diverticula. Genital pore opening midventral, anterior to copulatory complex; genital atrium muscular. Gonads tandem; testis dorsal to germarium. Testis elongate, fusiform, 140 (n=1) long, 55 (n=1) wide. Vas deferens looping left intestinal cecum; seminal vesicle a dilatation of vas deferens. Prostatic reservoir spherical. Copulatory complex comprising male copulatory organ accessory piece (Fig. 48); male copulatory organ, sclerotized elongate tube with small base covered by sclerotized cap, proximal shaft directed posteriorly and reaching level of vaginal sclerotization, then recurving anteriorly to genital pore, terminal portion twisted. Accessory piece sclerotized, non-articulated with male copulatory organ comprising variable sheath along distal shaft of male copulatory organ. Germarium 74 (71–76; n=2) long, 150 (n=1) wide, ovate. Vaginal aperture marginal with dextroventral opening; vaginal vestibule with soft tissue at proximal portion; distal portion of vaginal vestibule comprising two portions: (1) a blind pouch containing a heavily sclerotized piece comprising a base with five projections directed to proximal portion of vaginal vestibule, three projections (two anterior, one posterior) armed with spines (Fig. 47); (2) vaginal canal sclerotized, elongate connected to seminal receptacle. Seminal receptacle medial, immediately pregermarial. Mehlis' gland large, dorsal, anterior to seminal receptacle, bilateral to ootype; uterus delicate, midventral. Vitellaria dense; bilateral vitelline ducts extending from lateral bands toward midline anterior to seminal receptacle, joining to form common vitelline duct. Egg not observed. Peduncle elongate. Haptor subtrapezoidal, 147 (136–158; n = 2) long, 142(n = 1) wide. Onchium (*sensu* Kritsky *et al.*, 2009) inverted "Y-shape, ventral in haptor, associated with hook pair 1 (Fig. 54). Anchors dissimilar. Ventral anchor (Fig. 55) 55 (55–56; n = 3) long, base 31 (30–34; n = 3) long, robust, with broad base, subequal divergent roots covered with sclerotized cap; shaft slightly recurved, point short with undulation; point extending beyond of tip of superficial root. Dorsal anchor (Fig. 56) 45 (45–46; n = 3) long, base 13 (12–15; n = 3) long, with depressed superficial root, subtriangular, short to inconspicuous deep root, margin covered with sclerotized cap; evenly curved shaft and point; union of point and shaft forming angle of approximately 65°. Ventral bar (Fig. 49), 43 (34–57; n = 3) long, 54 (50–61; n = 4) wide, subtriangular, with anteromedial projection; small protuberances at each end for articulation with ventral anchor. Dorsal bar (Fig. 50) 5 (4–16; n = 3) long, 34 (31–37; n = 3) wide, broadly U-shaped, robust, with thumb-like projections in anterior direction, rounded ends. Hooks (Figs. 51–53) dissimilar, with ancyrocephalin distribution; hook pair 5 with erect thumb, lightly curved shaft, short point, uniform shank, filamentous hook loop extending to entire shank length (Fig. 51); other hook pairs with flattened thumb, short shaft, elongate point, having shanks comprised of 2 variably expanded subunits, filamentous hook loop extending to near beginning of shank dilation (Figs. 52–53). Hook pair 1 52 (50–53; n = 3) long, hook pairs 2–4, 6–7 39 (34–41; n = 5) long, hook pair 5 13 (14–15; n = 3) long.

Remarks: Zambrano and Añez (1993) proposed the monotypic genus *Neomurraytrematoides* Zambrano & Añez, 1993 to receive their new species, *N. proops* Zambrano & Añez 1993, from the gills of *Arius proops* (Valenciennes) [now *Sciades proops* (Valenciennes)] from the Bay of La Guardia, Margarita Island, Venezuela. The genus was characterized mainly by the possession of three separate bars, two of them associated with ventral/dorsal anchors, one bar associated with an atypical pair of larval hooks, and a sclerotized structure associated with the vagina.

Specimens collected from *Sciades passany* during the present study are fundamentally similar to *Neomurraytrematoides proops* based on the morphology of the haptoral and reproductive structures. However, we detected some misinterpretations in the morphological description of the haptoral structures of *N. proops* by Zambrano & Añez (1993). These authors reported 12 haptoral hooks for *N. proops.* However, our study of available specimens confirms the presence of 14 hooks, similar in distribution to the other ancyrocephalines. They also erroneously identified a haptoral structure associated with hook pair 1 as the proximal bar. We identify this structure as an *onchium,* typically found in species of *Neotetraonchus*. Although museum specimens of *N. proops* were not available, it is clearly evident that this species shares internal and haptoral features that are fundamentally similar to those of *Neotetraonchus.* This suggests that *Neomurraytrematoides proops* is congener with species of *Neotetraonchus.*

However, *Neotetraonchus* has temporal priority and, consequently, *Neomurraytrematoides* should be considered as its subjective junior synonym. Hence, the species of that latter genus are hereby transferred to *Neotetraonchus* as *N. proops* (Zambrano & Añez, 1993) **n. comb.**



FIGURES 47–56. *Neotetraonchus proops* (Zambrano & Añez, 1993) **n. comb. 47.** Vaginal sclerotization. **48.** Copulatory complex. **49.** Ventral bar. **50.** Dorsal bar. **51.** Hook pair 5. **51.** Hook pair 1. **53.** hook pairs 2–4, 6–7. **54.** Onchium. **55.** Ventral anchor. **56.** Dorsal anchor. Fig. 47 scale of 50 µm; Figs. 48–56 scale of 25 µm.

Neotetraonchus proops (Zambrano & Añez, 1993) **n. comb.** appears to be closely related to *N. felis* (Hargis, 1955) Paperna, 1977 based on the general morphology of the copulatory complex, anchors/bars complex and hooks. Both species also share the presence of a large vaginal vestibule with a vaginal duct originating from the proximal end of the vestibule. However, it can be easily differentiated from this and other species of the genus by the presence of a heavily sclerotized piece associated with the distal portion of the vaginal vestibule.

Discussion

Although 67 species representing 10 genera of monogenoids (*i.e.*, *Chauhanellus, Calceostomella* Palombi, 1943, *Fridericianella* Brandes, 1894, *Hamatopeduncularia*, *Metahaliotrema* Yamaguti, 1953, *Neocalceostoma* Tripathi, 1959, *Neocalceostomoides* Kritsky, Mizelle & Bilqees, 1978, *Neotetraonchus* Bravo-Hollis, 1968, *Rhamnocercus* Monaco, Wood & Mizelle, 1954, *Thysanotohaptor* Kritsky, Shameem, Padma Kumari & Krishnaveni, 2012) are known to infest ariids, the diversity of the Monogenoidea taken from these fish is still poorly understood. From the 135 valid species of ariids, only 19 percent were examined for monogenoids, which undoubtedly represents a limited proportion of the real diversity of monogenoidean parasites hosting in members of this fish family. *Fridericianella, Neocalceostomoides, Neotetraonchus* and *Thysanotohaptor* are restricted to ariid hosts, whereas *Chauhanellus*, *Calceostomella*, *Hamatopeduncularia*, *Metahaliotrema*, *Neocalceostoma* and *Rhamnocercus* occur in members of ariid and non-ariid hosts (*i.e.,* Bagridae, Clariidae, Congridae, Gerreidae, Mugilidae, Scatophagidae, Schilbeidae, Sciaenidae, Siluridae, Synodontidae, Terapontidae).

Lim *et al.* (2001) considered that species of *Hamatopeduncularia* reported from non-ariid hosts as species *inquirenda* (*H. lucknowensis* Agrawal & Sharma, 1988, *H. sohani* Tewari & Agrawal, 1986, *H. wallagonius* Singh, Agrawal, Kumar & Sharma, 1995, H. *yamagutii* Khoche, 1970, *H. yogendrai* Pandey & Mehta, 1986) or *incertae sedis* (*H. sauridi* Khoche, 1970 and *H. theraponi* Karyakarte & Das, 1972), this mainly because of the unavailability of type material for confirmation and comparative study. We also could not determine the taxonomic status of *H. batrachi* Rastogi, Arya & Singh 2005 from *Clarias batrachus* (Linnaeus) (Clariidae); *H. ritai* Rastogi, Arya & Singh 2005 and *H. ocidentalis* Rastogi, Arya & Singh 2005 from *Mystus tengara* (Hamilton) (Bagridae) (Rastogi *et al.* 2005); and *H. agrawali* Kumar, 2013 and *H. saharanpurensis* Kumar, 2013 from *Sperata seenghala* (Sykes) (Bagridae) (Kumar 2013a), because the original drawings and descriptions are inadequate and the type of specimens for those species were not available for study.

Except for *Chauhanellus alatus* (Chauhan, 1945) Bychowsky & Nagibina, 1969 and *C. indicus* Rastogi, Kumar and Singh, 2004, the other species of *Chauhanellus* seems to be restricted to ariid hosts. Lim *et al.* (2001) suggested that the occurrence of *Chauhanellus alatus* on *Arius falcarius* (Hamilton) [now *Arius arius* (Hamilton)] and non-arrid hosts (*i.e.,* Congridae, Mugilidae and Synodontidae) should be re-evaluated to verify the correct identification of host and parasite species. *Chauhanellus indicus* was reported from the gills of *Mystus tengara* (Hamilton), *Mystus seenghala* (Sykes) [now *Sperata seenghala* (Sykes)] (Bagridae) and *Wallago attu* (Bloch & Schneider) (Siluridae) from Meerut, Uttar Pradesh, India (Rastogi et *al.*, 2004; Rastogi et *al.*, 2007). Al-Zubaidy (2013) also reported this species infecting the gills of *Tachysurus dussumieri* (Valenciennes) [now *Plicofollis dussumieri* (Valenciennes)] (Ariidae) from the Yemen coast. The occurrence of this species in different hosts (*i.e.,* Bagridae, Siluridae, Ariidae) and localities (*i.e.,* India and Yemen) may be incorrect and only a careful analysis of specimens will enable us to determine the real status of this species and its host range.

Lim *et al.* (2001) also considered that the occurrence of *Neocalceostoma microformis* Swarup, 1978 from the gills of *W. attu* and *Silonia silondia* (Hamilton) (Schilbeidae); and *N. srivastavai* Singh & Agarwal, 1996 from the gills of *M. tengara* is erroneous. These authors believe that *N. microformis* does not belong to *Neocalceostoma* based on the haptoral structures. Kritsky *et al.* (2012) suggested that the calceostomatid, *Calceostomella herzbergii* Fuentes Zambrano, Dezón & León, 2004 described from *Arius herzbergii* (Bloch) [now *Sciades herzbergii* (Block)] was incorrect, because *C. herzbergii* shares the morphology of the reproductive and haptoral structures with member of Neocalceostomatidae. These authors suggested that an analysis should be performed to determine if this species is closed related with the other neocaslceostomatid species.

Kumar (2013b) described the diplectanid, *Rhamnocercus seenghali* Kumar, 2013 from the gills of *Mystus seenghala* [now *Sperata seenghala*] from the district of Saharanpur, Uttar Pradesh, India. However, an analysis of the illustrations of Kumar (2013) (Plate I, page 96; Plate II, page 97) indicates that this species belongs to *Chauhanellus* based on the morphology of the haptoral structures. Kumar (2013b) erroneously identified some sclerotized plates in the peduncle of *R. seenghali* as the peduncular spines (*sensu* Domingues & Boeger 2006) reported for the diplectanids *Rhamnocercus* Monaco, Wood & Mizelle, 1954 and *Rhamnocercoides* Luque & Iannacone, 1991. This species, originally described in *Rhamnocercus*, is transferred to *Chauhanellus* as *Chauhanellus seenghali* (Kumar, 2013) **n. comb.** by sharing the following features with member of *Chauhanellus*: ventral anchor with expanded deep root, dorsal anchor with spine blunt and ventral bar with protuberances at each end for articulation with ventral anchor. *Chauhanellus seenghali* **n. comb.** seems to be closely related to *Chauhanellus youngi* Kearn & Whittington, 1994 based on the presence of peduncular spiny plates (*sensu* Kearn & Whittington, 1994) in the peduncle, however, this species has plates that bear two median and two lateral acute spikes, whereas *Chauhanellus seenghali* **n. comb.** has two lateral round spikes.

Yamaguti (1953) described *Metahaliotrema arii* Yamaguti, 1953 from the gills of *Arius* sp. from Bandjermasin, Borneo. Except for this species, the remaining species of *Metahaliotrema* are reported from the gills of perciforms from the families Scatophagidae (*M. geminatohamula* Jun, Ding & Zhang, 1995, *M. mizellei* Venkatanarasaiah, 1981, *M. scatophagi* Yamaguti, 1953, *M. kulkarnii* Venkatanarasaiah, 1981, *M. yamagutii* Mizelle & Price, 1964), Gerreidae (*M. filamentosum* Venkatanarasaiah, 1981) and a siluriform from the Bagridae (*M. srivastavai* Singh & Agarwal, 1996). Lim *et al.* (2001) suggested that *Metahaliotrema* and other dactylogyrid genera that occur on siluriform and non-siluriform hosts should be revised to determine the real status of those species and their host range.

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