

A new species of *Cacatuocotyle* (Monogenea, Dactylogyridae) parasitizing two species of *Astyanax* (Ostariophysi, Characidae) in southern Brazil

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Abstract

A new species of *Cacatuocotyle* is described from the external surface of *Astyanax* aff. *fasciatus* and *Astyanax jacuhiensis* from Lake Guaíba, State of Rio Grande do Sul, Brazil. It differs from the other three species of the genus, recorded from Mexico and the State of Paraná, Brazil, by possessing an accessory piece with a long proximal portion, a U-shaped bar with irregular posterior margin in its midportion, and a haptor containing two circular thickenings with muscular anterior margins. Only one monogenean species, *Urocleidoides astyanacis* (= *Characithecium costaricensis*) was recorded for the host *Astyanax* aff. *fasciatus*, whereas none were known for *A. jacuhiensis*. This paper records a new host (*A. jacuhiensis*) for monogeneans in southern Brazil and extends southward with the geographical distribution of the genus *Cacatuocotyle* to the State of Rio Grande do Sul, Brazil.

Keywords

Monogenean, dactylogyrid, characid, taxonomy, Neotropical Region

Introduction

Cacatuocotyle Boeger, Domingues and Kritsky, 1997 was proposed as a monotypic genus containing only *Cacatuocotyle paranaensis* Boeger, Domingues and Kritsky, 1997, whose diagnostic characteristics include: vagina with sinistral opening, haptor with muscular anterior margin, one pair of ventral anchors in the haptor, seven pairs of ventral hooks and reduction in the number and complexity of the cephalic organs (Boeger *et al.* 1997).

Three *Cacatuocotyle* species are currently known: *C. paranaensis*, a parasite of *Characidium lanei* Travassos, 1967 and *Characidium pterostictum* Gomes, 1947 in the State of Paraná, Brazil (Boeger *et al.* 1997); *Cacatuocotyle chajuli* Mendoza-Franco, Caspeta-Mandujano and Salgado-Maldonado, 2013 and *Cacatuocotyle exiguum* Mendoza-Franco, Caspeta-Mandujano and Salgado-Maldonado, 2013 collected in *Astyanax aeneus* (Günther, 1860) in the State of Chiapas, Mexico (Mendoza-Franco *et al.* 2013).

Characid fish *Astyanax* aff. *fasciatus* (Cuvier, 1819) and *Astyanax jacuhiensis* (Cope, 1894) are resident species in

Lake Guaíba, State of Rio Grande do Sul, Brazil (Flores-Lopes *et al.* 2010). So far, *Urocleidoides astyanacis* (= *Characithecium costaricensis* (Price and Bussing, 1967) Mendoza-Franco, Reina and Torchin, 2009) was the only monogenean species cited for *A. aff. fasciatus* in Brazil (Gioia *et al.* 1988; Mendoza-Franco *et al.* 2009), and none was known for *A. jacuhiensis*. In this study we describe a new species of *Cacatuocotyle* that parasitizes the body surface of *A. aff. fasciatus* and *A. jacuhiensis* in southern Brazil.

Materials and Methods

A total of 62 *A. aff. fasciatus* and 46 *A. jacuhiensis* specimens were collected with seine nets in Lake Guaíba, Municipalities of Guaíba (30°08'28"S, 51°18'53"W) and Barra do Ribeiro (30°17'11"S, 51°18'01"W), State of Rio Grande do Sul, Brazil, between March 2012 and April 2013. Each fish was individually packed in a plastic bag and transported in an ice cooler to the Laboratório de Helmintologia, Departamento de Zoologia, Universidade Federal do Rio Grande

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do Sul for necropsy. Each fish was placed in a Petri dish with drops of formalin solution 1:4000 and had its external surface scraped with a knife to remove mucus, scales and to detach the monogeneans, that were subsequently collected and fixed in 5% formalin and preserved in 70°GL ethanol (Amato 1994).

Helminths were stained with Gomori's trichrome (Humason 1979) and mounted in Canada balsam for visualization and measurement of internal characters. Sclerotized structures were analyzed in specimens mounted in Gray and Wess or Faure's medium (Humason 1979; Amato and Amato 2010). Measurements followed Mizelle and Klucka (1953), with the exception of (a) anchors and hooks, whose measurements followed Eiras *et al.* (2006) (Figs 1 and 3); (b) the bar, whose length was determined as the distance between the extremities in a parallel line and width as the perpendicular distance between the extremities both in a frontal plane (Fig. 2); and (c) the coil and accessory piece of the male copulatory organ (MCO), whose measurement and determination followed Kritsky *et al.* (1985). Anchor and hook terminology followed Mizelle and Kritsky (1967) and Vianna *et al.* (2008), whereas hook numbering followed Mizelle (1936) and Mizelle and Price (1963). Measurements in micrometers (μm), unless otherwise stated, represent the range followed by the mean $\pm$ standard deviation, and sample size (in parenthesis).

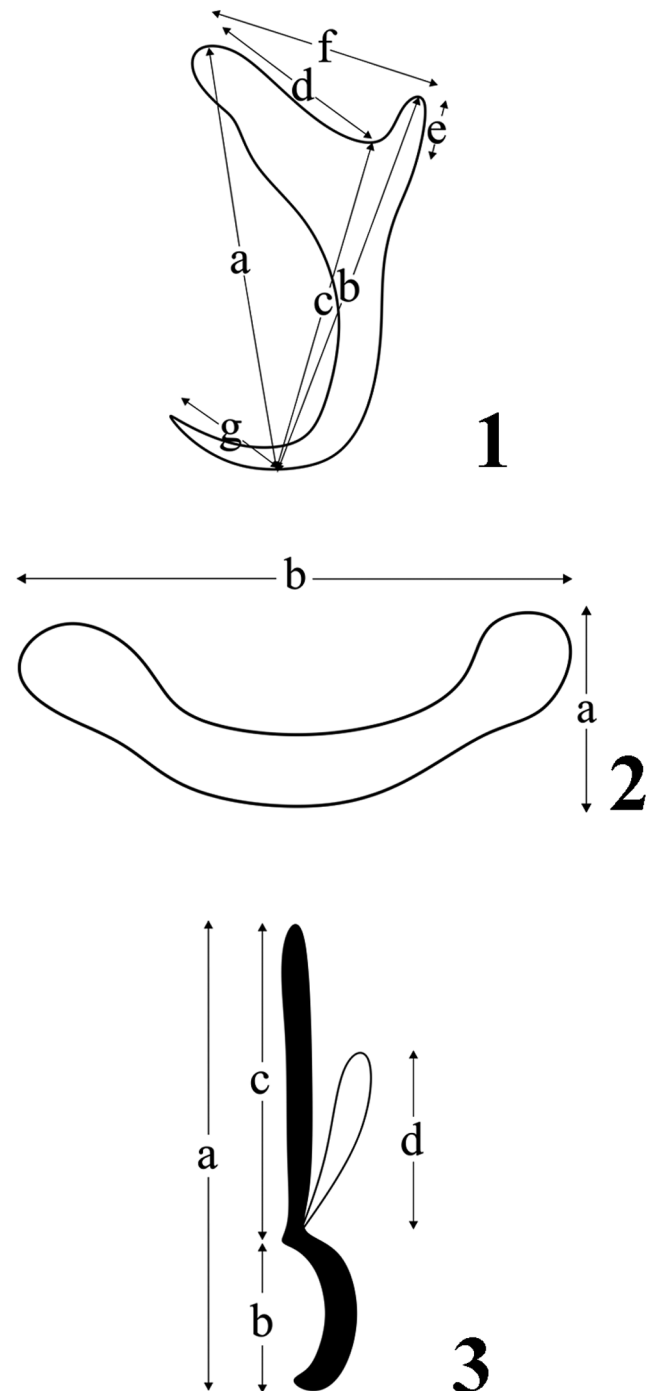
Line drawings were prepared with a drawing tube connected to a Nikon E-200 microscope, then scanned and prepared using CorelDraw X4® and Adobe's Photoshop® CS2. Ecological parameters were defined according to Bush *et al.* (1997). Helminth voucher specimens were deposited in the Helminthological Collection of the Instituto Oswaldo Cruz (CHIOC), Rio de Janeiro, State of Rio de Janeiro, Brazil. The remaining specimens were deposited in the Helminthological Collection of the Laboratório de Helminologia (CHDZ), Departamento de Zoologia, Universidade Federal do Rio Grande do Sul (UFRGS), Porto Alegre, State of Rio Grande do Sul, Brazil. Hosts were identified according to Bertaco and Lucena (2010). Host representative specimens were deposited in the Ichthyological Collection, Departamento de Zoologia (UFRGS).

Description

Cacatuocotyle guaibensis n. sp. (Figs. 4–10)

Diagnosis (based on 20 specimens: 13 whole mounted in Canada balsam, four mounted in Faure's mounting medium and three mounted in Gray and Wess medium). Monogenea, Dactylogyridae. Body 0.58–1.01 mm (0.74 ± 0.14 mm; $n = 13$) long; 112.5–192.5 (150.2 ± 24.5 ; $n = 13$) wide near gonads. Cephalic lobe well defined, cephalic glands not observed. Two pairs of eyes, anterior pair smaller, slightly closer than posterior pair; numerous accessory granules in cephalic area and anterior body. Pharynx spherical, 25–41 (32 ± 5.4 ;

$n = 14$) in diameter; oesophagus length 52.5–112.5 (74.8 ± 20.6 ; $n = 12$); caeca without branches, cyclocoel form, posterior to gonads. Haptor 72.5–112.5 (87.5 ± 10.4 ; $n = 12$) long, 90–147.5 (126.4 ± 16.0 ; $n = 14$) wide, two circular



Figs 1–3. Diagram measurement of sclerotized structures of the haptor. (1) Anchor, with superficial length (a); deep length (b); shaft length (c); superficial root length (d); deep root length (e); base width (f); point length (g). (2) Bar, with length (a); width (b). (3) Marginal hook with total length (a); hooklet length (b); shaft length (c); FH length (d)

thickenings with muscular anterior margins, diameter 46.5–75 (64.5 ± 10.1 ; $n = 14$) (Fig. 5). Anchor with broad superficial root, without protuberances, short deep root. Superficial length 30–42.5 (36 ± 3.5 ; $n = 15$), superficial root length 10–17.5 (13.8 ± 2.5 ; $n = 15$); deep length 35–42.5 (38.5 ± 2.8 ; $n = 15$), deep root length 7.5–12.5 (9.7 ± 1.6 ; $n = 15$). Shaft 27.5–35 (31.3 ± 2.3 ; $n = 15$), point 7.5–12.5 (9.8 ± 1.8 ; $n = 14$); base 20–30 (25.5 ± 3.0 ; $n = 15$) wide. Bar 10–15 (11.5 ± 1.6 ; $n = 15$) long, 17.5–25 (21.7 ± 2.0 ; $n = 15$) wide, sclerotized, broadly U-shaped, regular anterior margin and irregular posterior margin at midportion. Hooks similar, 17.5–25 (21.3 ± 2.5 ; $n = 15$) long, protruding thumb, 5–7.5 (6.8 ± 1.1 ; $n = 15$) long and shank simple, 12.5–17.5 (14.7 ± 1.8 ; $n = 15$) long; filamentous hooklet (FH) loop 5–7.5 (7 ± 1.0 ; $n = 15$) long. Testis pyriform, 35–55 (43.6 ± 6.4 ; $n = 9$) long, 17.5–37.5 (23.6 ± 6.6 ; $n = 9$) wide. MCO, 4–5 counterclockwise ring coil, base with two *tandem* circular flanges; ring diameter 17.5–25 (21.5 ± 2.6 ; $n = 13$). Accessory piece with articulation process difficult to visualize, complex distal portion and elongated proximal portion, 20–30 (25.6 ± 2.5 ; $n = 13$) long. One prostatic reservoir, posterior to base of MCO. Seminal vesicle present, a dilation of vas deferens; vas deferens looping left caeca, anterior to ovary. Ovary 67.5–95 (83.8 ± 10.9 ; $n = 12$) long, 20–30 (22.5 ± 3.0 ; $n = 12$) wide. Oviduct, ootype and uterus not observed. Seminal receptacle present, anterior to ovary. Vagina sinistral, elongate, sclerotized, 320–590 (436.4 ± 85.1 ; $n = 11$) from posterior end. Vitelline follicles from midportion of esophagus to the end of the intestinal caeca. Eggs not observed.

Taxonomic summary

Type host: *Astyanax* aff. *fasciatus* (Cuvier, 1819).

Other host: *Astyanax jacuhiensis* (Cope, 1894).

Hosts specimens deposited: *A. aff. fasciatus* UFRGS 19121 (male); UFRGS 19122 (female) and *A. jacuhiensis* UFRGS 19123 (male); UFRGS 19124 (female).

Type locality: Lake Guaíba, Municipality of Barra do Ribeiro (30°17'11"S, 51°18'01"W), State of Rio Grande do Sul, Brazil.

Other locality: Lake Guaíba, Municipality of Guaíba (30°08'28"S, 51°18'53"W), State of Rio Grande do Sul, Brazil.

Site of infestation: external surface.

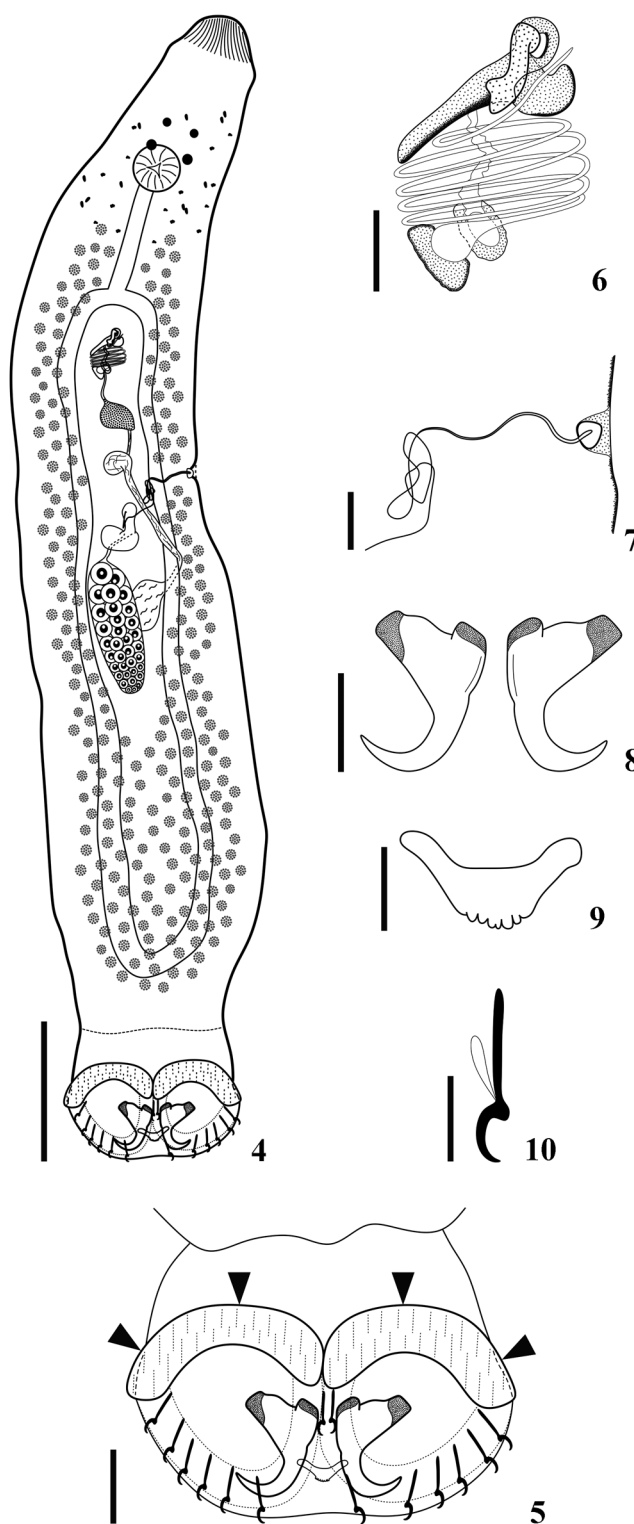
Prevalence: 24.2% (*A. aff. fasciatus*) and 6.5% (*A. jacuhiensis*).

Mean intensity of infestation: 2 helminths/host (*A. aff. fasciatus*) and 1 helminth/host (*A. jacuhiensis*).

Mean abundance of infestation: 0.48 helminth/host (*A. aff. fasciatus*) and 0.06 helminth/host (*A. jacuhiensis*).

Voucher specimens deposited: CHIOC n° 37965a (holotype); 37965b, c (paratypes).

Etymology: *Cacatuocotyle guaibensis* n. sp. The specific epithet *guaibensis* refers to Lake Guaíba from which the species was collected.



Figs 4–10. *Cacatuocotyle guaibensis* n. sp. (4) Composite (ventral view) of entire specimen. Scale bar = 100 μ m. (5) Detail of the haptor with two circular thickenings with muscular anterior margins (black head arrows). Scale bar = 25 μ m. (6) Copulatory complex. Scale bar = 10 μ m. (7) Detail of the vagina. Scale bar = 10 μ m. (8) Anchors. Scale bar = 20 μ m. (9) Bar. Scale bar = 10 μ m. (10) Hook. Scale bar = 10 μ m.

Remarks

The new species was assigned to the genus *Cacatuocotyle* by the presence of a haptor with muscular anterior margin and a pair of anchors, and a vagina with sinistral opening. This new species resembles *C. paranaensis* by the format and position of the testis and the U-shaped bar, to *C. chajuli* by the format of the ovary (elongated), the seminal receptacle and the number of coils of the MCO (4 to 5), and to *C. exiguum* by the number of coils of the MCO (4 to 5) and the U-shaped bar.

Cacatuocotyle guaibensis n. sp. differs from the congeneric species by having a longer body (it is the longest known among the species of *Cacatuocotyle*); lengthy esophagus; accessory piece with elongated proximal portion; anchor with a longer shaft compared with *C. paranaensis* and a superficial root with margin without protuberances compared with *C. exiguum*; U-shaped bar with irregular posterior margin in its midportion, and haptor with two circular thickenings with muscular anterior margins.

Discussion

All examined specimens of *C. guaibensis* n. sp. had two pairs of eyes, whereas *C. paranaensis* may lack one or both pairs (Boeger *et al.* 1997). This trait is not mentioned in the descriptions of *C. chajuli* and *C. exiguum* (Mendoza-Franco *et al.* 2013). The diagnosis of *Cacatuocotyle* proposed by Boeger *et al.* (1997) mentions the MCO with counterclockwise coils, but their diagram of *C. paranaensis* shows clockwise coils. Like in *C. chajuli* and *C. exiguum*, the MCO described and drawn the coils of *C. guaibensis* n. sp. as counterclockwise.

Cacatuocotyle paranaensis and *C. exiguum* are parasites of the gill lamellae, whereas *C. chajuli* was collected from a new microhabitat, the external surface of the anus of *A. aeneus* (Boeger *et al.* 1997; Mendoza-Franco *et al.* 2013). Therefore, the presence of *C. guaibensis* n. sp. in the external surface of the two host species further expands the range of microhabitats used by *Cacatuocotyle* species.

The prevalence of *C. guaibensis* n. sp. was higher in *A. aff. fasciatus* (24.2%) than in *A. jacuhiensis* (6.5%). The prevalence range found for *C. chajuli* in *A. aeneus* collected in 11 locations and for *C. exiguum* in *A. aeneus* from four water courses, was 6.6–20% and 6.6–15%, respectively (Mendoza-Franco *et al.* 2013). These figures are similar despite a different number of necropsied hosts (in the present study, 62 specimens of *A. aff. fasciatus* and 46 of *A. jacuhiensis* and varying between 14 and 15 in Mendoza-Franco *et al.* 2013).

The mean intensity of infestation of *C. guaibensis* n. sp. in *A. aff. fasciatus* (2 helminths/host) and *A. jacuhiensis* (1 helminth/host) is also similar to that reported for *C. chajuli* (1–2 helminths/host) and *C. exiguum* (1 helminth/host). These low mean intensities may result from low host specificity as proposed by Mendoza-Franco *et al.* (2013), a low coloniza-

tion power of *Cacatuocotyle* species or both. A parasitological study at the community level is necessary to test these hypotheses.

According to Mendoza-Franco *et al.* (2013), *Astyanax* Baird and Girard, 1854 species are hosts to a high diversity of monogeneans. Research on the parasite communities of *Astyanax* spp. in Brazil, however, has shown that other parasite taxonomic groups are even more diverse (Abdallah *et al.* 2004; Azevedo *et al.* 2007; Paraguassú and Luque 2007; Lizama *et al.* 2008). This study describes a new parasite species of *A. aff. fasciatus* and *A. jacuhiensis*; the latter also representing a new host for monogeneans. Future studies of the helminth fauna of Characidae species, the most specious Neotropical fish family (Lima *et al.* 2007), are likely to boost our knowledge on the diversity of monogeneans in general and especially of *Cacatuocotyle*.

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