Proterodiplostome Parasites (Digenea, Proterodiplostomidae) of the Caiman, *Caiman crocodilus yacare* (Reptilia, Crocodylia) in the Pantanal Mato-Grossense, Brazil, with the Description of Two New Species

João B Catto, JFR Amato*

Centro de Pesquisa Agropecuária do Pantanal, EMBRAPA, Rua 21 de Setembro 1880, 79320-900 Corumbá, MS, Brasil *Departamento de Biologia Animal, Universidade Federal Rural do Rio de Janeiro, Caixa Postal 74512, 23851-970 Seropédica, RJ, Brasil

Two new species are described from the caiman, Caiman crocodilus yacare. Proterodiplostomum breve *n. sp. differs from all other species in the genus by the following characteristics: (1) the paraprostate gland is shorter and club-shaped; (2) the genital cone is, in average, eight times longer than that of* P. medusae; *(3) the genital atrium is larger and without pseudosuckers; (4) the oral sucker and pharynx are longer; and (5) there are larger numbers of papillae surrounding the tribocytic organ (40) against 20 in* P. longum, *16 in* P. tumidilum, *8 in* P. ophidum, *and 16-18 in* P. medusae. Proterodiplostomum globulare *n. sp. differs from all the other species in the genus by the following characteristics: (1) from* P. tumidilum, P. longum, P. medusae, *and* P. breve *n. sp. for the absence of pseudosuckers or muscular bunches in the inferior wall of the genital atrium; (2) the shape of the paraprostate gland, which is globular and not cylindrical as in* P. longum, P. tumidilum, P. medusae, *and* P. ophidum; *(3) the size of the tribocytic organ is 201-407 long, 183-495 wide, while is* 138-270 long, 102-292 wide *in* P. medusae, and 138-270 long, 255 wide in P. ophidum; *(4) the number of papillae in the tribocytic organ (18-20)* in P. globulare *and 16-18 in* P. medusae, *and 8 in* P. ophidum. *Specimens belonging to six other species of proterodiplostomes are recorded for the first time infecting the caiman,* C. c. yacare *in the Pantanal Mato-grossense, Brazil, namely:* Proterodiplostomum medusae, P. tumidilum, Cystodiplostomum hollyi, Prolecithodiplostomum constrictum, Paradiplostomum abbreviatum, *and* Herpetodiplostomum caimancola.

Key words: *Proterodiplostomum breve* n. sp. - *Proterodiplostomum globulare* n. sp. - *Proterodiplostomum medusae* - *Proterodiplostomum tumidilum* - *Cystodiplostomum hollyi* - *Prolecithodiplostomum constrictum* - *Paradiplostomum abbreviatum* - *Herpetodiplostomum caimancola*

Twenty four of the 64 species of digenetic trematode parasites from crocodilians are proterodiplostomes. The proterodiplostomes are distributed in all the continents and regions inhabited by their hosts. Dubois (1936) described specimens of eight species from crocodilians of the Amazon Region of Brazil, namely: *Proterodiplostomum longum* (Brandes 1888), *Paradiplostomum abbreviatum* (Brandes 1888); *Herpetodiplostomum caimancola* (Dollfus 1935); *Proterodiplostomum tumidilum* Dubois, 1936, *Proterodiplostomum medusae* (Dubois 1936), *Mesodiplostomum gladiolum* Dubois, 1936, *Cystodiplostomum hollyi* Dubois, 1936, and *Prolecithodiplostomum constrictum* Dubois, 1936.

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The Pantanal Mato-grossense is inhabited by a single species and subspecies of crocodilians, *Caiman crocodylus yacare* (Daudin) which has its distribution restricted by the Paraguay and Paraná river basins. From this host, in the Pantanal Mato-grossense, Travassos (1922) reported two species: *Odhneriotrema microcephala* Travassos, 1922 and *Pachypsolus sclerops* Travassos, 1922; Catto and Amato (1993a) reported two species: *Caimanicola marajoara* Freitas and Lent, 1938 and *Proctocaecum dorsale* Catto and Amato, 1993; and Catto and Amato (1993b) reported two species: *Pseudotelorchis caimanis* Catto and Amato, 1993, and *P. yacarei* Catto and Amato, 1993. In the present paper specimens belonging to eight species of proterodiplostomes are described as parasites of *C. c. yacare*, two of which, are new species.

MATERIALS AND METHODS

The specimens studied are part of the material collected from 64 necropsies performed from Janu-

ary 1985 to January 1989 in the Pantanal Matogrossense region (Catto 1991). The hosts were captured alive with written permission from IBAMA/MS (Instituto Brasileiro do Meio Ambiente) given to the senior author and killed in the Laboratório de Parasitologia do Centro de Pesquisa Agropecuária do Pantanal, State of MS, with an ethyl alcohol injection between the occipital bone and the 1st cervical vertebrae. The helminths were collected and processed according to Amato (1982, 1985). The small intestine was divided into three sections, anterior, middle, and posterior, and the proterodiplostomes, when present over 200 specimens, were sampled through two aliquots of 10% each. The aliquots were taken after the removal of all other helminths present. The helminths were fixed in cold AFA (ethyl alcohol 70°GL (Gay Lussac) - 93 parts, formaldehyde solution 37% - 5 parts, and glacial acetic acid - 2 parts) under slight coverslip pressure, or in glacial acetic acid for 2-3 min, without coverslip pressure. After 24 hr in AFA, the specimens were transferred to the preservative ethyl alcohol 70°GL. The helminths were stained with Delafield's hematoxylin and were destained in ethyl alcohol 70°GL with hydrochloric acid 0.5%, dehydrated in an ethyl alcohol series, cleared in beechwood creosote or methyl benzoate, and mounted in Canada balsam. The descriptions were based on 10 specimens fixed in AFA and 10 specimens fixed in glacial acetic acid. All the measurements were pooled because they varied only slightly for most characters or completely overlapped. The illustrations were prepared with a drawing tube and a Wild Leitz microscope. Measurements are in micrometers unless otherwise indicated. The range of measurements is followed by the average within parentheses. The ecological terms follow Margolis et al. (1982). Holotypes and paratypes were deposited in the Coleção Helmintológica do Instituto Oswaldo Cruz (CHIOC), Rio de Janeiro, Brazil, while paratypes were also deposited in the Helminthological Collection of the United States National Museum (USNM), Beltsville, Maryland, USA.

DESCRIPTIONS

Proterodiplostomum breve n. sp.
(Figs 1-2)

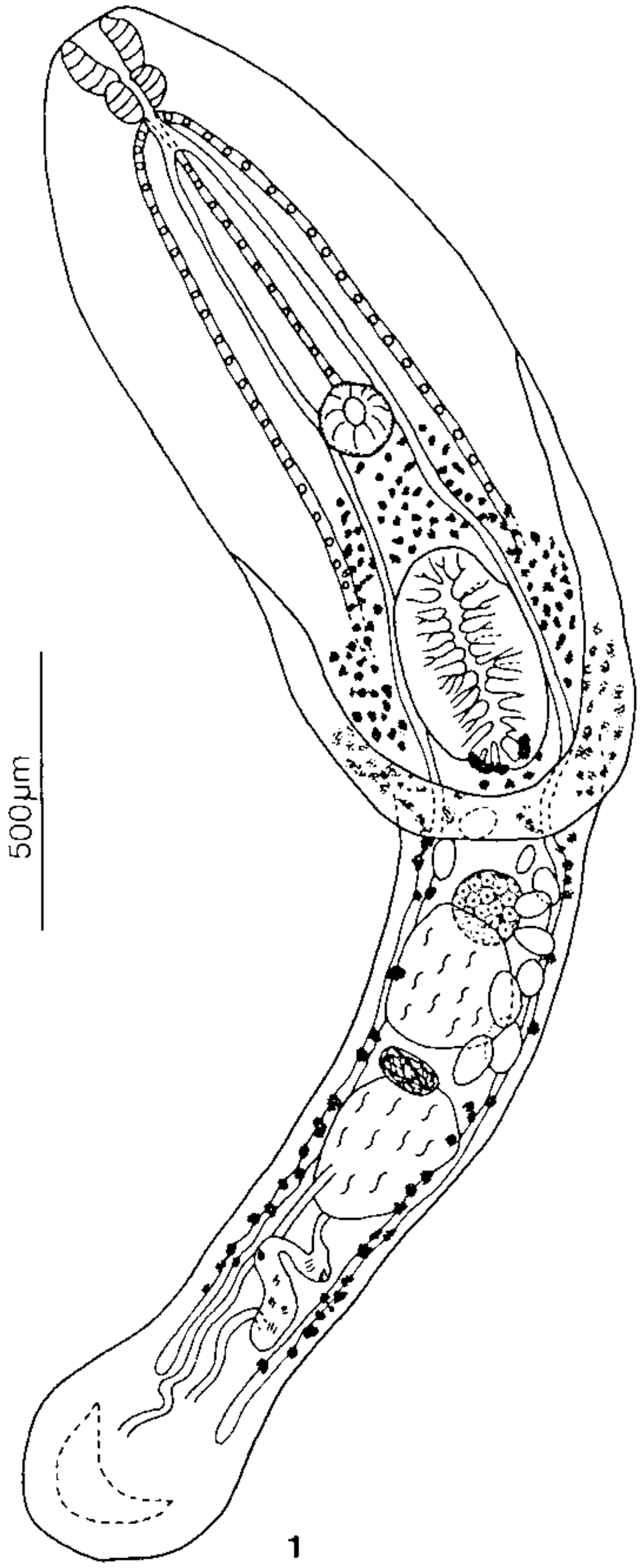
DESCRIPTION (based on 20 specimens): Proterodiplostomidae. Body divided into two parts, 2.69-4.22 mm (3.28 mm) in total length. Anterior part elliptic, foliaceous, with lateral and posterior margins curved ventrally, 1.46-1.97 mm (1.65 mm) long, 0.47-1.18 mm (0.80 mm) wide. Posterior part joining anterior part dorsally, 0.97-2.38 mm (1.63 mm) long, 237-710 (435) wide; maximum width at posterior extremity, at level of copulatory bursa; tribocytic organ elliptic, in posterior third of anterior part; opening median, sorrounded, internally, by 20, wide, papillae, intercalated by 20, narrower, papillae, 366-658 (488) long, 192-549 (347) wide. Space between anterior extremity and tribocytic organ 55-73% (65%) of length of anterior part; proteolitic glands distinct, dorsal, in posterior margin of tribocytic organ. Acetabulum 109-164 (136) long, 109-164 (136) wide; preacetabular space 37-53% (43%) of length of anterior part. Oral sucker 102-146 (120) long, 109-175 (133) wide; prepharynx not measurable; pharynx 73-116 (100) long, 80-167 (122) wide; esophagus short, 37-124 (66) long; ceca narrow, tangent to tribocytic organ in anterior part, lateral in posterior part, ending at base of copulatory bursa. Oral sucker to acetabulum width ratio 1:0.93-1.17 (1:1.08); oral sucker to pharynx width ratio 1:0.64-1.06 (1:0.89). Testes, median, in tandem; anterior testis 164-439 (258) long, 146-512 (237) wide; posterior testis 146-494 (279) long, 128-347 (238) wide; pretesticular space 6-21% (14%) of length of posterior part; intertesticular space 2.9-11.3% (5.8%) of length of posterior part; seminal vesicle posttesticular, sinuous, continuing as sinuous ejaculatory duct, reaching genital cone through its base, opening in apex; prostate glands free in parenchyma, in the final portion of the ejaculatory duct; paraprostate gland 116-219 (168) long, 29-58 (42) wide, club-shaped, at the base of copulatory bursa, dorsal to ejaculatory duct, surrounded by glandular cells; efferent duct parallel to ejaculatory duct, also opening in apex of the genital cone; genital cone 80-292 (177) long, 51-255 (142) wide, usually everted; genital atrium spacious; genital pore ample, with aperture subterminal, dorsal. Ovary pretesticular, median, 91-164 (125) long, 91-219 (143) wide; preovarian space 2.5-15% (7.6%) of length of posterior part; Mehlis' gland intertesticular; uterus ventral to ejaculatory duct, opening in the bottom of genital atrium; vitelline glands in the two parts of body, between posterior margin of acetabulum and middle of posttesticular space, follicles dense, surrounding tribocytic organ, in anterior part; sparse, lateral in posterior part; vitelline reservoir intertesticular; eggs 80-102 (90) long, 44-65 (54) wide. Excretory vesicle with lateral branches in posterior part, two lateral branches and one median branch in anterior part, united at level of pharynx; excretory pore terminal.

Taxonomic summary

Type host: *Caiman c. yacare* (Daudin).

Sites of infection: anterior and middle sections of the small intestine.

Type locality: Nhumirim Farm, 18° 59'S, 56° 39'W, Corumbá, MS, Brasil.



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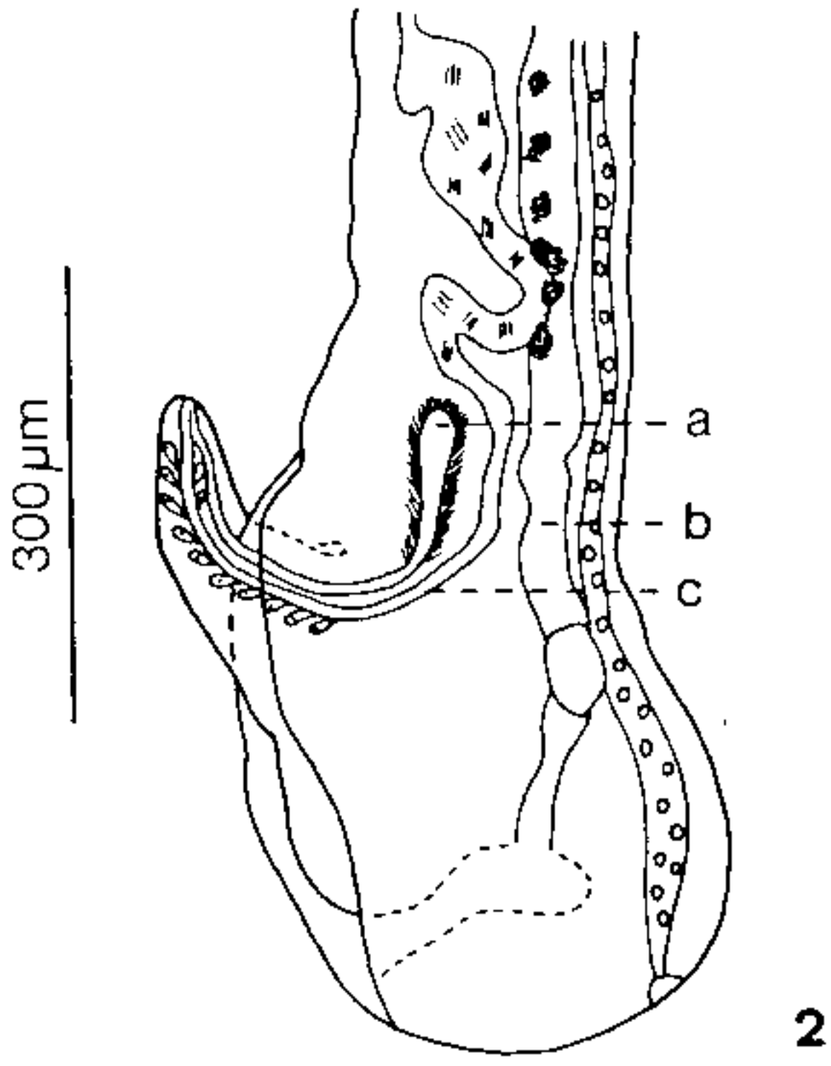

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Proterodiplostomum breve n. sp. Fig. 1: holotype, ventral view. Fig. 2: paratype, lateral view (a - paraprostate gland, b - uterus, and c - ejaculatory duct).

Prevalence: 28.1%.

Mean intensity of infection: 351, in 18 hosts.

Range of the intensities of infection: 4-2927.

Other locality: Santana, 18° 06'S, 56° 36'W, Corumbá, MS, Brazil.

Etymology: the specific name *breve* refers to the shorter size of the paraprostate gland of this species when compared to the paraprostate glands of the other species in the genus and it is the neutral form of the adjective (*brevis, e*) biform of 2nd class.

Specimens deposited: CHIOC holotype No. 33001c, CHIOC paratype Nos 33002a and b, 33001a and b, 33003a, b, c, and d, 33004; USNM paratype specimens No. 82618 (10 slides).

Remarks

Three species, *P. longum, P. tumidilum,* and *P. medusae* were included in this genus by Dubois

(1979), in the last revision of the Proterodiplostomidae. The three species are characterized by the closeness of the openings of the ejaculatory duct and the paraprostate gland, in the apex of the genital cone. The uterus opens separately in the bottom of the genital atrium.

Proterodiplostomum longum and *P. tumidilum* have atrial pseudosuckers, while *P. medusae* has muscular bunches in the inferior wall of the genital atrium disposed as those of the suckers. A fourth species, *P. ophidum* was described by Thatcher (1963), from *Drymarchon corais melanurus* (Dumeril, Bibron and Dumeril), in Mexico. This species, not mentioned by Dubois (1979), has the sexual ducts characteristic of the genus, but does not have the pseudosucker in the genital atrium. *Proterodiplostomum breve* n. sp. differs from all other species in the genus by the following characteristics: (1) the paraprostate gland is shorter and club-shaped, (2) the genital cone is, in average, eight times longer than that of *P. medusae*, (3) the genital atrium is larger and without pseudosuckers; (4) the oral sucker and pharynx are longer, and (5) there are larger numbers of papillae surrounding the tribocytic organ (40) against 20 in *P. longum*, 16 in *P. tumidilum*, 8 in *P. ophidum*, and 16-18 in *P. medusae*.

Proterodiplostomum globulare n. sp.
(Figs 3-4)

DESCRIPTION (based on 20 specimens, mounted *in toto*): Proterodiplostomidae. Body divided into two parts, 2.56-4.75 mm (3.50 mm) of total body length. Anterior part elliptic, foliaceous, with lateral and posterior margins curved ventrally, 1.10-1.83 mm (1.49 mm) long, 0.55-1.24 mm (0.78 mm) wide. Posterior part cylindrical, posterior extremity thin, joining dorsally the posterior extremity of the anterior part, 1.28-2.92 mm (2.01 mm) long, 237-713 (455) wide. Tribocytic organ elliptic, in posterior third of anterior part, aperture median, surrounded, internally, by 18-20, generally 20 papillae, 201-457 (314) long, 183-495 (299) wide; space pre-tribocytic organ 52-70% (62%) of length of anterior part; proteolitic glands distinct, in posterior region of tribocytic organ. Acetabulum 73-109 (82) long, 80-124 (95) wide; preacetabular space 31-48% (42%) of length of anterior part. Oral sucker 51-73 (58) long, 43-73 (58) wide; prepharynx 7.3-22 (14) long; pharynx 51-73 (62) long, 36-73 (50) wide; esophagus 65-168 (107) long; ceca thin, tangent to tribocytic organ in anterior part, lateral in posterior part, reaching middle of posttesticular space. Oral sucker to acetabulum width ratio 1:1.3-2.28 (1:1.66); oral sucker to pharynx width ratio 1:0.6-1.16 (1:0.87). Testes subspherical, median, in tandem, in second half of posterior part; anterior testis 183-402 (270) long, 164-439 (269) wide; posterior testis 109-402 (275) long, 183-439 (258) wide; pretesticular space 33-51% (42%) of length of posterior part; intertesticular space 2.1-12.5% (5.3%) of length of posterior part; posttesticular space 18-36% (26%) of length of posterior part; seminal vesicle posttesticular, sinuous, with thin ejaculatory duct, opening in apex of the genital cone; paraprostate gland small, 43-109 (58) long, 36-116 (57) wide, globular-shaped, generally, full of sperm, not surrounded by glandular cells; efferent canal parallel to ejaculatory duct, also opening in apex of genital cone; genital cone small, 18-37 (28) high, 22-40 (32) wide at base, inside genital atrium; genital atrium tubular, anteriorly; genital pore with aperture subterminal, dorsal. Ovary pretesticular, median, subspherical, 91-220 (135) long, 91-201 (139) wide; preovarian space 24-43 (33%) of length of posterior part; ootype and Mehlis' gland intertesticular; uterus opening in the bottom of genital atrium; vitelline glands in both parts of body, between anterior border of tribocytic organ and posterior margin of anterior testis, surrounding the tribocytic organ in anterior part of body, lateral in posterior part; vitelline reservoir intertesticular; eggs 98-131 (116) long, 44-66 (60) wide. Excretory system with lateral branches in posterior part, two lateral branches and one median branch in anterior part, united at pharynx level; excretory pore terminal.

Taxonomic summary

Type host: *Caiman c. yacare* (Daudin).

Site of infection: anterior, middle, and posterior sections of the small intestine.

Type locality: Nhumirim Farm, 18° 59' S, 56° 39'W, Corumbá, MS, Brazil.

Prevalence: 46.8%.

Mean intensity of infection: 128, in 30 hosts.

Range of intensities of infection: 1-2685.

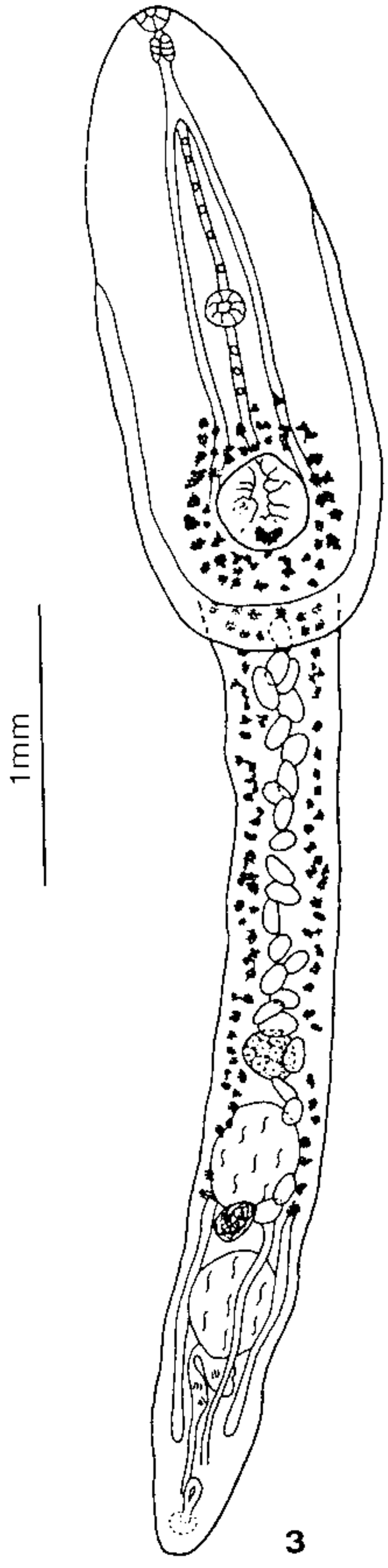
Other locality: Santana Farm, 18° 06' S, 56° 36'W, Corumbá, MS, Brazil.

Etymology: the specific name *globulare* refers to the globular shape of the paraprostate gland, unique in the genus *Proterodiplostomum*, and it is the neutral form of the adjective (*globularis, e*), biform of 2nd class.

Specimens deposited: CHIOC holotype No. 33005b, CHIOC paratype Nos 33005a, 33006, 33007, 33008a and b, 33009, 33010a and b; USNM paratype Nos 82619, 82620, 82621 (6 slides), 82622 (2 slides).

Remarks

Proterodiplostomum globulare n. sp. differs from all the other species in the genus by the following characteristics: (1) from *P. tumidilum, P.*



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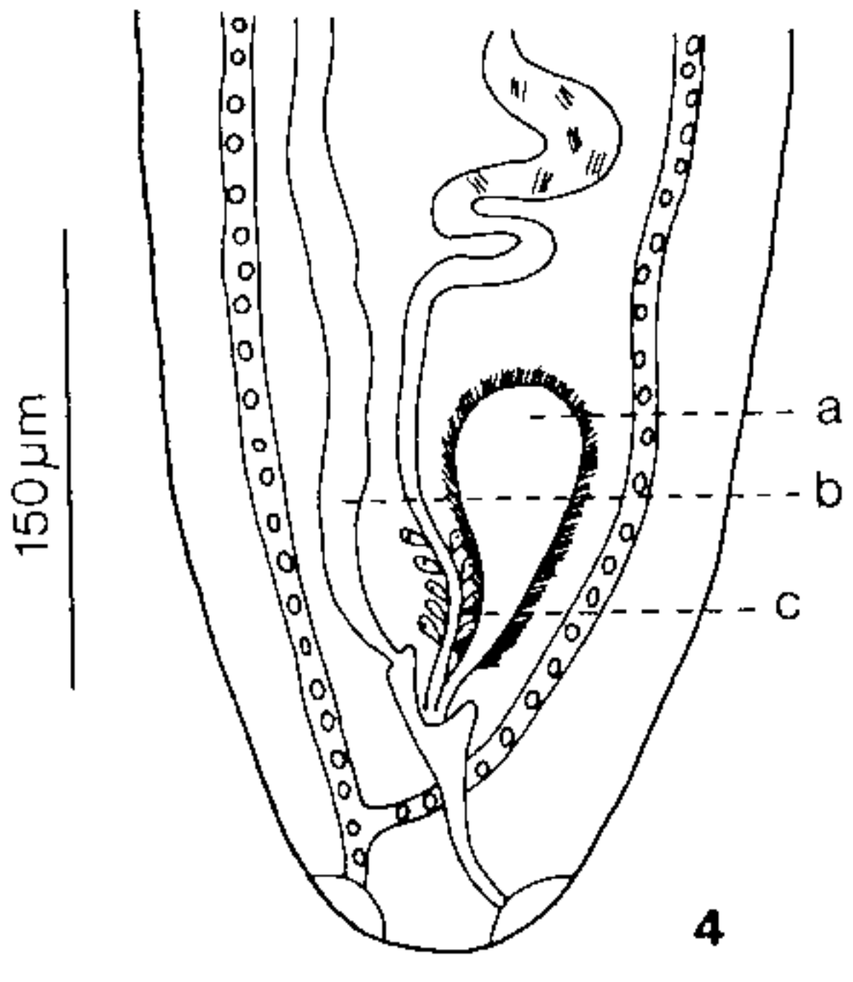

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Proterodiplostomum globulare n. sp. Fig. 3: holotype, ventral view. Fig. 4: paratype, lateral view (a - paraprostate gland, b - uterus, and c - ejaculatory duct).

longum, *P. medusae*, and *P. breve* n. sp. for the absence of pseudosuckers or muscular bunches in the inferior wall of the genital atrium; (2) the shape of the paraprostate gland, which is globular and not cylindrical as in *P. longum*, *P. tumidilum*, *P. medusae*, and *P. ophidum*; (3) the size of the tribocytic organ is 201-407 long, 183-495 wide, while is 138-270 long, 102-292 wide in *P. medusae*, and 138-270 long, 255 wide in *P. ophidum*; (4) the number of papillae in the tribocytic organ (18-20) in *P. globulare* and 16-18 in *P. medusae*, and 8 in *P. ophidum*.

Proterodiplostomum tumidilum Dubois, 1936
(Fig. 5)

DESCRIPTION (based on 129 specimens, 20 measured): Body divided into two parts by trans-

versal constriction, 1.73-3.31 mm (2.85 mm) of total length. Anterior part elliptic, foliaceous, 0.89-1.46 mm (1.17 mm) long, 0.38-1.00 mm (0.71 mm) wide; maximum width at middle of anterior part. Posterior part, cylindrical, club-shaped, maximum width at level copulatory bursa, in posterior extremity, 0.75-2.03 mm (1.68 mm) long, 256-732 (500) wide. Tribocytic organ, elliptic, in posterior half of anterior part, with opening median, surrounded, internally, by 16 papillae, 237-457 (364) long, 164-439 (270) wide; space pre-tribocytic organ 45-69% (60%) of length of anterior part; proteolitic glands distinct, in posterior margin of tribocytic organ. Acetabulum 58-109 (82) long, 58-124 (92) wide; preacetabular space 38-55% (46%) of length of anterior part. Oral sucker 58-109 (88) long, 65-116 (88) wide; pharynx 65-102 (80) long, 58-102 (79) wide; esophagus short, 36-131 (87) long; ceca thin, tangential to tribocytic organ, in anterior part, lateral in posterior part of body, ending near posterior extremity. Oral sucker to acetabulum width ratio 1:0.88-1.55 (1:1.05); oral sucker to pharynx width ratio 1:0.76-1.22 (1:0.89). Testes subspherical, median, in tandem, in second third of posterior part; anterior testis 109-274 (177) long, 109-274 (182) wide; posterior testis 109-274 (186) long, 109-274 (188) wide; pretesticular space 21-36% (30%) of length of posterior part; intertesticular space 4-8% (5.8%) of length of posterior part; posttesticular space 30-50% (43%) of length of posterior part; seminal vesicle sinuous, posttesticular, ejaculatory duct narrow, opening in apex of the genital cone; paraprostate gland well developed, 201-585 (333) long, 36-73 (53) wide, cylindrical, dorsal to ejaculatory duct, surrounded by numerous glandular cells; efferent duct narrow, opening in apex of the genital cone, as the ejaculatory duct; genital cone with lower wall united to superior margin of the atrial pseudosucker; genital atrium spacious, with the pseudosucker in inferior wall; genital pore ample, with aperture subterminal, dorsal. Ovary pretesticular, median, subspherical, 45-109 (87) long, 54-128 (95) wide; preovarian space 24-43 (33%) of length of posterior part; ootype and Mehlis' gland intertesticular; uterus ventral, reaching copulatory bursa, where it follows between genital cone and the atrial pseudosucker, opening separate from male ducts; vitelline glands going beyond acetabulum in anterior part and posterior testis, in posterior part, surrounding ceca and tribocytic organ in anterior part, lateral in posterior part; vitelline reservoir intertesticular; eggs 80-102 (89) long, 44-65 (55) wide. Excretory system with lateral branches in posterior part, two lateral branches and one median branch in anterior part of the body, united at pharynx level; excretory pore terminal.

Taxonomic summary

Host: *Caiman c. yacare* (Daudin).

Site of infection: anterior, middle, and posterior sections of the small intestine.

Prevalence: 31.2%.

Mean intensity of infection: 543, in 20 hosts.

Range of the intensities of infection: 3-2842.

Localities: Nhumirim Farm, 18° 59'S, 56° 39'W and Santana Farm, 18° 06'S, 56° 36'W, Corumbá, MS, Brazil.

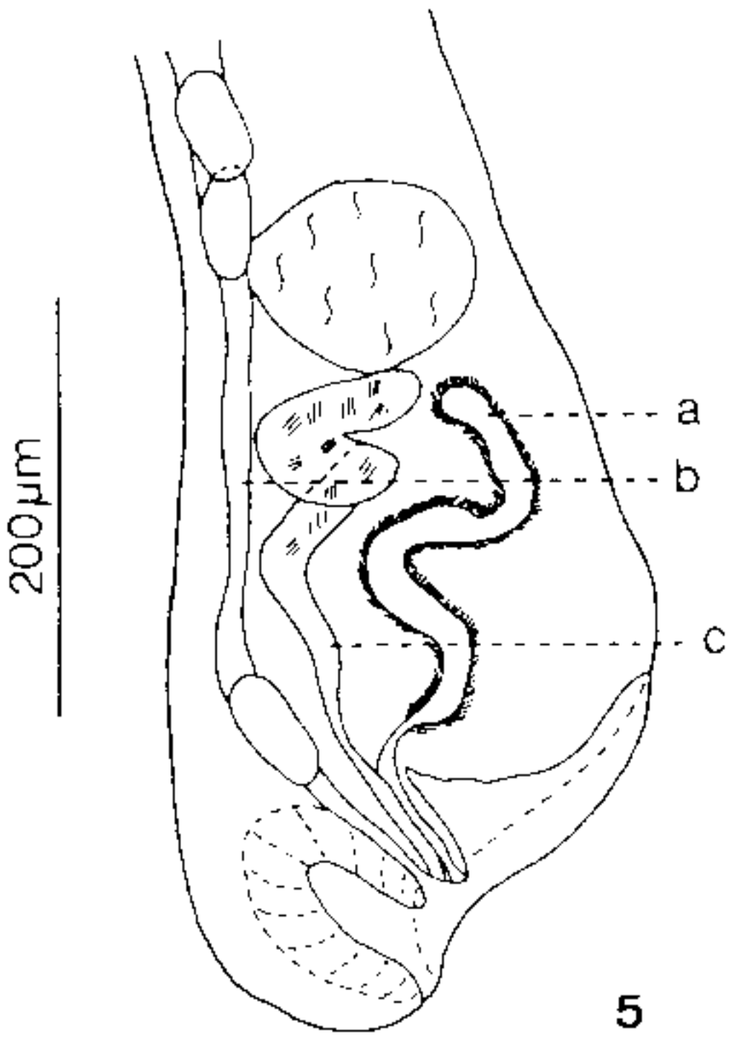
Specimens deposited: CHIOC voucher specimen Nos 33029, 33030, 33034, 33035a and b; USNM voucher specimens Nos 82633, 82634, 82635 (3 slides).

Remarks

After the original description by Dubois (1936) where the species was recorded parasitizing *C. c. crocodilus*, in Brazil, this species was only collected in Panama, from *C. c. fuscus* (Caballero et al. 1957). *Caiman c. yacare* is a new host record and enlarges southward the known geographical distribution of this species. The measurements obtained from the present specimens agree with the measurements reported by the previous published descriptions of specimens of this species.

Proterodiplostomum medusae (Dubois, 1936)
(Fig. 6)

DESCRIPTION (based on 253 specimens, 20 measured): Body divided into two parts by a transversal constriction, 1.24-2.83 mm (2.0 mm) in total length. Anterior part elliptic, foliaceous, 512-915 (688) long, 274-823 (459) wide; maximum width at level of tribocytic organ. Posterior part cylindrical, posterior extremity thinner, inserting dorsally in posterior extremity of anterior part, 0.68-1.92 mm (1.31 mm) long, 109-366 (223) wide. Tribocytic organ 138-270 (196) long, 102-292 (161) wide, elliptic, in the second third of anterior part, with opening median, surrounded, internally, by 16-18, generally 18 papillae, disposed irregularly; space pre-tribocytic organ 32-45% (38%) of length of anterior part; proteolytic glands distinct, grouped in posterior border of the tribocytic organ. Acetabulum small, 27-58 (37) long, 33-64 (48) wide, usually contiguous to tribocytic organ; preacetabular space 27-38% (35%) of length of anterior part. Oral sucker 33-53 (48) long, 42-67 (51) wide; pharynx 25-45 (35) long, 27-47 (36) wide; esophagus short, 18-55 (37) long; ceca tangential to tribocytic organ in anterior part, lateral in posterior part, ending near posterior extremity. Oral sucker to acetabulum width ratio 1:0.72-1.12 (1:0.89); oral sucker to pharynx width ratio 1:0.6-0.88 (1:0.69). Testes subspherical, in tandem, median, in second third of posterior part; anterior testis 65-255 (126) long, 87-248



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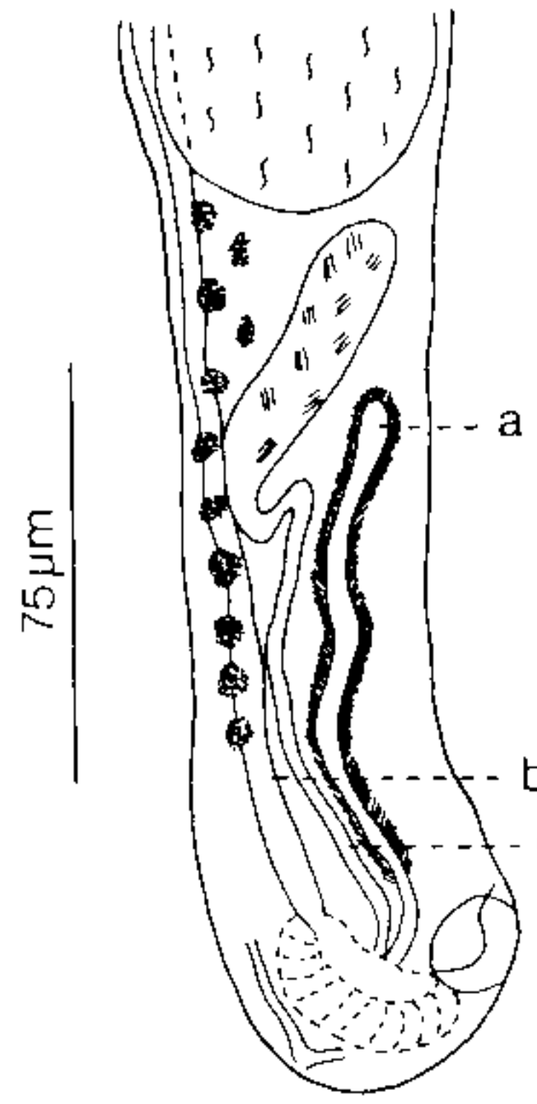

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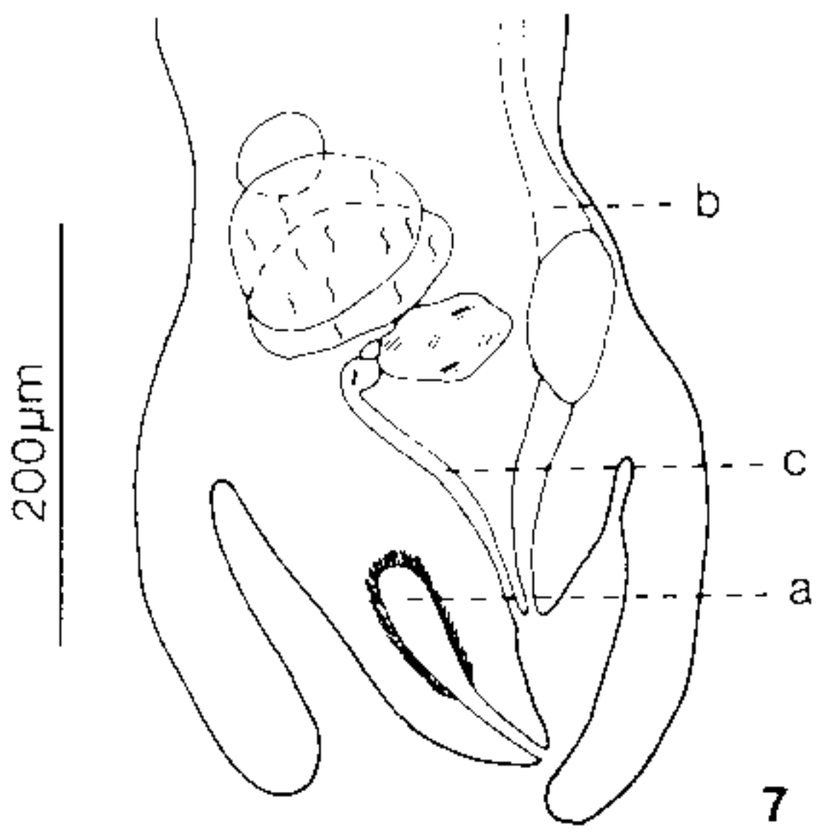

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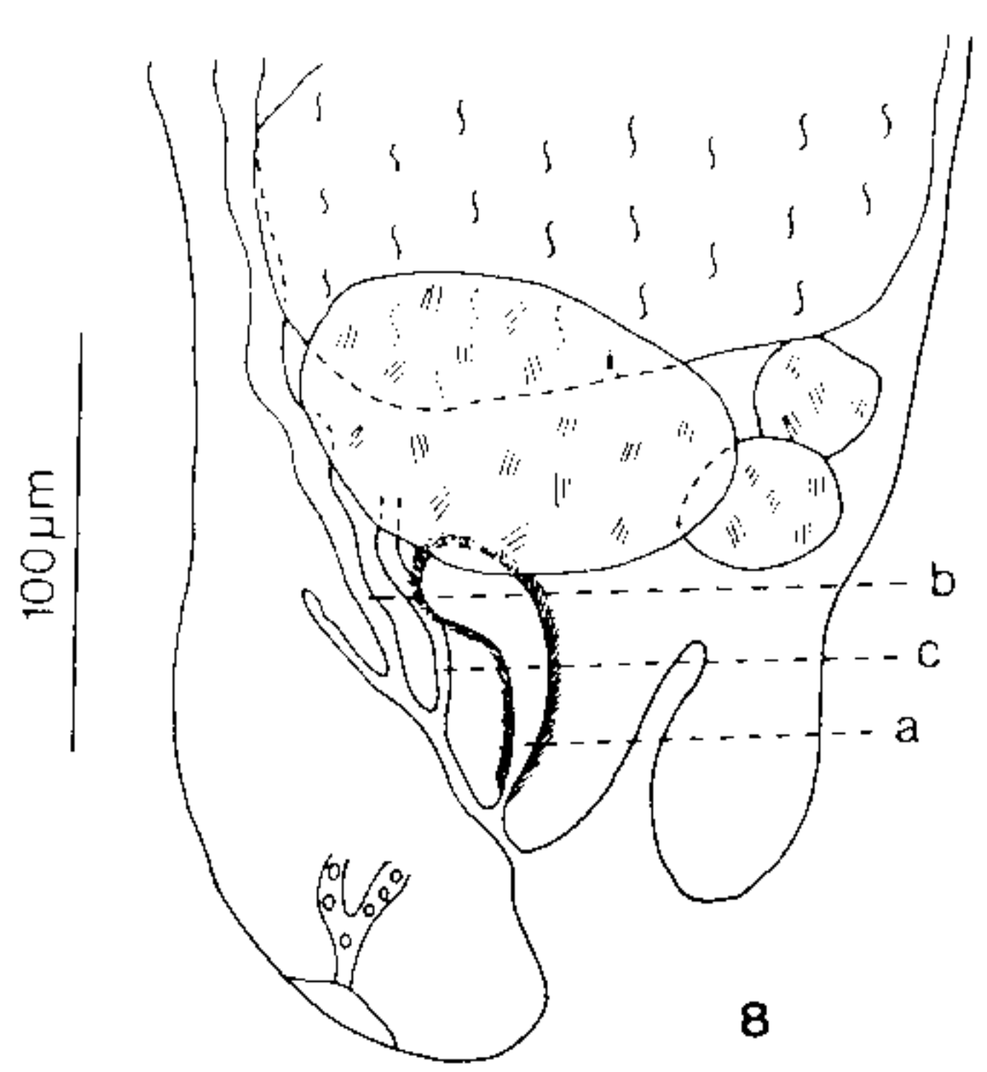

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Posterior extremities of proterodiplostomes, lateral view. Fig. 5: *Proterodiplostomum tumidilum*. Fig. 6: *P. medusae*. Fig. 7: *Paradiplostomum abbreviatum* and Fig. 8: *Herpetodiplostomum caimancola* (a - paraprostate gland, b - uterus, and c - ejaculatory duct).

(158) wide; posterior testis 80-270 (150) long, 87-255 (163) wide; pretesticular space 36-52% (39%) of length of posterior part; intertesticular space 3.3-8.5% (5.2%) of length of posterior part; posttesticular space 26-36% (31%) of length of posterior part; seminal vesicle posttesticular, sinuous, with ejaculatory duct opening in the inferior wall of the genital cone; paraprostate gland well developed, cylindrical, 167-386 (260) long, surrounded by glandular cells, opening near and above the ejaculatory duct, in genital cone; genital cone small, 13-45 (22) high, 27-54 (36) wide at base. Ovary pretesticular, median, sometimes contiguous to anterior testis, subspherical, 51-138 (71) long, 51-146 (89) wide; preovarian space 27-47% (35%) of length of posterior part; Mehlis' gland

intertesticular; uterus ventral, opening in the bottom of the genital atrium; genital atrium with muscular bundles, arranged as in a sucker, in the lower wall; genital pore subterminal, dorsal; vitelline glands between anterior margin of the tribocytic organ and the base of the copulatory bursa, surrounding the tribocytic organ and ceca in anterior part, in four longitudinal rows between the anterior extremity of posterior part and the ovary, posteriorly arranged in two lateral rows; vitelline reservoir intertesticular; eggs 80-95 (92) long, 37-58 (45) wide. Excretory system with lateral branches in posterior part, two lateral branches and one median branch in anterior part, united at pharynx level; excretory pore terminal.

Taxonomic summary

Synonyms: *Proterodiplostomum intermedium* Nasir and Rodrigues, 1967. *Pseudoneodiplostomum brasiliensis* Ruiz and Rangel, 1954.

Host: *Caiman c. yacare* (Daudin).

Site of infection: anterior, middle, and posterior sections of the small intestine.

Prevalence: 68.7%.

Mean intensity of infection: 183, in 44 hosts.

Range of the intensities of infection: 1-1823.

Localities: Nhumirim Farm, 18° 59'S, 56°39'W and Santana Farm, 18°06'S, 56°36'W, Corumbá, MS, Brazil.

Deposited specimens: CHIOC voucher specimen Nos 33023, 33024, 33027, 33028a and b; USNM voucher specimen Nos 82636, 82637 (3 slides).

Remarks

This species was described by Dubois (1936) from *C. c. crocodilus*, in Brazil. Later, it was described as *P. brasiliensis* from *Caiman* sp. in the same country (Ruiz and Rangel 1954). Specimens of this species were also collected from *C. c. fuscus*, in Panama (Caballero et al. 1957); from *Crocodylus acutus* and *C. c. fuscus*, in Costa Rica (Caballero and Brenes 1958) and (Brooks et al. 1977), respectively, and described from *C. c. crocodilus*, in Venezuela as *P. intermedium* (Nasir and Rodrigues 1967). Dubois (1979), in the revision of the Proterodiplostomidae, synonymized *P. intermedium* Nasir and Rodrigues, 1967 and *Pseudoneodiplostomum brasiliensis* Ruiz and Rangel, 1954 as *P. medusae*.

Three characters, the distribution of the vitelline glands, the number of papillae surrounding the tribocytic organ, and the final portion of the sexual ducts, have motivated the main discrepancies between the various descriptions of specimens of this species. From all species of proterodiplostomes collected in the present study, this was the only species which presented a considerable variation in the distribution of the vitelline glands, and, as in all other descriptions, there is a condensation of the follicles between the posterior extremity of the anterior part and the ovary. It was also the species which presented the most difficulty to count the papillae of the tribocytic organ. From the 20 specimens measured it was possible to count the papillae in only seven.

The differences in the descriptions of specimens in relation to the final portions of the sexual ducts are due to the superposition of these thin ducts when the specimens are mounted with the ventral or dorsal sides up. The difficulty in the visualization of these ducts was mentioned by Dubois (1936), when he affirmed to be almost impossible to classify proterodiplostomes, without the use of serial sections.

Paradiplostomum abbreviatum (Brandes, 1888) (Fig. 7)

DESCRIPTION (based on 85 specimens, 15 measured): Body without transversal constriction clearly dividing it in two parts, 1.04-1.95 mm (1.46 mm) of total length. The two parts of body are defined by the decreasing of the transversal diameter at level of the posterior extension of vitelline glands and ovary. Anterior part foliaceous, 0.67-1.00 mm (0.91 mm) long, 311-549 (435) wide; maximum width at equator of anterior part. Posterior part shorter, cylindrical, 311-786 (560) long, 292-603 (461) wide, occupied, largely, by the copulatory bursa, which is well developed. Tribocytic organ small, spherical to subspherical, 87-146 (124) long, 102-160 (126) wide, without papillae surrounding its aperture; proteolytic glands conspicuous in posterior half of tribocytic organ; space pretribocytic organ 69-82% (75%) of length of anterior part. Acetabulum equal to, or just smaller, than the tribocytic organ, 73-109 (84) long, 80-131 (97) wide; preacetabular space 56-64% (60%) of length of posterior part. Oral sucker 37-65 (53) long, 37-73 (53) wide; pharynx 29-43 (36) long, 29-36 (33) wide; esophagus 22-102 (52) long; ceca lateral, reaching the base of copulatory bursa. Oral sucker to acetabulum width ratio 1:1.65-2.24 (1:1.88); oral sucker to pharynx width ratio 1:0.5-0.8 (1:0.62). Testes lateral, subspherical, partially obliquous; anterior testis in the limit of the two parts of body, 72-164 (102) long, 72-201 (115) wide; posterior testis 72-146 (92) long, 72-237 (121) wide; posttesticular space 60-90% (72%) of length of posterior part; seminal vesicle posttesticular, sinuous, with ejaculatory duct opening in reentrance in the inferior side of genital cone, approximately at midway between base and apex; paraprostate gland cylindrical, small, 80-180 (121) long, surrounded by few glandular cells, with

sperm inside, in axle of genital cone, opening in its apex; genital cone well developed, 109-402 (244) high, 109-384 (237) wide at base, sometimes extroverted. Ovary subspherical, median, totally or partially in anterior part, anterior or partially superposed with anterior testis, 36-91 (57) long, 45-91 (62) wide; Mehlis' gland between the ovary and testes; uterus intertesticular, ventral, opening in the lower side of the genital cone, in the same reentrance, near and bellow the aperture of the ejaculatory duct; genital atrium spacious, genital pore wide, terminal; vitelline glands reaching, anteriorly, middle of preacetabular space; posteriorly determining the posterior extremity of the anterior part; vitelline reservoir between ovary and testes; eggs 87-109 (99) long, 43-58 (52) wide. Excretory system with lateral branches in posterior part, two lateral branches and one median branch in anterior part, united at pharynx level; excretory pore not observed.

Taxonomic summary

Host: *Caiman c. yacare* (Daudin).

Site of infection: middle and posterior sections of the small intestine.

Prevalence: 66.6%.

Mean intensity of infection: 86, in 43 hosts.

Range of the intensities of infection: 1-5225.

Localities: Nhumirim Farm, 18° 59'S, 56° 39'W and Santana Farm, 18° 06'S, 56° 36'W, Corumbá, MS, Brazil.

Specimens deposited: CHIOC voucher specimen Nos 33011a and b, 33012, 33013, 33014a and b; USNM voucher specimen Nos 82623 (4 slides), 82624 (2 slides).

Remarks

The two times that *P. abbreviatum* was found they were recorded in *C. c. crocodilus*, in Brazil (Brandes 1890, Dubois 1936). *Caiman c. yacare* is a new host record for the species. Probably, because we examined a large number of specimens, pressed and not, the present paper indicates the larger range of variation in the measurements of characters, when compared to those of Dubois (1936).

In the same way, as in *Herpetodiplostomum*, *P. abbreviatum* does not have a clear separation between the two parts of the body. For the sake of the measurements, the posterior extension of the vitelline follicles was defined as the limit between the two parts of the body, consequently, the ovary was partially located in the anterior part.

Other characters such as the reduction of the posterior part, the voluminous genital cone, the small paraprostate gland, and the final portions of the sexual ducts similar, make this species close to those in the genus *Herpetodiplostomum*, but the circular shape of the tribocytic organ, without papillae, makes it unique among the proterodiplostomes.

Herpetodiplostomum caimancola (Dollfus, 1935) (Fig. 8)

DESCRIPTION (based on 72 specimens, 20 measured): Body tongue-shaped, without transversal constriction at limit of the two parts of body, 1.55-3.0 mm (2.23 mm) of total length. Parts of body defined by reduction of the transversal diameter at level of posterior extension of vitelline glands and anterior testis. Anterior part foliaceous, 1.24-2.20 mm (1.69 mm) long, 0.25-1.20 (0.61) wide, anterior margins thickened; maximum width at level of tribocytic organ. Posterior part short, cylindrical, 274-826 (543) long, 221-750 (416) wide. Tribocytic organ in posterior half of anterior part, elliptic, median, 219-549 (380) long, 128-457 (251) wide, with 12 insconpicuous papillae surrounding aperture; space between tribocytic organ and anterior extremity 53-73% (63%) of length of anterior part; proteolytic glands well developed, in posterior third of tribocytic organ. Acetabulum large, 73-146 (105) long, 80-175 (132) wide; preacetabular space 37-46% (44%) of length of anterior part. Oral sucker 36-80 (60) long, 22-51 (38) wide; pharynx 36-80 (60) long, 29-44 (38) wide; esophagus 65-189 (104) long; ceca tangential to tribocytic organ in anterior part, lateral in posterior part, ending at base of copulatory bursa. Oral sucker to acetabulum width ratio 1:1.5-7.3 (1:3.8); oral sucker to pharynx width ratio 1:0.7-1.6 (1:1). Testes median, in tandem; anterior testis in anterior part, 91-311 (176) long, 91-512 (276) wide; posterior testis 91-274 (170) long, 110-494 (285) wide; posttesticular space 35-69% (48%) of length of posterior part; seminal vesicle posttesticular, sinuous, ejaculatory duct opening in lower side of genital cone, approximately in middle of distance between base and apex; paraprostate gland club-shaped, small, 36-182 (135) long, surrounded by few glandular cells, arranged in axle of the genital cone, opening in its apex; genital cone 51-248 (109) high, 43-255 (102) wide at base; genital atrium spacious, genital pore subterminal, dorsal. Ovary pretesticular, in anterior part, median, 37-147 (88) long, 55-238 (123) wide; Mehlis' gland intertesticular; uterus ventral, opening in the lower side of genital cone, bellow and near the opening of ejaculatory duct; vitelline glands in anterior part, reaching, anteriorly, posterior margin of acetabulum, and posteriorly, determining the limit between the two parts of body; vitelline reservoir intertesticular; eggs 73-102 (90) long, 44-66 (56) wide, mainly in intertesticular space. Excretory system with lateral branches in posterior part,

two lateral branches and one median branch in anterior part, united at level of pharynx; excretory pore terminal.

Taxonomic summary

Synonym: *Prohemistomum babai* Nasir and Diaz, 1971.

Host: *Caiman c. yacare* (Daudin).

Site of infection: posterior section of the small intestine and large intestine.

Prevalence: 53.1%.

Mean intensity of infection: 20, in 34 hosts.

Range of the intensities of infection: 1-152.

Localities: Nhumirim Farm, 18° 59'S, 56° 39'W and Santana Farm, 18° 06'S, 56° 36'W, Corumbá, MS, Brazil.

Specimens deposited: CHIOC voucher specimen Nos 33015a and b, 33016, 33017; USNM voucher specimen Nos 82625 (3 slides), 82626.

Remarks

This species, was described, originally, from *C. latirostris*, in Brazil, by Dollfus (1935), and later was collected by Dubois (1936) from *C. c. crocodilus* and *M. niger*, also in Brazil, and by Caballero et al. (1957) from *C. c. fuscus*, in Panama.

Prohemistomum babai Nasir and Diaz, 1971, parasite of *C. c. crocodilus* from Venezuela, was synonymized as *H. caimancola* by Dubois (1979). In the present paper, *C. c. yacare* is recorded as new host for this species.

Differently from other genera within the family (with the exception of *Paradiplostomum*), the species of this genus do not present a clear separation between the two parts of the body, as well as the genital ducts in posterior part. In the present study, as the limit between the two parts of the body it was defined by the posterior extension of the vitelline follicles, what implied in accepting the ovary and the anterior testis in the anterior part of the body. A modification of the tegument with the function of fixation was also observed in the anterior margins of the body. A similar modification was previously noted by Caballero et al. (1957) in *H. caimancola* and Caballero (1948) in *Crocodilicola pseudostoma* (Willemoes-Sum).

Cystodiplostomum hollyi Dubois, 1936
(Fig. 9)

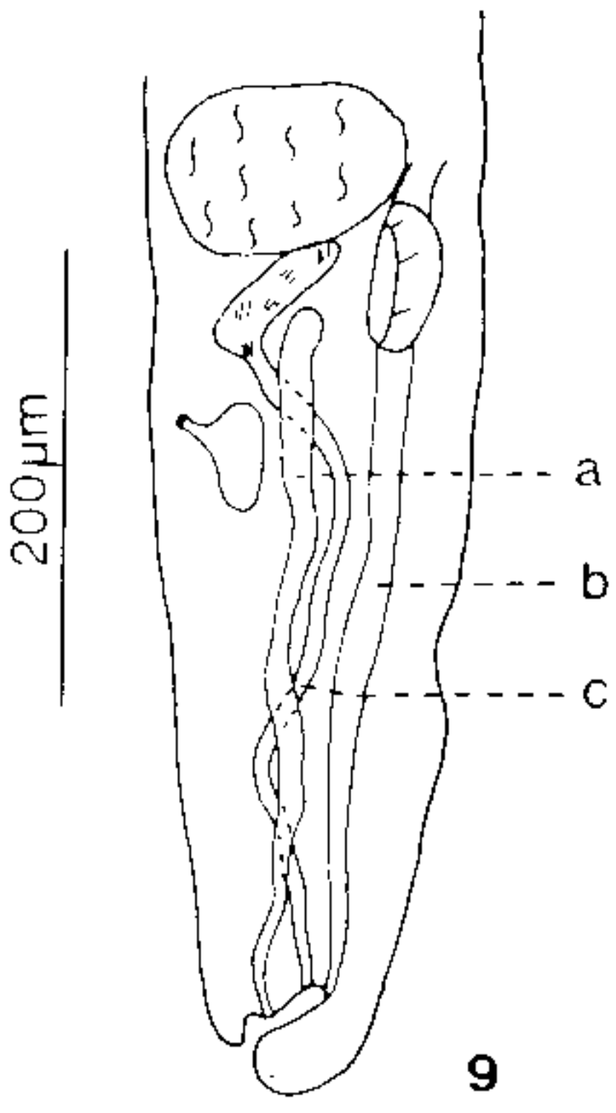
DESCRIPTION (based on 110 specimens, 20 measured): Body divided into two parts by a transversal constriction, 1.5-2.19 mm (1.77 mm) of total length. Anterior part elliptic, foliaceous, 0.84-1.26 mm (1.0 mm) long, 366-823 (555) wide; maximum width at level of acetabulum. Posterior part cylindrical, wider in anterior extremity, inserting, dorsally, in posterior extremity of anterior part, 0.58-1.62 mm (0.74 mm) long, 146-311 (287) wide, with a posttesticular "dorsal capsule", surrounded by glandular cells and a recess in the tegument, near posterior extremity, in ventral side of tribocytic organ, 164-329 (227) long, 109-292 (194) wide, elliptic, in posterior third of anterior part, with median aperture surrounded, internally, by 18 papillae; space pre-tribocytic organ 54-73% (65%) of length of anterior part; proteolytic glands conspicuous, in posterior margin of tribocytic organ. Acetabulum 51-102 (71) long, 65-146 (92) wide; preacetabular space 39-56% (48%) of length of anterior part. Oral sucker 51-73 (61) long, 51-87 (70) wide; pharynx 30-51 (39) long, 29-44 (35) wide; esophagus short, 21-94 (63) long; ceca tangential to tribocytic organ in anterior part, lateral in posterior part, ending near copulatory bursa. Oral sucker to acetabulum width ratio 1:1.12-2 (1:1.32); oral sucker to pharynx width ratio 1:0.4-0.6 (1:0.5). Testes subspherical, in tandem, median, near anterior part; pretesticular space 2.7-10% (5.4%) of length of posterior part; anterior testis 73-138 (93) long, 87-219 (137) wide; posterior testis, sometimes, contiguous to anterior testis, 58-153 (90) long, 87-240 (153) wide; intertesticular space 3.0-7.0% (4.6%) of length of posterior part; posttesticular space 60-84% (70%) of length of posterior part; seminal vesicle posttesticular, sinuous; ejaculatory duct long, opening in the bottom of the genital atrium; paraprostate gland well developed, 277-564 (291) long, surrounded by few glandular cells, dorsal to ejaculatory duct, with sperm in globular posterior portion, opening in the upper wall of the genital atrium, near genital pore; genital atrium underdeveloped; genital pore with opening subterminal, dorsal. Ovary pretesticular, median, contiguous to anterior testis, in the limit of the two parts of the body, subspherical, 51-109 (69) long, 58-138 (99) wide; Mehlis' gland intertesticular; uterus ventral to ejaculatory duct, opening near and behind the opening of ejaculatory duct, in the bottom of genital atrium; vitelline glands anteriorly reaching the acetabulum, posteriorly reaching the posterior extremity of anterior part; vitelline follicles surrounding tribocytic organ and ceca; vitelline reservoir intertesticular; eggs 87-102 (93) long, 44-58 (52) wide. Excretory system with lateral branches in posterior part, two lateral branches and one median branch in anterior part, united at pharynx level; excretory pore terminal.

Taxonomic summary

Host: *Caiman c. yacare* (Daudin).

Site of infection: anterior section of the small intestine.

Prevalence: 59.3%.



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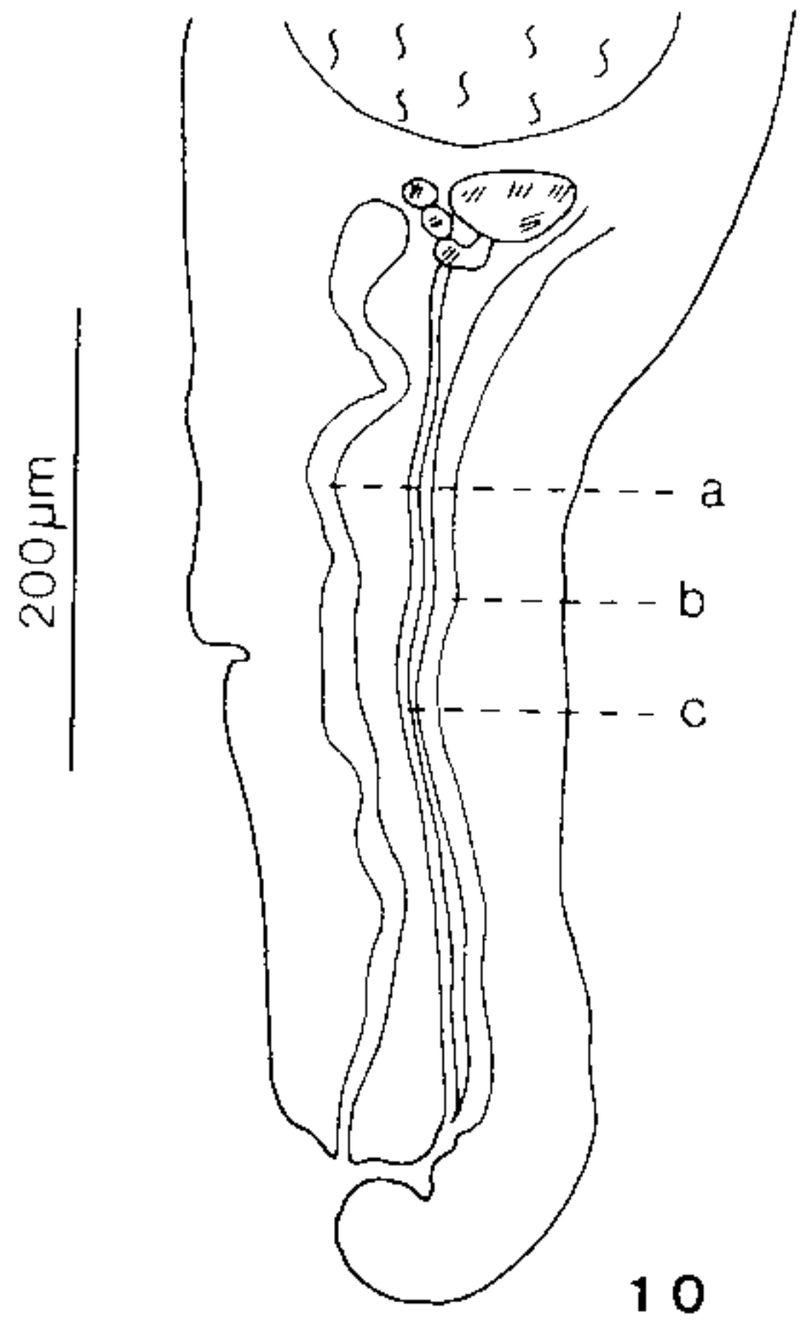

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Posterior extremities of proterodiplostomes, lateral view. Fig. 9: *Cystodiplostomum hollyi*. Fig. 10: *Prolecithodiplostomum constrictum* (a - paraprostate gland, b - uterus, and c - ejaculatory duct).

Mean intensity of infection: 102, in 38 hosts.
Range of the intensities of infection: 2-1012.
Localities: Nhumirim Farm, 18° 59'S, 56° 39'W and Santana Farm, 18° 06'S, 56° 36'W, Corumbá, MS, Brazil.
Specimens deposited: CHIOC voucher specimen Nos 33021a, b, and c, 33022; USNM voucher specimen Nos 82631 (3 slides), 82632.

Remarks

The previous descriptions of specimens of this species were based on specimens collected from *C. c. crocodilus* in Brazil (Dubois 1936, Ruiz and Rangel 1954), in Venezuela (Nasir and Diaz 1971), and from *C. latirostris* (Dubois 1948) in Brazil. *Caiman c. yacare* is a new host record for this species.

Cystodiplostomum hollyi, type and only species in the genus, is similar to *Prolecithodiplostomum constrictum*, also the type and only species in its genus, in relation to the reproductive system as follows: (1) the testes and the ovary are located in the anterior half of the posterior part of the body, (2) the paraprostate gland is long, not surrounded intensely by glandular cells, and with sperm in its posterior portion, (3) the final portion of the sexual ducts is similar, and (4) the size and the shape of the genital atrium. The presence of a "dorsal capsule" in *C. hollyi* and the transversal constriction in the posterior part of the body in *P. constrictum*, distinguish these two genera.

Prolecithodiplostomum constrictum Dubois, 1936
(Fig. 10)

DESCRIPTION (based on 79 specimens, 20 measured): Body divided into two parts by transversal constriction, 1.4-2.76 mm (2.12 mm) of total length. Anterior part elliptic, foliaceous, with lateral margins curved ventrally, 0.89-1.61 mm (1.14 mm) long, 274-805 (486) wide, maximum width in posterior half. Posterior part cylindrical, wider in anterior extremity, inserting dorsally in posterior extremity of anterior part, 0.38-1.18 mm (0.92 mm) long, 146-622 (338) wide, with transversal constriction at posttesticular level. Tribocytic organ 183-311 (250) long, 128-384 (204) wide, elliptic, in posterior extremity of anterior part, opening median, surrounded, internally, by 20 papillae; space pre-tribocytic organ 65-81% (71%) of length of anterior part; proteolytic glands conspicuous, in posterior part of tribocytic organ. Acetabulum 58-124 (95) long, 80-146 (111) long; preacetabular space 39-54% (47%) of length of anterior part. Oral sucker 51-95 (66) long, 44-88 (70) wide; pharynx 44-66 (53) long, 36-58 (42) wide; esophagus 51-160 (90) long; ceca tangential to tribocytic organ in anterior part, lateral in posterior part, reaching the copulatory bursa. Oral sucker to acetabulum width ratio 1:1.25-2 (1:154); oral sucker to pharynx width ratio 1:0.44-0.83 (1:0.57). Testes subspherical, in tandem, median, near anterior part of body, sometimes contiguous

to it; anterior testis 55-128 (99) long, 91-220 (126) wide; posterior testis 55-128 (102) long, 82-219 (152) wide; pretesticular space 2.1- 3.8% (2.8%) of length of posterior part; intertesticular space 1-6% (3%) of length of posterior part; posttesticular space 64-80% (74%) of length of posterior part; seminal vesicle posttesticular, sinuous, with long ejaculatory duct, opening in the bottom of the genital atrium; paraprostate gland well developed, 201-640 (470) long, surrounded by few glandular cells, dorsal to the ejaculatory duct, with sperm in its posterior part, opening in the upper wall of genital atrium, near genital pore; genital atrium underdeveloped; genital pore subterminal, dorsal. Ovary pretesticular, median, contiguous to anterior testis, in the limit of the two parts of body, subspherical, 37-91 (67) long, 37-128 (89) wide; Mehlis' gland intertesticular; uterus ventral to ejaculatory duct, opening near and behind the opening of ejaculatory duct, in the bottom of genital atrium; vitelline glands reaching, anteriorly, the posterior border of the acetabulum, posteriorly, the posterior extremity of anterior part of body; vitelline follicles surrounding tribocytic organ and ceca; vitelline reservoir intertesticular, eggs 80-102 (90) long, 44-66 (59) wide. Excretory system with lateral branches in posterior part; two lateral branches and one median branch in anterior part, united at pharynx level; excretory pore terminal.

Taxonomic summary

Synonym: *Prolecithodiplostomum cavum* Dubois, 1936.

Host: *Caiman c. yacare* (Daudin).

Site of infection: anterior section of the small intestine.

Prevalence: 26.5%.

Mean intensity of infection: 18, in 17 hosts.

Range of the intensities of infection: 1-99.

Localities: Nhumirim Farm, 18° 59'S, 56° 39'W and Santana Farm, 18° 06'S, 56° 36'W, Corumbá, MS, Brasil.

Specimens deposited: CHIOC voucher specimen Nos 33018a and b,33019, 33020a and b; UNSM voucher specimen Nos 82627, 82628 (4 slides).

Remarks

This species was described by Dubois (1936) from *C. c. crocodilus*, in Brazil, and was collected again in Brazil by Ruiz and Rangel (1954) from *Caiman* sp., and in Central America from *C. c. fuscus* (Caballero et al. 1957, Brooks et al. 1977).

GENERAL REMARKS

Dubois (1936) proposed the Proterodiplostomidae to group a dozen species of Strigeiformes digenetic trematodes then grouped with parasites of reptiles, and nine other new species described using material collected by Natterer (1840), in Brazil, all parasites of crocodilians, quelonians, and ophidians. This author has separated the group from the other diplostomes of birds and mammals by the presence of a paraprostate gland underdeveloped or well developed and testes in tandem, spherical or elliptic. Dubois mentioned the excellent state of the specimens collected by Natterer, which allowed excellent *in toto* preparations, which, in turn, allowed detailed study of the genital ducts, which showed a wide range of variations in their size and in their connections, characters used to determine the genera within the family. Dubois (1936), considered necessary in order to determine the proterodiplostomes of reptiles, to serially section the specimens.

In the present study, the fixation of the proterodiplostomes in AFA under coverslip pressure revealed to be inefficient in the study of the terminal genitalia, as Dubois predicted, due to the fine nature and superposition of the genital ducts. The fixation of proterodiplostomes with glacial acetic acid, without coverslip pressure, allowed, however, the mounting of specimens with the cylindrical posterior part of the body in any desired position, allowing the visualization of the connections of male and female genital ducts, making it unnecessary, the use of serial sections to their identification. The fixation with acetic acid did not influence the morphometry of characters, as the averages and ranges of measurements fell within the averages and the ranges of measurements of specimens fixed with AFA.

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