

# Dactylogyrids (Monogenea) parasitic on cichlids from northern Brazil, with description of two new species of *Sciadicleithrum* and new host and geographical records

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## Abstract

Two new species of *Sciadicleithrum* Kritsky, Thatcher and Boeger, 1989 are described from two cichlids from the Araguari River, State of Amapá, northern Brazil. *Sciadicleithrum edgari* n. sp. from *Satanoperca jurupari* (Heckel, 1840) differs from all congeneric species in the morphology (hook-shaped, with middle process and distally bifurcate) of the accessory piece of the male copulatory organ (MCO). *Sciadicleithrum araguariensis* n. sp. from *Crenicichla labrina* (Spix and Agassiz, 1831) can be distinguished from all other species by a Y-shaped accessory piece of MCO. In addition to the description of two new species, new host and geographical records of six dactylogyrid monogeneans from cichlid fishes are presented.

## Keywords

Monogenea, Dactylogyridae, *Sciadicleithrum*, Cichlidae, Araguari River, Xingu River, neotropics

## Introduction

Monogeneans, especially dactylogyrids (Dactylogyridae: Ancyrocephalinae), are the most species-rich group of metazoan ectoparasites of freshwater fishes in the Neotropical region (Thatcher 2006; Mendoza-Franco *et al.* 2010; Cohen *et al.* 2013). Fishes of the family Cichlidae are a diverse group of commercial importance as food and ornamental fishes (Ortega *et al.* 2007; Perez-Sanchez and Páramo-Delgadillo 2008). In the Neotropical region, native cichlids are parasitised by dactylogyrid monogeneans of the genera *Gussevia* Kohn and Paperna, 1964 (17 species described from cichlids in South America); *Sciadicleithrum* Kritsky, Thatcher and Boeger, 1989 (24 spp. occurring also in Central America and Neotropical Mexico); *Trinidactylus* Hanek, Molnar and Fernando, 1974 (one species limited to the Caribbean); and *Tucunarella* Mendoza-Franco, Scholz and Rozkošná, 2010 (also monotypic, with the only record from the Peruvian Amazonia) (Vidal-Martínez *et al.* 2001; Bellay *et al.* 2009; Mendoza-Franco *et al.* 2010).

As part of the current effort to map the diversity of metazoan ectoparasites of freshwater fishes in the Neotropical Region (see e.g. Mendoza-Franco *et al.* 2010; Mendoza-Palmero *et al.* 2012; Braga *et al.* 2014), cichlid fishes from two localities in northern Brazil, the Xingu River in Altamira, a principal southern tributary of the Amazon River, and the Araguari River, which enters the Atlantic Ocean just north of the Amazon River estuary, were examined. In the present paper, two new species of *Sciadicleithrum* are described and new host records of other dactylogyrid monogeneans are presented.

## Materials and Methods

A parasitological survey was carried out in two river basins in northern Brazil between April and May 2013. The hosts were collected by local fishermen in Altamira, State of Pará and Ferreira Gomes, State of Amapá. The gills were excised and placed in Petri dishes with tap water and examined for monogeneans with the use of a stereomicroscope. Monogeneans

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found were fixed in a mixture of glycerin ammonium picrate (GAP) to study sclerotised structures (Malmberg 1957). After morphological evaluation, the specimens fixed in GAP were remounted in Canada balsam following the procedure of Ergens (1969). Other specimens were fixed in hot 4% formalin, stained with Gomori's trichrome and mounted in Canada balsam to study internal organs. In morphological descriptions, measurements are in micrometres, the ranges followed by the mean and number of measurements (n) in parentheses. Drawings were made with the aid of an Olympus BX53 microscope (Olympus Corporation, Tokyo, Japan) equipped with a drawing tube. The description of the male copulatory organ (MCO) follows Kritsky *et al.* (1985) and Bellay *et al.* (2009). The abbreviations *Sc.* for the parasites (*Sciadicleithrum*) and *Sa.* for the hosts (*Satanoperca*) are used to avoid doubt as to the genera. For comparative purposes and based on the similarity with the new taxa, the following specimens deposited in the Helminthological Collection of Institute Oswaldo Cruz (CHIOC) of Rio de Janeiro, Brazil, were examined: *Sciadicleithrum joanae* Yamada, Takemoto, Bellay and Pavanelli, 2009 (CHIOC 37161, holotype; CHIOC 37163 a-b, 2 paratypes); *Sciadicleithrum satanopercae* Yamada, Takemoto, Bellay and Pavanelli, 2009 (CHIOC 37165a, holotype; CHIOC 37166a and 37167, 2 paratypes).

Type and voucher specimens of monogeneans found in the present study were deposited in the Helminthological Collection of Institute Oswaldo Cruz (CHIOC) of Rio de Janeiro, Brazil and the Helminthological Collection of the Institute of Parasitology, Biology Centre of the Czech Academy of Sciences, České Budějovice (acronym IPCAS), as indicated in the respective descriptions. Scientific and common names of host are those provide in FishBase (Froese and Pauly, 2015).

### Family Dactylogyridae Bychowsky, 1933

#### Subfamily Ancyrocephalinae Bychowsky, 1937

#### *Sciadicleithrum edgari* n. sp. (Fig. 1 A–H)

*Description (based on 7 specimens):* Body fusiform, 406–510 (442; n = 5) long including haptor; greatest width 90–99 (95; n = 4), at level of ovary. Anterior region with 3 bilateral pairs of head organs; cephalic glands distinct, anterolateral to pharynx. Eyespots 4, with posterior pair being larger; accessory granules scattered in cephalic region. Pharynx spherical, 16–21 (18; n = 4) in diameter; oesophagus short; intestine bifurcates closely posterior to pharynx; caeca confluent posterior to testis, without diverticula. Haptor globose, 34–52 (45; n = 5) wide; armed with 2 pairs of anchors, 2 bars and 7 pairs of similar hooks. Ventral anchor 24–27 (25; n = 6) long, with elongate superficial root, short deep root and curved shaft and point; base width 21–24 (23; n = 6). Dorsal anchor 37–41 (39; n = 6) long, with elongate well-developed superficial root, poorly developed deep root and curved shaft and point; base width 27–30 (28; n = 6). Ventral

bar 29–32 (30; n = 6) long, slender, with delicate umbelliform membranes and enlarged ends. Dorsal bar 27–29 (28; n = 6) long, winding, with enlarged ends. Hooks 14, similar, each with erected thumb, relative robust point, FH loop  $\frac{3}{4}$  shank length; total length 15–18 (16; n = 6). Male copulatory organ (MCO) comprising a delicate coil of 2  $\frac{1}{2}$  clockwise rings with diameter of proximal coil 14–16 (15; n = 5) long; copulatory tube with 87–105 (92; n = 5) long. Sclerotised accessory piece 30–34 (32; n = 5) long, hook-shaped, with middle process 6–7 (6; n = 4) long, and distally bifurcate. Gonads overlapping. Testis dorsal, slightly visible at posterior end of germarium; vas deferens loops left caecum and dilates to form seminal vesicle. Prostatic reservoir ovoid, near to proximal part of copulatory tube. Vagina opening dextrally, cone-shaped with coiled distal part, slightly sclerotised, connected to medial seminal receptacle anterior to germarium. Germarium with irregular margin. Oviduct, ootype and uterus not observed. Vitellarium scattered throughout trunk, except regions of reproductive organs.

Type host: *Satanoperca jurupari* (Heckel, 1840).

Site of infection: Gills.

Type locality: Araguari River at Ferreira Gomes (0°52'N, 51°12'W), State of Amapá, Brazil.

Prevalence: 50% (4 from 8 fish examined)

Intensity of infection: 1–2

Specimens deposited: Holotype CHIOC no. 38092a, 2 paratypes CHIOC no. 38092b, c; 1 paratype IPCAS no. M-604.

Etymology: The new species is named in honour to Edgar Fernando Mendoza-Franco (Universidad Autónoma de Campeche, Mexico) for his contribution to the knowledge of dactylogyrids in Neotropical freshwater fishes.

#### Remarks

*Sciadicleithrum* Kritsky, Thatcher and Boeger, 1989 accommodates dactylogyrids possessing overlapping gonads, a coiled male copulatory organ with 1 to more rings, unmodified anchors, a ventral bar with umbelliform membranes or cavities on the anterior bar margin, and similar marginal hooks with undilated shanks and erected thumb (Kritsky *et al.* 1989). Bellay *et al.* (2009) amended the generic diagnosis to include the presence of longitudinal lateral grooves on the shafts and points of ventral and dorsal anchors, variation in the size of the hooks pairs, dorsal bar with umbelliform membranes, median projection in bars and MCO with more than two rings.

At present, 24 valid species of *Sciadicleithrum* are known, all of them described from Neotropical cichlid fishes, but only two of them having been reported from species of *Satanoperca* Günther, 1862, namely *Sc. juruparii* Melo, Santos and Santos, 2012 from *Sa. jurupari* in the Guamá River, Amazon Basin (Melo *et al.* 2012), and *Sc. satanopercae* from *Sa. pappaterra* (Heckel, 1840) in the River Paraná, Paraná Basin, South America (Bellay *et al.* 2009; Yamada *et al.* 2009).

Of these species, *Sciadicoleithrum edgari* n. sp. most resembles *Sc. satanopercae* by having a male copulatory organ with 2 ½ rings and by the presence of a distally bifurcated accessory piece. However, *Sc. edgari* n. sp. differs from this species by the morphology of the accessory piece, hook-shaped with a middle process and distally bifurcate versus not bifurcated in *Sc. satanopercae*, which was also confirmed in the present paper by a study of the holotype of the latter species (CHIOC 37165a). In addition, *Sc. satanopercae* has a median process on the ventral bar called 'denticulum' (Yamada *et al.* 2009, confirmed also by observation of paratypes CHIOC 37166a and 37167), whereas this process is absent in the new species. *Sciadicoleithrum edgari* n. sp. and *Sc. satanopercae* can be also easily distinguished by the morphology of the anchors. *Sciadicoleithrum edgari* n. sp. can be distinguished of *Sc. juruparii* by having 2½ rings of the MCO and the absence of a median process on the ventral bar versus 3 ½ rings and a median process present.

Based on the morphology of the male copulatory organ, the new species closely resembles three other species, namely *Sc. meekii* Mendoza-Franco, Scholz and Vidal-Martínez, 1997 from *Thorichthys meeki* (Brind, 1918) in Mexico; *Sc. splendidae* Kritsky, Vidal-Martínez and Rodríguez-Canul, 1994 from *Petenia splendida* Günther, 1862 (type-host), *Parachromis friedrichsthalii* (Heckel, 1840) and *P. managuensis* (Günther, 1867) in Mexico; and *Sc. umbilicum* Kritsky, Thatcher and Boeger, 1989 from *Cichla ocellaris* Bloch and Schneider, 1801 in Brazil (Kritsky *et al.* 1989, 1994; Mendoza-Franco *et al.* 1997, 2000). However, *Sc. edgari* n. sp. differs from these species and all other congeners by the morphology of the hook-shaped accessory piece of the male copulatory organ with a middle process and distally bifurcate.

This is the third *Sciadicoleithrum* species described from the genus *Satanoperca* and it is the first dactylogyrid monogenean reported from cichlids in the River Araguari basin.

#### *Sciadicoleithrum araguariensis* n. sp. (Fig. 2 A–G)

*Description (based on 12 specimens):* Body fusiform, 412–430 (419; n = 8) long including haptor; greatest width 90–102 (95; n = 6), at opening of vagina. Anterior region with 3 bilateral pairs of head organs; cephalic glands indistinct. Eyespots 4; accessory granules absent. Pharynx spherical 21–24 (22; n = 4) in diameter; oesophagus short; intestine bifurcates closely posterior to pharynx; caeca confluent posterior to testis, without diverticula. Haptor globose, 40–48 (43; n = 8) wide. Ventral anchor 24–28 (26; n = 7) long, with elongate superficial root, poorly developed deep root, evenly curved shaft and point; base width 21–24 (22; n = 7). Dorsal anchor 31–39 (34; n = 7) long, with with elongate superficial root, evenly curved shaft and point; base width 30–34 (32; n = 6). Ventral bar 29–34 (31; n = 4) long, yoke-shaped, with delicate umbelliform membranes. Dorsal bar 21–25 (22; n = 5) long, robust, with enlarged ends,

and delicate umbelliform membranes. Hooks 14, similar, each with erect thumb, delicate shaft and point, FH loop ¾ shank length; total length 12–16 (14; n = 9). Male copulatory organ (MCO) comprising a delicate coil of 2 counterclockwise rings with diameter of proximal coil 14–16 (14; n = 4) long; copulatory tube with 92–104 (100; n = 4) long. Sclerotised accessory piece 38–42 (40; n = 5) long, Y-shaped, proximally bent. Gonads overlapping. Testis dorsal, slightly visible at posterior end of germarium; vas deferens loops left caecum and dilates to form seminal vesicle; prostatic reservoir ovoid, near to proximal part of copulatory tube. Vagina opening ventrally, comprising a delicate tube, slightly sclerotised, connected to medial seminal receptacle anterior to ovary. Germarium with irregular margin. Oviduct, ootype and uterus not observed. Vitellarium scattered throughout trunk, except regions of reproductive organs.

Type host: *Crenicichla labrina* (Spix and Agassiz, 1831).  
Site of infection: Gills.

Type locality: Araguari River in Ferreira Gomes (0°52'N, 51°12'W), State of Amapá, Brazil.

Prevalence: 100% (1 from 1 fish examined).

Intensity of infection: 12

Specimens deposited: Holotype CHIOC no. 38091a; 2 paratypes CHIOC no. 38091b, c, d; 1 paratype IPCAS no. M-605.

Etymology: The specific name *araguariensis* refers to the type locality.

#### Remarks

Based on the shape and size of anchors and bars and the dorsal vagina, *Sciadicoleithrum araguariensis* n. sp. most closely resembles *Sc. joanae*, a species described from *Crenicichla niederleini* (Holmberg, 1891) and *C. britskii* Kullander, 1982 in the River Paraná, Brazil, South America (Yamada *et al.* 2009). Both species can be distinguished by the following characteristics: the copulatory tube in *Sc. araguariensis* n. sp. comprises a delicate coil of two counterclockwise rings, whereas it is about half a clockwise loop and winding distal portion in *Sc. joanae* (confirmed in the present paper by the study of the holotype CHIOC 37161 and paratype CHIOC 37163a). In addition, the vagina of *Sc. joanae* has a 'bulb-shaped' structure near its aperture (Yamada *et al.* 2009), whereas it comprises a delicate, slightly sclerotised tube in *Sc. araguariensis* n. sp.

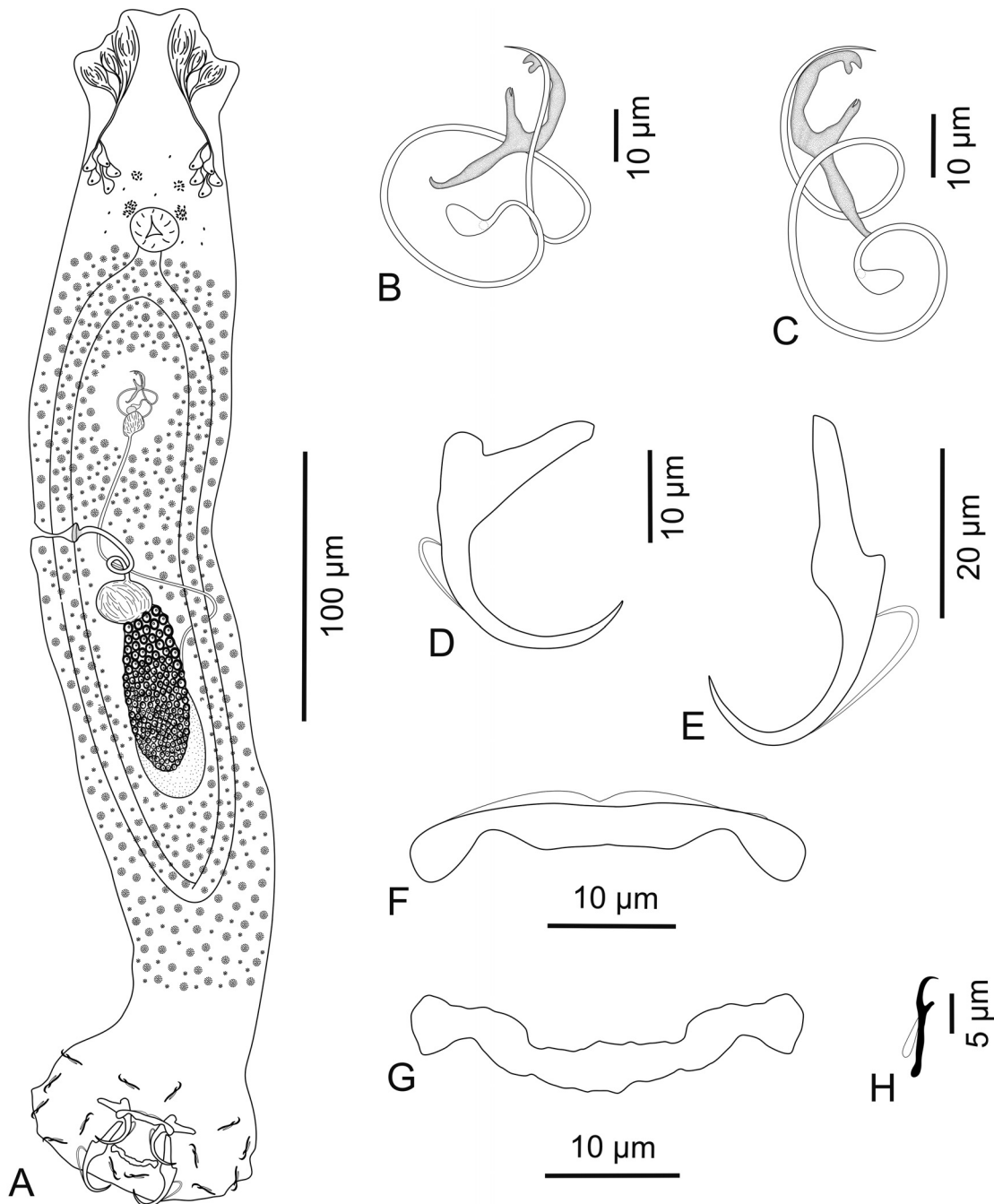
The morphology of the ventral bar (yoke-shaped, with delicate umbelliform membranes) of the new species closely resembles that of six other species, namely *Sc. aequidens* (Price and Schlueter, 1967) and *Sc. cavanaughi* (Price, 1966) from *Cleithracara maronii* (Steindachner, 1881) in the Republic of Guiana; *Sc. iphthimum* Kritsky, Thatcher and Boeger, 1989 from *Pterophyllum scalare* (Lichtenstein, 1823); *Sc. tortrix* Kritsky, Thatcher and Boeger, 1989 from *Uaru amphiacanthoides* Heckel, 1840; *Sc. variabilum* (Mizelle and Kritsky, 1969) from *Symphysodon discus* Heckel, 1840, all in Brazil;

and *Sc. bravohollisae* Kritsky, Vidal-Martínez and Rodríguez-Canul, 1994 from *Cichlasoma pearsei* (Hubbs, 1936) in Mexico, North America (Kritsky *et al.* 1989, 1994; Bellay *et al.* 2009). However, *Sc. araguariensis* n. sp. differs from these species and all other congeners, including *Sc. edgari*, by a Y-shaped accessory piece of the male copulatory organ.

*Sciadicleithrum araguariensis* n. sp. is the first parasite reported from *Crenicichla labrina*.

### New host and geographical records

In addition to two new species of *Sciadicleithrum* described above, another six species of gill monogeneans of the family Dactylogyridae were found during parasitological surveys carried out in the Xingu River (State of Pará) in April 2013 and the Araguari River (State of Amapá), Brazil in May 2013; most of them represent new host and geographical records (see

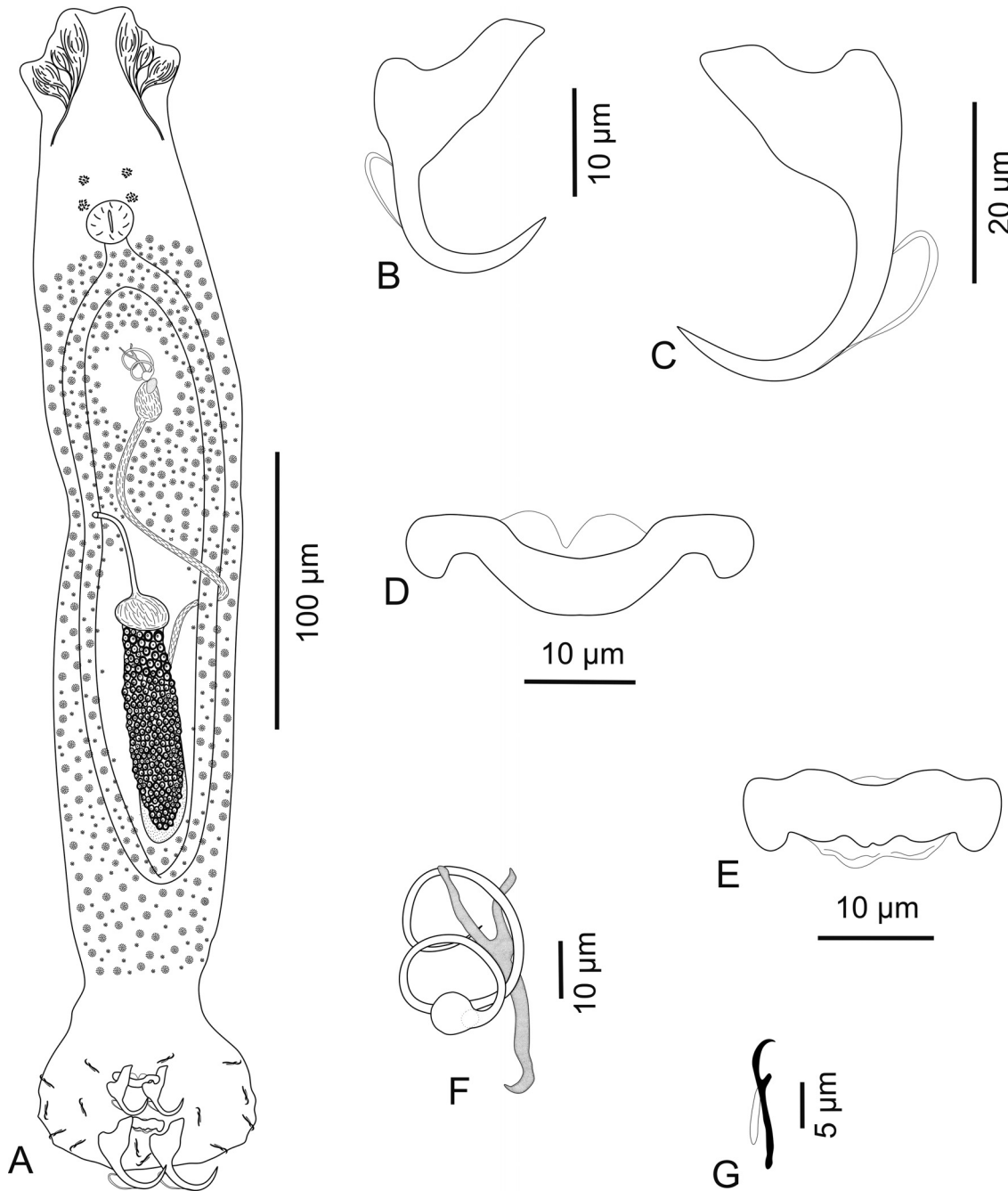


**Fig. 1.** *Sciadicleithrum edgari* n. sp. from *Satanoperca jurupari*. **A** – whole-mounted specimen, ventral view; **B**, **C** – copulatory complex, ventral and dorsal view, respectively; **D** – ventral anchor, ventral view; **E** – dorsal anchor, ventral view; **F** – ventral bar, ventral view; **G** – dorsal bar, ventral view; **H** – Hook

Table I). In the Xingu River in Altamira ( $3^{\circ}12'S$ ,  $52^{\circ}12'W$ ), the following monogeneans were found on 43 cichlid fish of 7 species: *Gussevia undulata* Kritsky, Thatcher and Boeger, 1986, *Sciadicleithrum umbilicum* Kritsky, Thatcher and Boeger, 1989, *Sc. uncinatum* Kritsky, Thatcher and Boeger, 1989 and *Tucunarella cichlae* Mendoza-Franco, Scholz and Rozkošná, 2010 on *Cichla melaniae* Kullander and Ferreira, 2006; *Sciadicleithrum geophagi* Kritsky, Thatcher and Boeger,

1989 on *Geophagus altifrons* Heckel, 1840 and *Geophagus argyrostictus* Kullander, 1991; and *Sciadicleithrum satanopercae* on *Satanoperca* sp.

In the Araguari River, five species of dactylogyrid monogeneans were found on 35 cichlids of four species besides the two above described new species of *Sciadicleithrum*, namely *Gussevia undulata*, *Sciadicleithrum umbilicum* and *Sc. uncinatum* on *Cichla temensis* Humboldt, 1921; *Sciadicleithrum*



**Fig. 2.** *Sciadicleithrum araguariensis* n. sp. from *Crenicichla labrina*. **A** – whole-mounted specimen, ventral view; **B** – ventral anchor, ventral view; **C** – dorsal anchor, ventral view; **D** – ventral bar, ventral view; **E** – dorsal bar, ventral view; **F** – copulatory complex, ventral view; **G** – hook

**Table I.** New host and geographical records of dactylogyrids of cichlids found in the present study

Species of monogeneans	Known hosts	New host records	New geographical records (River)	References
<i>Gussevius undulata</i> CHIOC*No 38099 IPCAS No M-609	<i>Cichla ocellaris</i> <i>Cichla kelberi</i> <i>Cichla monoculus</i>	<i>Cichla melaniae</i> <i>Cichla temensis</i>	Xingu, Araguari, Brazil	Cohen <i>et al.</i> (2013) Mendoza-Franco <i>et al.</i> (2010)
<i>Sciadicleithrum geophagi</i> CHIOC No 38093, 38094 IPCAS No M-606	<i>Geophagus surinamensis</i>	<i>Geophagus altifrons</i> <i>Geophagus argyrostictus</i> <i>Geophagus proximus</i>	Xingu, Araguari, Brazil	Kritsky <i>et al.</i> (1989)
<i>Sc. umbilicum</i> CHIOC No 38097 IPCAS No M-607	<i>Cichla ocellaris</i>	<i>Cichla melaniae</i> <i>Cichla temensis</i>	Xingu, Araguari, Brazil	Kritsky <i>et al.</i> (1989)
<i>Sc. uncinatum</i> CHIOC No 38098 IPCAS No M-608	<i>Cichla ocellaris</i>	<i>Cichla temensis</i> <i>Cichla melaniae</i>	Xingu, Araguari, Brazil	Kritsky <i>et al.</i> (1989)
<i>Sc. satanopercae</i> CHIOC No 39095, 38096	<i>Satanoperca pappaterra</i> <i>Satanoperca jurupari</i>	–	Xingu, Araguari, Brazil	Yamada <i>et al.</i> (2009); Mendoza-Franco <i>et al.</i> (2010)
<i>Tucunarella cichlae</i> CHIOC No 36311	<i>Cichla monoculus</i>	<i>Cichla melaniae</i>	Xingu, Brazil	Mendoza-Franco <i>et al.</i> (2010)

\*CHIOC – Coleção Helmintológica do Instituto Oswaldo Cruz, Rio de Janeiro; IPCAS – Helminthological Collection of the Institute of Parasitology, Biology Centre of the Czech Academy of Sciences

*geophagi* on *Geophagus proximus* (Castelnau, 1855); and *Sciadicleithrum satanopercae* on *Satanoperca jurupari*. All fishes except *Satanoperca jurupari* represent new hosts of these monogeneans (see Table I) and all parasites are reported from the Araguari River for the first time.

## Discussion

The present study provides the first data on monogeneans parasitising cichlid fishes in two rivers in northern Brazil. Eight species of dactylogyrid monogeneans of three genera were found on cichlid fishes of the genera *Cichla* Bloch and Schneider, 1801, *Crenicichla* Heckel, 1840, *Geophagus* Heckel, 1840 and *Satanoperca*, namely six species of *Sciadicleithrum* including two new taxa, and one species of *Gussevius* and *Tucunarella* each.

The monogeneans found on cichlids from the Xingu River have been previously recorded in the Amazon River basin (Kritsky *et al.* 1986, 1989; Mendoza-Franco *et al.* 2010). The most remarkable is the first record of *Tucunarella cichlae* from Brazil, because this species was known only from the type locality in the Peruvian Amazon (Mendoza-Franco *et al.* 2010) and the present finding considerably expands its distribution area. In contrast, the fauna of fish of the Araguari River, which is 300 km long and empties to the Atlantic Ocean 12 km northwest of the Amazon estuary, has not been studied and nothing was also known about fish parasites in this river before the present study.

*Gussevius undulata*, *Sciadicleithrum umbilicum* and *Sc. uncinatum* were originally described from '*Cichla ocellaris*'

from the Negro River in Manaus, Amazon Basin, in Brazil; *Cichla melaniae* and *C. temensis* are their new hosts. However, several species of *Cichla* previously identified as *C. ocellaris* have been recently recognised as separate taxa (see Kullander and Ferreira 2006). In fact, the distribution area of *C. ocellaris* is limited to Guayanas, whereas a number of other species such as *C. monoculus* Agassiz, 1831, *C. melaniae* and *C. temensis* occur in the River Amazon basin (Kullander and Ferreira 2006).

At present, 26 valid species of *Sciadicleithrum* are recognised including two new species of *Sciadicleithrum* described in the present paper. Bellay *et al.* (2009) presented some morphological characteristics shared by species of this genus occurring in the same geographical areas, such as the number of rings of the male copulatory organ (MCO). However, two new species described herein more resemble congeners from Central America and southeastern Mexico in the number of rings in the MCO and in the morphology of connecting bars and anchors, similarly as some other species described in Brazil, e.g. *Sc. juruparii* and *Sc. satanopercae* (see Yamada *et al.* 2009; Melo *et al.* 2012).

Mendoza-Franco *et al.* (2010) pointed out a relatively low host specificity of species of *Sciadicleithrum*, mainly those parasitising cichlids of the genera *Cichla*, *Cichlasoma* Swainson, 1839 and *Satanoperca*, compared to other groups of gill monogeneans of the family Dactylogyridae. The number of new hosts of three species of *Sciadicleithrum* found in the present study (Table I) supports this assumption because some of these species are probably stenoxenous, i.e. they occur in several congeneric species of fish hosts. However, a high num-

ber of cichlids occurring in the Neotropical Region have not yet been examined for parasites and thus more data are necessary before the actual species richness and host-parasite associations of their gill monogeneans are sufficiently described.

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