



New species of *Demidospermus* (Monogenoidea: Dactylogyridae) from the gills of *Pseudoplatystoma punctifer* (Siluriformes: Pimelodidae) collected in the Peruvian Amazonia

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Abstract *Pseudoplatystoma punctifer* is a catfish species that occupies the first place in the statistics of fishing landings in the region of Loreto, being of economic importance in the Peruvian Amazonia. As an initiative to know the parasites present in the gills of *P. punctifer* from the Peruvian Amazonia, a study was carried out with fish collected in the Belén Market, in Loreto-Peru. Specimens were provided between June and October 2018 from local fishermen from the Belén Market, in Loreto-Peru and samples were processed and analyzed in the “Laboratorio de Parasitología y Sanidad Acuícola” from the “Instituto de Investigaciones de la Amazonía Peruana” (IIAP) in Iquitos, Loreto-Peru. The analyzes of the gills revealed the presence of two new species of Monogenoidea: *Demidospermus aureagarciae* **n. sp.** and *D. doncellae* **n. sp.** These species are unique among

congeners by the morphology of the copulatory complex and vagina. *Demidospermus aureagarciae* **n. sp.** presents a male copulatory organ as a coiled tube, with a complete counterclockwise ring, with dilated base with a developed sclerotized margin, from which a flap projects; a concave accessory piece, with a tapered and curved distal part and a saculiform vaginal vestibule, connected to the vaginal canal. *Demidospermus doncellae* **n. sp.** presents a copulatory complex that is an elongated coiled tube, with approximately three clockwise rings, with dilated base with a developed sclerotized margin, from which a flap projects; an accessory piece sheath like, and a sclerotized vagina with dextral position, with saclike vaginal vestibule, connected to an elongated canal.

Introduction

Pseudoplatystoma punctifer, commonly known as the spotted tiger shovelnose catfish and locally named in Peru as “doncella” is a fish species belonging to the Order Siluriformes, which can reach up to 1.30 m in length and weigh up to 20 kg. Its distribution occurs in South America (Brazil, Bolivia, Colombia, Ecuador and Peru). It is a fish-eating species that inhabits the main channels of rivers and white and black water lagoons, migrating for food and reproduction purposes (García et al., 2018).

It occupies the first place in the statistics of fishing landings in the region of Loreto, being of economic

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importance in other Amazonian regions of Peru. Due to its fishing pressure, studies have been conducted on induced reproduction processes through hormonal inducers, life traits, population genetic structure, cannibalism, parasitology, aquaculture and among others (García et al., 2018).

For species of *Pseudoplatystoma*, studies focused on their monogenoids reported the presence of *Van- cleaveus* sp. 1 and *Van- cleaveus* sp. 2 for *P. fasciatum* from the Aquidauana river, Brazil (de Campos et al., 2008); *Amphocleithrium* sp.; *Amphocleithrium paraguayensis*; *Van- cleaveus* sp.; *Van- cleaveus fungulus*; *Unibarra* sp. on *P. fasciatum* (Fernandes and de Campos, 2010); *Ameloblastella* sp., *Amphocleithrium paraguayensis*, *Van- cleaveus ciccinus*, *V. fungulus* and *V. janacauensis* on the hybrid surubim (*Pseudoplatystoma reticulatum* x *P. corruscans*) (Jerônimo et al., 2016); *Van- cleaveus ciccinus* from *P. fasciatum* and *P. tigrinum* from Rondônia, Brazil (Carvalho et al., 2019); *V. ciccinus*, *V. fungulus*, *Ameloblastella martiniae* from *P. punctifer* from the Peruvian Amazon (Morey et al., 2023).

As part of this initiative to know the parasites present in the gills of specimens of *P. punctifer* from the Peruvian Amazonia, a study was carried out with fish collected in the Belén Market, in Loreto-Peru, finding two new species of monogenoids, which are described in the present study.

Materials and methods

Specimens were provided between June and October 2018 from local fishermen from the Belén Market, in Loreto-Peru. Fish were transported to the Laboratory of Parasitology of the “Instituto de Investigaciones de la Amazonía Peruana” (IIAP) where gill archers were removed and placed in vials containing heated water (cca. 68°C). Each vial was shaken vigorously, and formalin was added to obtain a 5% solution. In the laboratory, the content of each vial was examined using a dissecting microscope and helminths were removed from the gills or sediment using dissection needles.

Some specimens were stained with Gomori’s trichrome (Humason, 1962; Boeger & Vianna, 2006) and mounted in Canada balsam to determine internal soft structures, while others were cleared in Hoyer’s medium for the study of sclerotized structures

(Humason, 1979; Boeger & Viana, 2006). Sclerotized structures of all parasites were photographed with a digital camera (LEICA ICC50 W) connected to a phase contrast microscope (LEICA DM750), and the images were used to obtain the measurements of the male copulatory organ (MCO) and haptor sclerites. Average measurements are followed by ranges in parentheses. Measurements, all in micrometers, were made following the procedures of Mizelle & Klucka (1953) and represent straightline distances between extreme points of the body and structures measured [anchors, bars, hooks, male copulatory organ (MCO) and accessory piece] and were expressed as the range followed by the mean and the number of measurements (n) in parentheses. Illustrations were prepared with the aid of a drawing tube and a micro-projector.

Type-specimens were deposited in the Helminthological Collection of the Museum of Natural History at the San Marcos University (MUSM) Lima, Peru, and the collection of the “Laboratorio de Parasitología y Sanidad Acuicola” of the “Instituto de Investigaciones de la Amazonía Peruana” (LPYSA).

Results

Class Monogenoidea Bychowsky, 1937
Subclass Polyonchoinea Bychowsky, 1937
Order Dactylogyridea Bychowsky, 1937
Dactylogyridae Bychowsky, 1933

Demidospermus Suriano, 1983

Type species, host and locality: Demidospermus anus Suriano, 1983 from *Loricaria anus*, from Argentina

***Demidospermus aureagarciae* n. sp.**

Type-host: Pseudoplatystoma punctifer (Castelnau) (Siluriformes: Pimelodidae)

Type-locality: Belén Market, in Loreto-Peru

Type-material: Holotype (MUSM 4231), three paratypes (MUSM 4232a-c) and six vouchers (LPYSA MD 30a-f).

Site of infestation: Gill filaments.

Etymology: The specific name is in honor of researcher Aurea García Vásquez, researcher at the “Instituto de Investigaciones de la Amazonía Peruana” (IIAP, Peru), in recognition of her valuable work in the fisheries in the Peruvian Amazon and for being responsible for the academic formation of many students.

Description (Fig. 1A-H)

[Based on 10 specimens – 2 stained, 8 cleared.] Body elongate, fusiform 576 (434 – 734; n = 10) long, 173 (108 – 255; n = 10) width. Cephalic lobes moderately developed, 2 lobes located anteriorly and 2 bilateral; four pairs of head organs lying in cephalic lobes; cephalic glands not visible. Spherical chromatic granules clustered together anterior to the pharynx. Pharynx spherical 34 (30 – 38; n = 10) wide, esophagus short. Peduncle short. Haptor tetralobated 62 (49 – 80; n = 10) long, 90 (71 – 99; n = 10) wide. Anchors different in size and shape; ventral anchor with robust superficial root and small deep root, 31 (23 – 40; n = 10) long, 24 (17 – 27; n = 10) wide; dorsal anchor smaller than ventral anchor, with poorly-developed roots, 18 (15 – 26) long, 15 (13 – 17) wide. Ventral bar 52 (34 – 64; n = 10) long, 10 (7 – 13; n = 10) wide, elongated with conspicuous ornamentations on posterior ends. Dorsal bar 55 (37 – 70; n = 8) long, 7 (4 – 10; n = 10) wide, elongated with expanded ends directed posteriorly. Marginal hooks similar with Ancyrocephalinae distribution (pairs I, II, II, IV and V, ventral; pairs VI and VII, dorsal). Hooks similar in shape and different in size, with robust shank, expanded in its middle portion, slightly curved proximally, erect thumb, recurved shaft and short and straight point; filamentous hooklet (FH) loop about 3/4 of shank length; hook 1 and 5 with 6 (4 – 8; n = 10) long, hooks 2, 3, 4, 6 and 7 with 10 (8 – 16; n = 10) long. Male copulatory organ (MCO) with 40.45 (27– 52; n = 10) long, variable in shape, like a coiled tube, with flaps that connect to a sclerotized margin or G-shaped, with a counterclockwise ring, dilated base with a developed sclerotized margin, from which a flap projects, distal portion expanded forming a pointed termination. Accessory piece 43 (28 – 61; n = 10) long, variable shape, slightly concave or concave, tapered distal part, curved or slightly curved, with an expansion sac-like in its distal portion. A sclerotized vagina 26 (15 – 35; n = 10) long, and 19 (16 – 25; n = 10) wide, with a mid-ventral position, saclike vaginal vestibule, connected to the vaginal canal. Gonads intercecal, tandem; duct from seminal vesicle enters base of cirrus alongside ducts from prostatic reservoirs. Seminal vesicle robust. Two oval prostatic reservoirs, similar in size. Germarium ovoid. Oviduct, ootype and uterus

not observed. Vitellaria densely dispersed throughout trunk.

Remarks

Demidospermus aureagarciae n. sp. was included in the genus *Demidospermus* by the presence of a tubular MCO, counterclockwise, concave accessory piece, with an expansion sac-like in its distal portion, overlapping gonads (testis posterior to germarium). The new species differentiates from the other species allocated in the genus, by the shape of the MCO, accessory piece and vagina (Fig. 2A-H).

Among species of *Demidospermus*, the new species is more similar to *D. brachyplatystomae* Cepeda & Luque, 2010 by the shape of the MCO, but it differs in some characteristics not observed. The new species present a prominent sac-like vagina, characteristic that is not observed in *D. brachyplatystomae*.

***Demidospermus doncellae* n. sp.**

Type-host: *Pseudoplatystoma punctifer* (Castelnaud) (Siluriformes: Pimelodidae)

Type-locality: Belén market in Loreto-Peru.

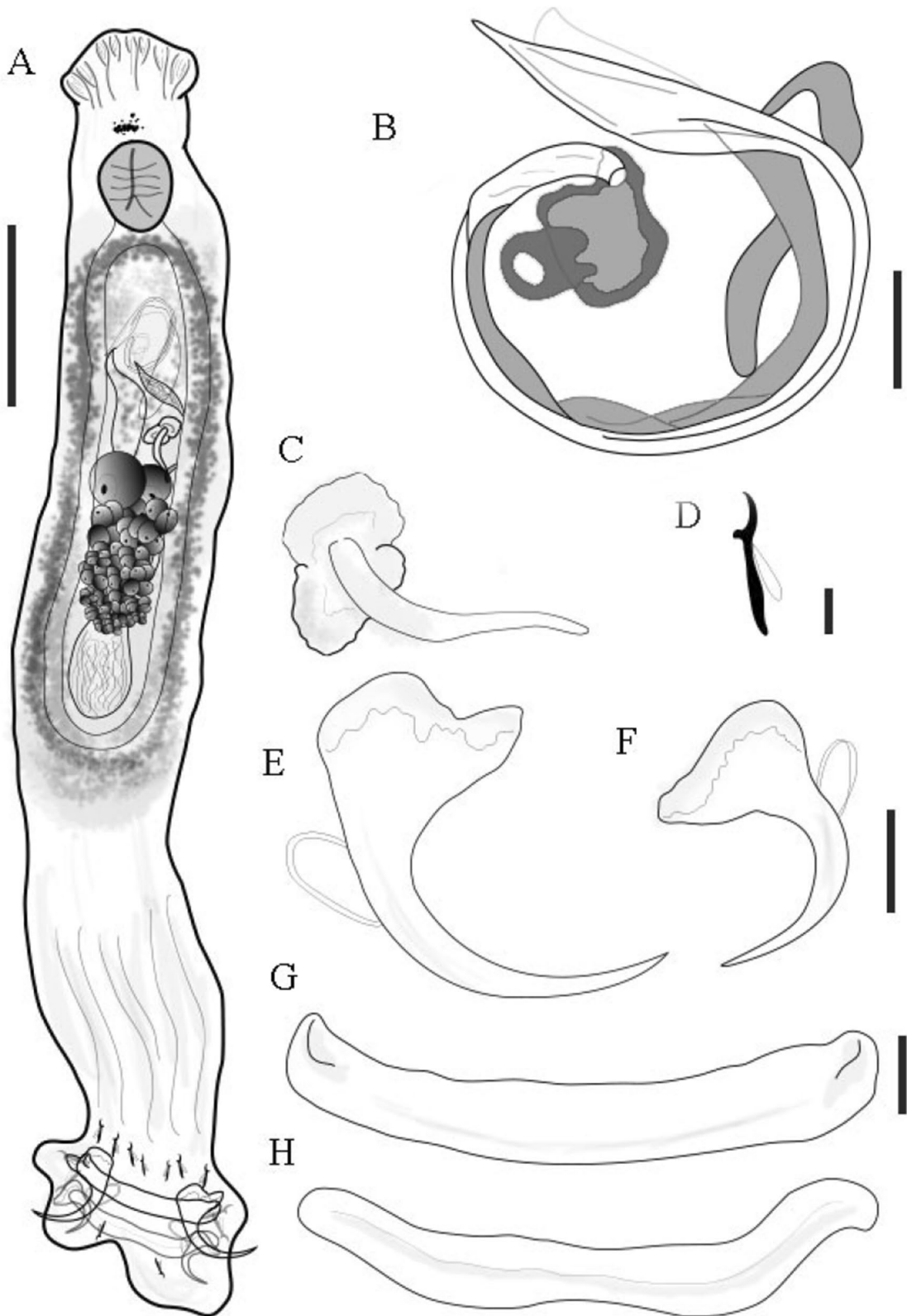
Type-material: Holotype (MUSM 4233), three paratypes (MUSM 4234a-c) and six vouchers (LPYSA MD 31a-f).

Site of infestation: Gill filaments.

Etymology: The specific name is related to the popular name of the fish host in Peru: “doncella”

Description (Fig. 3A-F)

[Based on 10 specimens – 2 stained, 8 cleared.] Body elongate, fusiform 1352 (976 – 1696; n = 10) long, 308 (265 – 35; n = 10) width. Cephalic lobes poorly developed, 2 lobes located anteriorly and 2 bilateral; four pairs of head organs lying in cephalic lobes; cephalic glands not visible. Spherical chromatic granules clustered together anterior to the pharynx, in one pair and in some specimens, scattered throughout the head anterior to the pharynx. Pharynx spherical 85 (64 – 113; n = 10) wide, esophagus short. Peduncle wide and short. Haptor with slightly oval ending 126 (100 – 138; n = 10) long, 116 (110 – 122; n = 10) wide (Fig. 3A-D). Ventral anchor 65 (60 – 70; n = 10) long, 41 (36 – 47; n = 10) wide; with robust and triangular superficial root, with delicate sclerotization on distal extremity, robust and short deep root, with delicate sclerotization on distal extremity, short



◀**Figure 1.** *Demidospermus aureagarciae* n. sp. A. Whole body in ventral view. B. Copulatory complex. C. Vagina. D. hook pair 4. E. Ventral anchor. F. Dorsal anchor. G. Ventral bar. H. Dorsal bar. Scale bars: A = 100 μ m. B = 30 μ m. C. D. = 5 μ m. E. F. = 40 μ m. G. H. = 10 μ m.

shaft with a small hump in its middle portion, slightly curved point, exceeding base width. Dorsal anchor smaller than ventral anchor, 32 (24 – 36) long, 22.70 (17 – 26) wide; with small and triangular superficial root, short and robust deep root, short and slightly curved shaft, straight point at the level of the point of superficial root. Ventral bar 76 (71 – 82; n = 10) long, 16 (14 – 18; n = 10) wide, elongated and robust, with sclerotized lateral extremities. Dorsal bar 83 (73 – 92; n = 8) long, 12 (9 – 15; n = 10) wide, elongated and thin. Marginal hooks similar with Ancyrocephalinae distribution (pairs I, II, II, IV and V, ventral; pairs VI and VII, dorsal). Hooks similar in shape and different in size, with slender shank, slightly curved proximally, erect thumb, slightly curved shaft and point; FH loop about 50% of shank length; hook 1 and 5 with 10 (6 – 12; n = 10) long, hooks 2, 3, 4, 6 and 7 with 16 (14 – 17; n = 10) long. Male copulatory organ (MCO) with 64 (45 – 93; n = 10) long, an elongated coiled tube, with approximately three clockwise rings, with dilated base with a developed sclerotized margin, from which a flap projects. Accessory piece with 88 (70 – 109; n = 10) long, sheath like, composed of 2 units, the biggest one being curved at the bottom, giving the appearance of the letter "L", with setae from the bottom to the middle part. The other subunit fang tooth-shaped. A sclerotized vagina with dextral position, saclike vaginal vestibule, connected to the vaginal canal that is elongated connecting to the seminal receptacle. Gonads intercecal, tandem; duct from seminal vesicle enters base of cirrus alongside ducts from prostatic reservoir. Seminal vesicle robust. One saclike prostatic reservoir. Germarium ovoid. Oviduct, ootype and uterus not observed. Vitellaria densely dispersed throughout trunk.

Remarks

Demidospermus doncellae n. sp. was included in the genus *Demidospermus* by the presence of a tubular MCO and an accessory piece sheath like. Features that distinguish the new species from most of its congeners includes to the morphology of the copulatory

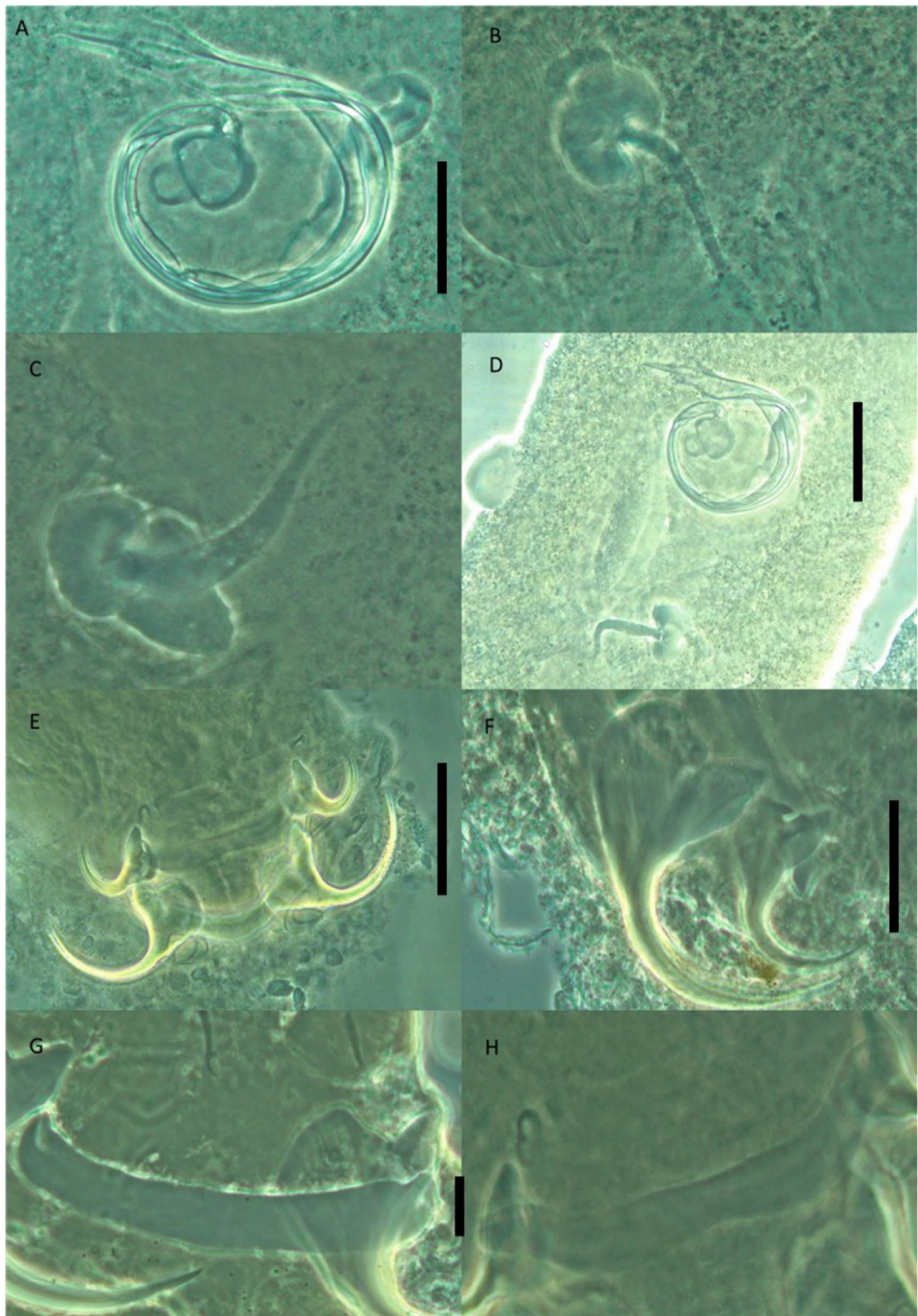
complex, bars, anchors and mainly the presence of a sclerotized sac-like vagina (Fig. 4A – E).

Among species of *Demidospermus* recorded in hosts belonging to *Pseudoplatystoma* and *Brachyplatystoma*, *D. doncellae* n. sp. is presented as the largest parasite within congeneric species, while *D. aureagarciae* n. sp. is presented as the smallest species within this group of parasites. A comparative table of the measurements of the sclerotized structures of *Demidospermus* spp. in host from *Pseudoplatystoma* and *Brachyplatystoma* is presented in Table 1.

Discussion

Demidospermus Suriano, 1983 was proposed by Suriano (1983), when she found *D. anus* parasitizing the gills of *Loricaria* (*L.*) *anus* (= *Loricariichthys anus*) (Valenciennes, 1835), collected in Lagoa de Chascomús, Buenos Aires, Argentina (Suriano, 1983). Studies on monogeneans of *Demidospermus* are practically restricted and geographically concentrated in the Neotropical region. Its descriptions and occurrences are currently in fish of the Auchenipteridae, Heptapteridae, Loricariidae, Mockokidae and Pimelodidae from South America with (see Cohen et al., 2013; Braga et al., 2014; Franceschini et al., 2017; Acosta et al., 2018; Cohen et al., 2020; Brito-Junior and Tavares-Dias, 2021; Morey et al., 2023).

Species of *Demidospermus* are recognized and distributed in South America. From Auchenipteridae four species have been described: *D. bidiverticulatum* (Suriano & Incorvaia, 1995), *D. osteomystax* Tavernari, Takemoto, Lacerda & Pavanelli, 2011 from Brazil; *D. centromochli* Mendoza-Franco & Scholz, 2009 from Peru and *D. uncusvalidus* Gutiérrez & Suriano, 1992 from Argentina. From Heptapteridae: *D. cornicinus* Kritsky & Gutiérrez, 1998, *D. leptosynophallus* Kritsky & Gutiérrez, 1998 from Brazil; from Loricariidae: *D. anus* Suriano, 1983 from Argentina, *D. anus* and *D. paranaensis* Ferrari-Hoeinghaus, Bellay, Takemoto & Pavanelli, 2010 from Brazil; from Mockokidae: *D. armostus* Kritsky & Gutiérrez, 1998, *D. paravalenciensesi* Gutiérrez & Suriano, 1992 and *D. uncusvalidus* Gutiérrez & Suriano, 1992 from Argentina; from Pimelodidae: *D. cornicinus* Kritsky & Gutiérrez, 1998, *D. ichthyocercus* Monteiro, Kritsky & Brasil-Sato, 2010, *D. leptosynophallus*, *D. annulus*,

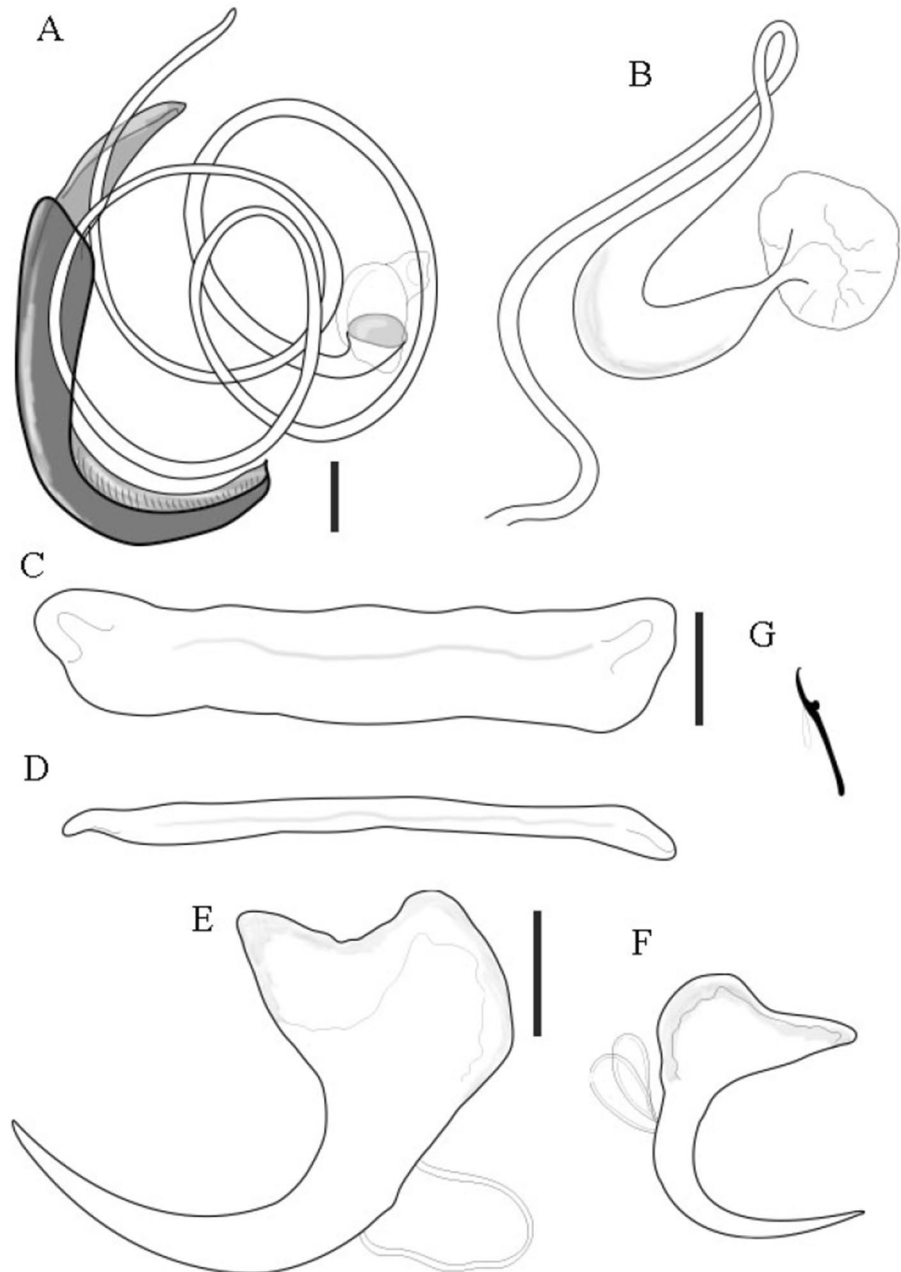


◀**Figure 2.** Photomicrographies of *Demidospermus aureagariciae* n. sp. A. Copulatory complex. B, C. Vagina. D. View of middle part of the body showing the copulatory complex, vagina and prostatic reservoir. Scale bars: A = 30 μ m. B.C.D. = 50 μ m. E = 50 μ m. F = 50 μ m. G. H. = 10 μ m.

D. armostus, *D. bidiverticulatum*, *D. idolus* Kritsky & Gutiérrez, 1998, *D. majusculus* Kritsky & Gutiérrez, 1998 and *D. valenciennesi* Gutiérrez

& Suriano, 1992 from Argentina, *D. armostus*, *D. bidiverticulum*, *D. brachyplatystomae* Cepeda & Luque, 2010, *D. ceccarellii* Cepeda & Luque, 2010, *D. cornicinus*, *D. leptosynophallus*, *D. ichthyocercus*, *D. majusculus*, *D. paravaleciennesi*, *D. uncusvalidus* and *D. valenciennesi*, *D. rhinel-episi* and *D. tocaninensis* from Brazil. *D. brevicirrus* Mendoza-Palermo, Scholz, Mendoza-Franco & Kuchta, 2012, *D. curvovaginatus* Mendoza-Palermo

Figure 3. Sclerotized structures of *Demidospermus doncellae* n. sp. A. Copulatory complex. B. Vagina. C. Ventral bar. D. Dorsal bar. E. Ventral anchor. F. Dorsal anchor. G. Hook pair 4. Scale bars: A.B = 20 μ m. C. D = 15 μ m. E. F. G = 15 μ m.



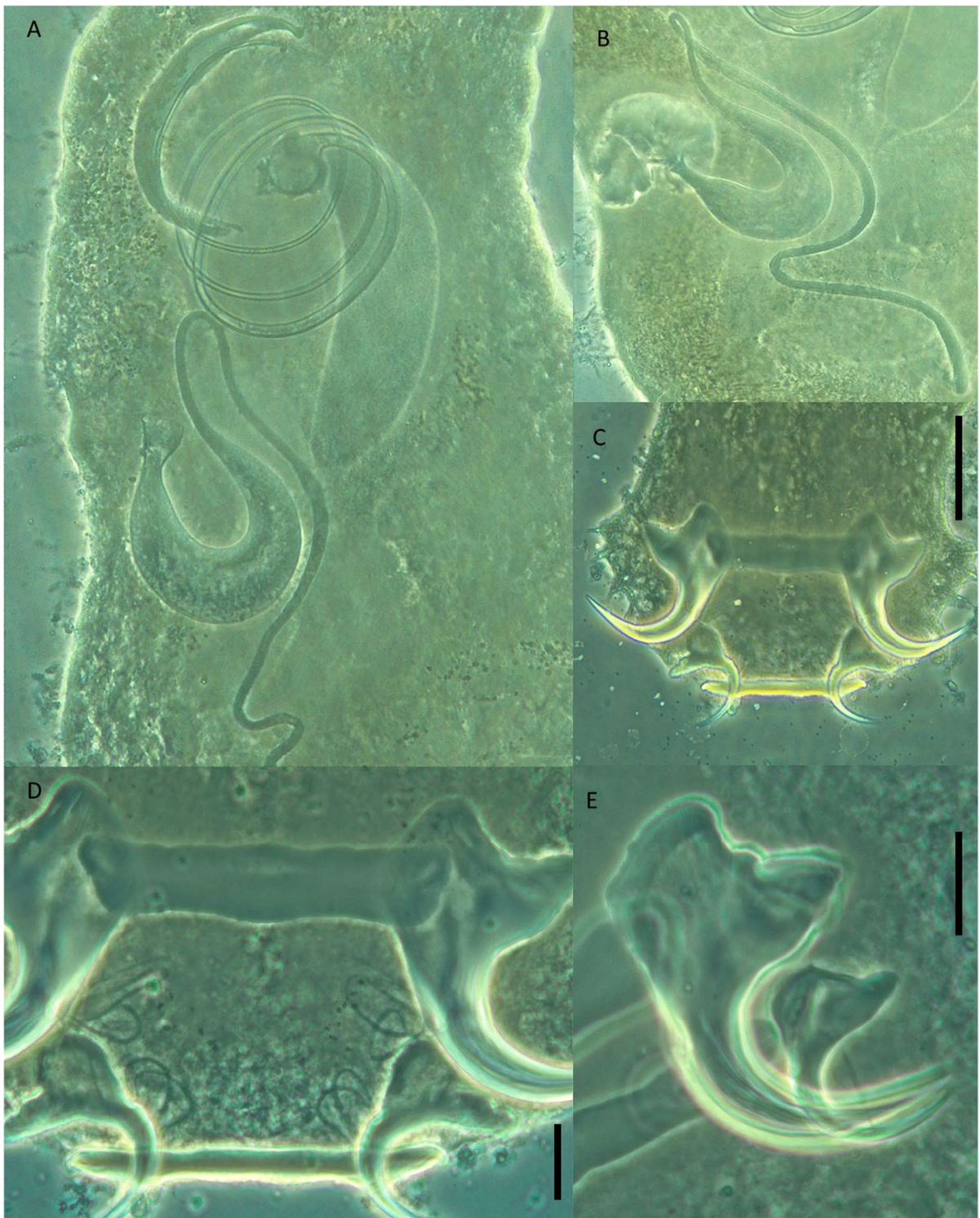


Figure 4. Photomicrographies of the sclerotized structures of *Demidospermus doncellae* n. sp. A. Ventral view showing the copulatory complex, vagina and prostatic reservoir. B. Vagina.

C. Haptor. D. Ventral and dorsal bar. E. Ventral and dorsal anchor. Scale bars: A.B.C = 50 μ m. D = 15 μ m. E = 15 μ m.

Table 1 Comparative measurements of *Demidospermus* spp. from fish host belonging to *Pseudoplatystoma* and *Brachyplatystoma*. Measurements expressed in micrometers (μm)

Host	<i>Pseudoplatystoma punctifer</i>		<i>Brachyplatystoma filamentosum</i>				<i>B. juruense</i>
	<i>D. aureagarciae</i> n.sp.	<i>D. doncellae</i> n. sp.	<i>D. ceccarellii</i>	<i>D. brachy-</i> <i>platys-</i> <i>tomae</i>	<i>D. araguai-</i> <i>aensis</i>	<i>D. mortenthaleri</i>	
Body Length	576	1353	793	1333	1098	692	
Body width	173	309	115	177	257	98	
Haptor length	62	126	71	65	97	56	
Haptor width	90	117	91	102	148	61	
Ventral anchor length	31	66	27	43	50	33	
Ventral anchor width	24	42	57	25	34	19	
Dorsal anchor length	18	32	28	41	53	29	
Dorsal anchor width	15	23	52	25	36	17	
Ventral bar length	52	76	71	66	78	43	
Ventral bar width	10	16	–	–	–	–	
Dorsal bar length	55	84	58	69	92	40	
Dorsal bar width	7	13	–	–	–	–	
Hook length	11	16	15	18	21	15	
MCO length	40	64	48	67	100	33	
Accessory piece length	43	88	50	69	81	26	
Pharynx diameter	34	85	51	90	65	56	
Reference	Current study	Current study	Cepeda and Luque, 2010			Mendoza-Palmero et al. (2012)	

& Scholz, 2011, *D. macropteri* Mendoza-Franco & Scholz, 2009, *D. peruvianus* Mendoza-Palermo & Scholz, 2011 and *D. striatus* Mendoza-Palermo & Scholz, 2011 from Peru (see Cohen et al., 2013; Acosta et al., 2018; Cohen et al., 2020).

Research based on the identification of monogenoids in species of *Pseudoplatystoma* have revealed the presence of species belonging to *Unibarra* Suriano & Incorvaia, 1995 (Fernandes and Campos, 2010); *Amphocleithrum* Price & Romero, 1969, *Pavanelliella* Kritsky & Boeger, 1998, *Vancleaveus* Kritsky, Thatcher & Boeger, 1986, *Phanerothecioides* Kritsky, Vianna & Boeger, 2007,

Scleroductus Jara & Cone, 1989 (see Cohen et al., 2013); and *Ameloblastella* Kritsky, Mendoza-Franco & Scholz, 2000 (Jerônimo et al., 2016, Morey et al., 2023). In the present study, two species of *Demidospermus* are cited for the first time in a fish host belonging to *Pseudoplatystoma*. Additionally, the number of species of *Demidospermus* in fish hosts from Peru increases from six to eight.

The only records of monogenoids parasitizing *P. punctifer* are cited by Morey et al. (2023), who reported *Vancleaveus cicinnus* Kritsky, Thatcher & Boeger, 1986, *V. fungulus* Kritsky, Thatcher & Boeger, 1986 and *Ameloblastella*

martinae Mendoza-Palmero, Rossin, Irigoitia & Scholz, 2020. In this study, the description of the two new species increase the number of species known for *P. punctifer* from three to five.

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Author contributions Germán Augusto Murrieta Morey: Conceptualization; Methodology; Validation; Investigation; Writing original draft; Supervision; prepared figures. Carlos Alfredo Tuesta Rojas; Methodology; Investigation; Formal analyses of samples. Gladys Vargas Dávila; collecting samples, formal analyses of samples. Luciano Alfredo Rodríguez Chu; Investigation; Formal analyses of samples.

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Data availability The data that support the findings of this study are available from the corresponding author upon reasonable request.

Declarations

Conflict of interest The authors declare no competing interests.

Ethical approval Specimens were collected and transported under the license 132-2014-GRL, 217-2016-GRL-DIREPRO and PTH-068-16-PEC-SANIPES.

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