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Taxonomic Revision of *Rhinebothroides* (Eucestoda: Tetraphyllidea: Phyllobothriidae), Parasites of Neotropical Freshwater Stingrays (Rajiformes: Myliobatoidei: Potamotrygonidae)

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TAXONOMIC REVISION OF *RHINEBOTHROIDES* (EUCESTODA: TETRAPHYLLIDEA: PHYLLOBOTHRIIDAE), PARASITES OF NEOTROPICAL FRESHWATER STINGRAYS (RAJIFORMES: MYLIOBATOIDEI: POTAMOTRYGONIDAE)

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ABSTRACT: Extensive new collections of specimens of *Rhinebothroides* spp. from a wide range of Neotropical freshwater potamotrygonid stingrays in numerous localities permitted critical evaluation of the validity of the 7 nominal species in the genus. Some qualitative characters previously used in the taxonomy of this group are highly variable within and among populations, and most morphometric and meristic characters thought to have taxonomic value for this group overlapped among several previously defined nominal species. Characters that were consistent throughout populations and that clearly define morphotypes supported recognition of 4 species: *R. freitasi* (syn. *R. circularisi* and *R. venezuelensis*), *R. glandularis* (syn. *R. mclennanae*), *R. molarai*, and *R. scorzai*. We provide a taxonomic review of the genus, 8 additional host records, 7 new localities, and an identification key.

Species representing 3 genera of phyllobothriid cestodes, *Rhinebothroides* Mayes, Brooks and Thorson, 1981, *Rhinebothrium* Linton, 1889, and *Anindobothrium* Marques, Brooks and Lasso, 2001, have been reported from freshwater potamotrygonids. Of these, only *Rhinebothroides* spp. occur exclusively in freshwater potamotrygonids (Marques et al., 2001).

The first phyllobothriid cestode described from freshwater potamotrygonids was *Rhinebothrium scorzai* López-Neyra and Diaz-Ungriá, 1958, in *Potamotrygon orbignyi* (Castelnau, 1855) from the Orinoco basin. Rego and Dias (1976) described *Rhinebothrium paratrygoni* in *Paratrygon aiereba* (Müller and Henle, 1841) from the upper Paraguay drainages. Brooks and Thorson (1976) described *Rhinebothrium molarai* in *Potamotrygon magdalenae* (Valenciennes) from Rio Magdalena, Colombia, in the same year that Rego (1979) described *Rhinebothrium freitasi* in *Potamotrygon orbignyi* from Rio Amazonas, Brazil. Mayes et al. (1981) erected *Rhinebothroides* to receive *Rhinebothrium molarai* (as the type species), *Rhinebothrium scorzai*, and a new species, *Rhinebothroides circularisi*, inhabiting *Potamotrygon constellata* (Vaillant) from the upper Amazon, noting that these species differed from species of *Rhinebothrium* by having ovaries with asymmetrical lobes, bothridia with marginal as well as transverse loculi, and external seminal vesicles inserting near the anterior end of the cirrus sac rather than near the posterior end. Subsequently, Brooks et al. (1981) described *Rhinebothroides glandularis* and *R. venezuelensis* inhabiting *Potamotrygon orbignyi* from the delta of the Orinoco and recognized *Rhinebothrium freitasi* as a member of *Rhinebothroides*. The latest species to be placed in this genus was *Rhinebothroides mclennanae* Brooks and Amato, 1992, inhabiting *Potamotrygon motoro* (Müller and Henle) from the upper Paraguay region. Currently, *Rhinebothroides* is represented by 7 nominal species: *R. circularisi*, *R. freitasi*, *R. glandularis*, *R. mclennanae*, *R. molarai*, *R. venezuelensis*, and *R. scorzai*.

As with many helminth species inhabiting freshwater potamotrygonids, most descriptions of new species have been based on relatively few specimens collected from 1 or a small number of host species in 1 or a few localities. Recent collection of

additional specimens from additional hosts and localities, as well as reexamination of previously collected specimens, revealed the need for a taxonomic revision of *Rhinebothroides*. In this article, we provide such a revision, including new host and distribution records, and a key for the identification of the species of *Rhinebothroides* that we consider valid.

MATERIALS AND METHODS

Collection and preparation of specimens

Specimens of freshwater potamotrygonids were collected using long lines from Rio Paraná (Puerto Reconquista, Santa Fé, Argentina) during February 1995 and from the Amazon region of Brazil during September–December, 1996. Live specimens and the majority of loose proglottides were removed from the spiral valve in situ, placed in freshwater, fixed with hot AFA, and transferred to a cool fixative. After 24 hr, worms were transferred to 70% ethanol for storage.

Whole mounts of all cestodes were stained with acetocarmine or Mayer's hematoxylin, dehydrated in ethanol, cleared in methyl salicylate, and mounted in Canada balsam. Serial transverse sections of specimens in paraffin were cut at 8- μ m intervals and stained with hematoxylin and eosin. Measurements were obtained using an OPITMAS image analysis system attached to a BH-2 Olympus microscope. Measurements include range followed by mean, standard deviation, and sample size. For measurements of sample size equal to 2 only the range is provided in parentheses. All measurements are in micrometers unless otherwise stated. Figures were drawn with the aid of a drawing tube on a BX-50 or BH-2 Olympus microscope. Additional specimens were obtained from the following parasite collections: Coleção Helmintológica do Instituto Oswaldo Cruz, Rio de Janeiro, Brazil (CHIOC); U.S. National Parasite Collection, Biosystematics and National Parasite Collection Unit, USDA, Agricultural Research Service, Beltsville, Maryland (USNPC); and Harold W. Manter Laboratory, University of Nebraska, Lincoln, Nebraska (HWML).

Material examined from museum collections

Rhinebothroides circularisi, USNPC 76362 (paratype), HWML 21020 (14 paratypes); *Rhinebothroides freitasi*, CHIOC 31485b–e (paratypes, 3 whole worms and 1 loose proglottides); *R. venezuelensis*, USNPC 75706 (2 paratypes), HWML 21005 (8 paratypes), HWML 21006 (13 paratypes), HWML 21024 (5 vouchers), HWML 21025 (3 vouchers), HWML 34092 (vouchers specimens), CHIOC 32818a–f (6 vouchers); *R. mclennanae*, CHIOC 32814a–f (holotype and 5 paratypes); *R. glandularis*, USNPC 75708 (2 paratypes), HWML 21007 (18 paratypes); *R. molarai*, USNPC 73544 (holotype), USNPC 73545 (2 paratypes), HWML 20255 (3 paratypes); and *R. scorzai*, USNPC 75074 (1 voucher), HWML 21014 (2 vouchers), HWML 21015 (20 vouchers).

Material examined from new collections

Rhinebothroides freitasi: Eleven mature specimens and 1 postgravid proglottis in *Potamotrygon motoro* from Puerto Reconquista, Santa Fé,

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Argentina (59°42'W, 29°29'S); 3 mature specimens in *Potamotrygon falkneri* Castex & Maciel from Rio Apa, Bela Vista, Mato Grosso do Sul, Brazil (56°25'W, 22°4'S); 3 incomplete immature and 21 mature complete specimens and 2 detached gravid proglottides in *P. motoro* and 6 complete and 2 incomplete mature specimens, 1 detached mature proglottis, and 1 detached gravid proglottis in *P. orbignyi* from the lower Rio Amazonas, Belém, Pará, Brazil (48°29'W, 1°27'S); 6 mature specimens, 1 detached gravid proglottis, and 2 detached postgravid proglottides in *P. henlei* (Castelnau) from Rio Tocantins, Marabá, Pará, Brazil (49°10'W, 5°23'S); 1 immature and 6 mature specimens, 1 detached gravid proglottis, and 5 detached postgravid proglottides in *P. motoro* from lower Rio Branco, Amazonas, Brazil (61°52'W, 1°19'S); 2 complete and 1 incomplete immature specimens and 7 mature specimens in *P. motoro* from Rio Negro, near Barcelos, Amazonas, Brazil (62°58'W, 0°59'S); 2 immature and 3 incomplete mature specimens in *P. schroederi* Fernandez-Yepe, 2 immature and 1 incomplete mature specimen and 1 detached mature proglottis in *P. scobina* Garman, and 3 mature specimens, 9 detached gravid proglottides, and 1 detached postgravid proglottis in *P. motoro* from lower Rio Solimões, near Manaus, Amazonas, Brazil (60°0'W, 3°6'S); 2 mature specimens and 1 detached gravid proglottis in *P. orbignyi* from Orinoco basin, Venezuela (69°20'W, 7°52'N); and 11 mature specimens in *P. leopoldi* Castex & Castello, Rio Xingu, Altamira, Pará, Brazil (52°15'W, 3°13'S).

Rhinebothroides glandularis: Two mature specimens in *Potamotrygon motoro* from lower Rio Branco, Amazonas, Brazil; 3 immature and 6 mature specimens, 1 detached gravid proglottis, and 2 detached postgravid proglottides in *P. motoro* and 1 mature specimen in *P. orbignyi* from Rio Negro, near Barcelos, Amazonas, Brazil; 19 mature specimens and 3 detached postgravid proglottides in *P. motoro* and 1 mature specimen and 1 detached postgravid proglottis in *P. scobina* from lower Rio Solimões, near Mamanus, Amazonas, Brazil; 9 mature specimens and 3 detached postgravid proglottides in *P. henlei* from Rio Tocantins, Marabá, Pará, Brazil; 3 immature and 18 mature specimens and 5 detached gravid proglottides in *P. motoro* and 2 mature specimens and 1 detached postgravid proglottis in *P. orbignyi* from lower Rio Amazonas, Belém, Pará, Brazil; 9 mature specimens and 3 detached postgravid proglottides in *P. motoro* from Puerto Reconquista, Santa Fé, Argentina; 2 mature specimens in *P. signata* Garman from the junction of Rio Poty and Rio Parnaíba, Teresina, Piauí, Brazil (42°46'W, 5°9'S); and 2 immature specimens in *Potamotrygon* sp. from Orinoco basin, Venezuela.

Rhinebothroides molararai: Two immature and 8 mature specimens, 1 detached gravid proglottis, and 7 detached postgravid proglottides in *Potamotrygon* sp. from Rio Negro, near Barcelos, Amazonas, Brazil.

Rhinebothroides scorzai: Three immature and 3 mature specimens and 5 detached proglottides in *Potamotrygon motoro* and 4 mature specimens and 1 detached gravid proglottis in *Paratrygon aiareba* from lower Rio Amazonas, Belém, Pará, Brazil.

All these specimens have been deposited in the Helminthological Collection of the Museum de Zoologia da Universidade de São Paulo, São Paulo, Brazil.

TAXONOMIC ACCOUNTS

Rhinebothroides Mayes, Brooks and Thorson, 1981

Diagnosis: Phyllobothriidae. Strobila acraspedote to slightly craspedote. Scolex with 4 sessile or pedicellated bothridia, bearing marginal and transverse loculi, poorly differentiated apical suckers. Genital pores marginal in posterior one-fourth of the proglottis, irregularly alternating. Testes numerous. External seminal vesicle distinct; internal seminal vesicle well developed. Cirrus sac with armed cirrus. Vas deferens joining cirrus sac at anterior margin or in middorsal portion of cirrus sac. Ovary near posterior end of proglottis, X shaped in cross section; arms asymmetrical. Vagina anterior to cirrus sac; vaginal sphincter present. Vitelline follicles lateral. Uterus saccate, with lateral diverticula. Parasites in spiral valve of freshwater potamotrygonids.

Type species: *Rhinebothroides molararai* (Brooks and Thorson, 1976).

Rhinebothroides freitasi (Rego, 1979) Brooks, Mayes, and Thorson, 1981 (Figs. 1–4)

Syns. *Rhinebothrium freitasi* Rego, 1979; *Rhinebothroides circularisi* Mayes, Brooks and Thorson, 1981, new synonym; *Rhinebothroides venezuelensis* Brooks, Mayes and Thorson, 1981, new synonym

Diagnosis: Bothridia, diamond shaped (Fig. 1A, B). Strobila with 5–25 segments. Testes number, 20–79; posterior preporal testes not reaching vaginal area (Figs. 1D, 2). Cirrus bearing microtriches. Genital atrium inconspicuous, lacking microtriches (Fig. 1C). Insertion of vas deferens at anterior margin of cirrus sac near genital pore (Fig. 1C). Poral ovarian lobe may or may not reach or extend beyond posterior margin of cirrus sac (Fig. 3); aporal lobe may or may not reach posterior aporal testes (Figs. 1D, 2). Vagina varying from semistraight to slightly coiled (Fig. 4). Meristic and morphometric attributes of *R. freitasi* given in Appendix I.

Type host: *Potamotrygon orbignyi*.

Type locality: Amazon River, Maicuru, Pará, Brazil.

Other hosts: *Potamotrygon constellata*, *P. motoro*, *P. yepezi* Castex and Castello; new host records, *P. falkneri*, *P. henlei*, *P. leopoldi*, *P. schroederi*, and *P. scobina*.

Distribution: Lago Maracaibo, Rio Orinoco, Rio Amazonas, Rio Solimões, Rio Xingu, Rio Tocantins, and upper Paraguay; new locality records for Rio Negro and Rio Apa (Paraguay River system).

Remarks

Rego (1979) based his description of *R. freitasi* on 6 complete specimens and on a number of detached proglottides. The type material deposited at the Coleção Helmintológica do Instituto Oswaldo Cruz, however, consisted of 1 complete specimen designated as the holotype (CHIOC 31486a), a vial holding unmounted cestodes (CHIOC 26499), and 4 slides designated as paratypes (CHIOC 31486b–e). The holotype was not examined in the present study. The vial with unmounted cestodes contained many incomplete specimens of *Paraoncomegas* sp. (representing a genus of trypanorhynch cestode inhabiting freshwater potamotrygonids), and the paratype series was represented by incomplete specimens and detached proglottides. Thus, the total number of segments (12–15) and the strobilar size (8.6 mm) reported by Rego (1979) could not be verified, but these values are within the ranges of our specimens (Appendix I). Other values obtained from the paratype series, such as the number of loculi, dimensions of mature and gravid proglottides, testes, cirrus sac, and ovary, as well as the number of testes, overlap with most of the values observed for other populations of what we consider to be *R. freitasi* (Appendix I).

Mayes et al. (1981) distinguished *R. circularisi* from *R. molararai* and *R. scorzai* but did not discuss *Rhinebothrium freitasi* (which was described after the manuscript was in press). Brooks et al. (1981) subsequently published a systematic review of cestodes inhabiting freshwater potamotrygonids, in which they assigned *Rhinebothrium freitasi* to *Rhinebothroides*, along with a nominal new species, *R. venezuelensis*, inhabiting Po-

FIGURE 1. *Rhinebothroides freitasi*. A–B. Scoleces (HWML 21020, paratype of *R. circularis*; CHIOC 31486d, paratype of *R. freitasi*, respectively). C. Cirrus sac region (HWML 21020). D. Mature terminal proglottis (HWML 21020). Bars = 100 μ m.

FIGURE 2. *Rhinebothroides freitasi*. **A.** Mature proglottis (USNPC 750706, paratype of *R. venezuelensis*). **B.** Mature detached proglottis (CHIOC 31486b, paratype of *R. freitasi*). Bars = 100 μm .

FIGURE 3. *Rhinebothroides freitasi*. A–C. Variation in length of the ovarian poral lobes in relation to cirrus sac (CHIOC 31486b, paratype of *R. freitasi*). Bars = 100 μ m.

tamotrygon orbignyi and *P. yepezi* from Orinoco River and Lago Maracaibo drainages, respectively. They acknowledged that *R. venezuelensis* resembled *R. circularisi* in having a straight vagina, vitelline follicles interrupted near the genital pore, and poral ovarian lobes extending anteriorly only to the posterior margin of the cirrus sac. Nevertheless, they did not discuss the similarities of *R. venezuelensis* with *R. freitasi*. According to Brooks et al. (1981), of the characters shared by *R. venezuelensis* and *R. circularisi*, only the possession of a straight vagina and the distribution of vitelline follicles are found in *R. freitasi*. Rego's (1979) illustration of a detached proglottis (fig. 3 in Rego [1979]) shows the absence of the preovarian vitelline follicles. This feature was used by Brooks et al. (1981) as a diagnostic character for *R. freitasi*. Reexamination of Rego's material and the proglottis illustrated by Rego (1979) (redrawn in Fig. 2B) showed that whereas antiporal vitelline follicles were not observed, vitelline follicles were present postporally. Examination of other proglottides of the type material also reveals their occurrence. In the text, Rego (1979) explicitly described the vitellaria as being "follicular, laterally distributed along the whole length of the proglottis, only interrupted near genital atrium" (Rego, 1979, p. 881, translation by FPLM.).

Reexamination of the type series of *R. freitasi* also revealed that the morphology of the poral ovarian lobe also displays some degree of intraspecific variation (Fig. 3). Rego's (1979) illustration suggests that the poral ovarian lobe extends anteri-

only to the posterior margin of the cirrus sac. This character was also used as diagnostic for this species by Brooks et al. (1981). However, the condition reported for *R. venezuelensis* and *R. circularisi*, in which the poral ovarian lobes extend anteriorly only to the posterior margin of the cirrus sac, is also present in the type series of *R. freitasi* (Fig. 3).

Brooks et al. (1981) distinguished *R. circularisi* from *R. venezuelensis* based on testes number and strobilar morphology. Accordingly, *R. circularisi* was originally described as having a larger number of testes than *R. venezuelensis* (66–88 vs. 45–64, respectively). Reexamination of the specimens used by Mayes et al. (1981) to describe *R. circularisi* indicated that testes number can range from as few as 38 to as many as 79 (Appendix I). As for *R. venezuelensis*, the number of testes ranges from 42 to 61 for the specimens from Orinoco River, 20 to 48 for specimens from Rio Negro, and 35 to 63 for specimens from Lago Maracaibo drainages (Appendix I). Rego (1979) reported 48–64 testes per proglottis for *R. freitasi*. The intraspecific variation found in *R. circularisi* alone suggests that the number of testes is highly variable within populations. The examination of additional specimens also suggests that the number of testes varies greatly among different populations, indicating that the number of testes has little taxonomic value (Appendix I). Other meristic and morphometric attributes, with the exception of the number of loculi for which we have a very small sample size for some populations, were of no use in defining the species considered in this study as synonyms of *R.*

FIGURE 4. Vaginal morphology in *Rhinebothroides freitasi*. **A–C.** Paratype of *R. freitasi* (CHIOC 31486b). **D–E.** Paratype of *R. venezuelensis* (USNPC 75706). **F.** Voucher specimen of *R. circularis* (HWML 21020). **G.** Paratype of *R. circularis* (USNPC 76362). Bars = 100 μ m.

freitasi because they showed a great degree of overlap among the 12 localities and 9 different host species (Appendix I).

The strobilar condition also proved to be of little value in distinguishing these taxa. *Rhinebothroides circularisi* was originally described as being acraspedote and *R. venezuelensis* as being craspedote. The paratype series for *R. freitasi* consisted of detached proglottides and immature joined proglottides, which made it difficult to assess the variation within this species. However, examination of specimens attributed to *R. circularisi* and *R. venezuelensis* revealed that there is intraspecific variation of this character within these 2 nominal species. Because the specimens showed varying degrees of relaxation, the assignment of an acraspedote–craspedote condition is difficult in most cases.

As a result of our findings, we propose that *Rhinebothroides freitasi* be considered the senior synonym of *R. circularisi* and *R. venezuelensis*. *Rhinebothroides freitasi* (sensu nobis) has previously been reported in *Potamotrygon constellata*, *P. orbignyi*, *P. motoro*, and *P. yepezi* (Brooks and Amato, 1992; Brooks, 1995). Rego's (1979) report of *Rhinebothroides freitasi* inhabiting *Potamotrygon hystrix* (d'Orbigny) in Rio Amazonas is likely erroneous because *Potamotrygon hystrix* is endemic to the Paraná drainage (Rosa, 1985). In this study, we collected *R. freitasi* in 5 additional hosts: *Potamotrygon falkneri*, *P. henlei*, *P. leopoldi*, *P. schroederi*, and *P. scobina*. Reports of the species were previously restricted to the mid to upper Amazon, the delta of Orinoco River, the Lago Maracaibo tributaries, and the upper Paraguay (Brooks and Amato, 1992; Brooks, 1995). We report *R. freitasi* for the first time from Rio Negro, Rio Xingu, Rio Tocantins, and Rio Apa (Paraguay basin).

***Rhinebothroides glandularis* Brooks, Mayes and Thorson, 1981**
(Figs. 5, 6)

Syn. *Rhinebothroides mclennanae* Brooks and Amato, 1992, new synonym

Diagnosis: Bothridia, diamond shaped (Fig. 5A). Strobila with 7–34 segments. Testes number, 17–53; posterior preporal testes not reaching vaginal area (Fig. 5C–D). Cirrus bearing microtriches (Fig. 5B). Genital atrium conspicuous, lined with microtriches. Insertion of vas deferens at the middorsal region of cirrus sac. Poral end of cirrus sac surrounded by darkly staining cells (Fig. 5B). Poral ovarian lobe extending beyond posterior margin of cirrus sac to near midregion; aporal lobe reaching posterior antiporal testes (Fig. 5C). Vagina varying from semistraight to slightly sinuous (Fig. 6). Meristic and morphometric attributes of *R. glandularis* given in Appendix II.

Type host: *Potamotrygon orbignyi*.

Type locality: Orinoco River delta, near Curiapo, Venezuela.

Other hosts: *Potamotrygon motoro*, and new host records for *Potamotrygon henlei*, *P. scobina*, *P. signata*, and *Potamotrygon* sp. (Venezuela).

Distribution: Rio Orinoco and upper Paraguay; new locality records for lower Rio Amazonas, Rio Solimões, Rio Negro, Rio Tocantins, and Rio Parnaíba.

Remarks

Brooks et al. (1981) described *Rhinebothroides glandularis* in *Potamotrygon orbignyi* from the Orinoco delta in Venezuela.

The most important diagnostic feature of this species was considered to be the presence of “prominent gland cells surrounding the terminal genitalia” (Brooks et al., 1981, p. 57). Brooks and Amato (1992) described *Rhinebothroides mclennanae* in *Potamotrygon motoro* from the upper Paraguay, noting that the new species shared the prominent gland cells as well as other characteristics with *R. glandularis*. These authors distinguished *R. mclennanae* from *R. glandularis* by having an average of 31 (with a range of 19–43) testes per proglottis rather than 45 (with a range of 41–51).

Darkly staining glandular cells surrounding the terminal genitalia are not found in any other species of *Rhinebothroides* nor in any other tetraphyllidean (Brooks and Amato, 1992). Reexamination of the type series of both *R. glandularis* and *R. mclennanae* revealed 2 other morphological features not reported before in members of this genus. Specimens having glandular cells surrounding the terminal genitalia also possess a genital atrium covered with prominent microtriches (Fig. 5B), whereas other *Rhinebothroides* species lack such microtriches (Fig. 1C) or have only few, and the vas deferens is inserted into the cirrus sac at the middle of the cirrus sac (Fig. 5B) rather than at the anterior margin of the cirrus sac near to the genital pore (Fig. 1C), as in other members of the genus. Our study also revealed that the number of testes varies greatly among and within populations (Appendix II; Fig. 7). Because of this variability, we do not regard the diagnostic features that were used to differentiate *R. mclennanae* from *R. glandularis* as valid. In addition, we were not able to recognize any meristic character (Appendix II) or morphological feature that would allow us to distinguish these 2 nominal species. Consequently, we consider *R. mclennanae* to be a junior synonym of *R. glandularis*.

Rhinebothroides glandularis (sensu nobis) has been previously reported only in *Potamotrygon orbignyi* and *P. motoro* (Brooks and Amato, 1992; Brooks, 1995). In this study, we report 4 new hosts: *Potamotrygon henlei*, *P. scobina*, *P. signata*, and *Potamotrygon* sp. (Venezuela). *Rhinebothroides glandularis* has previously been reported from the delta of the Orinoco and the upper Paraguay (Brooks and Amato, 1992; Brooks, 1995). We report 6 new localities: Rio Branco, Rio Negro, Rio Solimões, Rio Tocantins, lower Rio Amazonas, and Rio Parnaíba.

***Rhinebothroides molarai* (Brooks and Thorson, 1976)**
Brooks, Mayes, and Thorson, 1981
(Figs. 8–10)

Syn. *Rhinebothrium molarai* Brooks and Thorson, 1976

Diagnosis: Bothridia, quadrate. Strobila with 14–45 segments (Fig. 8A–C). Testes number, 43–69; posterior preporal testes not reaching the vaginal area (Fig. 9). Cirrus bearing spines. Genital atrium conspicuous, partially lined with microtriches. Insertion of vas deferens at anterior margin of cirrus sac near genital pore (Fig. 8D). Poral ovarian lobe not extending beyond posterior margin of cirrus sac; aporal lobe extending from posterior antiporal testes to midproglottis (Fig. 9). Vagina semistraight, somewhat saccate, slightly sinuous (Fig. 10). Meristic and morphometric attributes of *R. molarai* given in Appendix III.

Type host: *Potamotrygon magdalenae*.

FIGURE 5. *Rhinebothroides glandularis*. **A.** Scolex (HWML 21007). **B.** Cirrus sac region. **C.** Mature proglottis (HWML 21007). **D.** Postgravid proglottis (HWML 21007). Bars = 100 μ m.

FIGURE 6. Vaginal morphology. A. *R. glandularis* (HWML 21007). B–C. *R. glandularis* (USNPC 75708). D. *R. mclennanae* (CHIOC 32814e, paratype). E. *R. mclennanae* (CHIOC 32814a, holotype). F. *R. mclennanae* (CHIOC 32814c, paratype). Bar = 100 μ m.

FIGURE 7. Testes average and standard deviation for 13 populations of *R. glandularis* according to geographic area and host. 1. *Potamotrygon henlei*. 2. *P. motoro*. 3. *P. orbignyi*. 4. *P. scobina*. 5. *P. signata*. 6. *Potamotrygon* sp. from Venezuela. # Indicates specimens collected by Brooks and Amato (1992), and & indicates specimens collected by Brooks et al. (1981b).

Type locality: Magdalena River, Ciénaga Rabón, near San Cristóbal, Colombia.

New host: *Potamotrygon* sp. (upper Rio Negro).

Distribution: Rio Magdalena and upper Rio Negro, new locality.

Remarks

Brooks and Thorson (1976) described this species as *Rhinebothrium molararai* in *Potamotrygon magdalenae*, an endemic species of freshwater potamotrygonid from Rio Magdalena, Colombia. *Rhinebothroides molararai* possesses 2 diagnostic features that distinguish this species from the others included in the genus: quadrate rather than diamond-shaped bothridia and a heavily, rather than lightly, spined cirrus (Fig. 8D). The distinction between the 2 forms of spination can easily be observed using light microscopy. The specimens from upper Rio Negro do not show any considerable meristic or morphometric differences from those of Rio Magdalena (Appendix III). Also, meristic and morphometric attributes found in *R. molararai* (Appendix III) are within the ranges observed for *R. freitasi* (Appendix I) and *R. glandularis* (Appendix II).

Rhinebothroides molararai was previously known to inhabit *Potamotrygon magdalenae* and, as such, to be endemic to Rio Magdalena. This report of *R. molararai* in *Potamotrygon* sp. from the upper Rio Negro constitutes new host and locality records.

***Rhinebothroides scorzai* (López-Neyra and Díaz-Ungriá, 1958) Brooks, Mayes, and Thorson, 1981**
(Figs. 11, 12)

Syn. *Rhinebothrium scorzai* López-Neyra and Díaz-Ungriá, 1958

Diagnosis: Bothridia, diamond shaped, wider than longer, bearing 63–127 marginal loculi (Fig. 11A). Strobila with 33–

86 segments slightly craspedote (Fig. 11C, D). Testes number, 59–98; posterior preoral testes reaching the vaginal area (Fig. 11C, D). Cirrus bearing microtriches (Fig. 11B). Genital atrium conspicuous, partially covered with microtriches (Fig. 11B, C). Insertion of the vas deferens at the anterior margin of the cirrus sac near to genital pore (Fig. 11B). Poral ovarian lobe extending beyond posterior margin of cirrus sac to level of genital pore; aporal lobe overlapping several posterior aporal testes (Fig. 11C, D). Vagina straight at the anterior margin of cirrus sac coiling as it descends posteriorly (Fig. 12). Meristic and morphometric attributes of *R. glandularis* are given in Appendix IV.

Type host: *Potamotrygon orbignyi*.

Type locality: Orinoco River, Venezuela.

Other hosts: *Paratrygon aiereba* and *Potamotrygon motoro*, new host.

Distribution: Rio Orinoco, Upper Paraguay (?) (Rego and Dias, 1976, see below), and lower Rio Amazonas, new locality.

Remarks

Rhinebothroides scorzai was first described as *Rhinebothrium scorzai* inhabiting *Potamotrygon orbignyi* (reported as *P. hystrix*) from the delta of Orinoco (López-Neyra and Díaz-Ungriá, 1958). Mayes et al. (1981) transferred this species to *Rhinebothroides*. This species can be distinguished meristically from all other species of *Rhinebothroides* by having greater number of segments (43–70 in average among populations vs. 7–16 for *R. freitasi*, 13–30 for *R. glandularis*, and 20–36 for *R. molararai*) and greater number of testes per proglottis (75–80 in average among populations vs. 34–62 for *R. freitasi*, 28–43 for *R. glandularis*, and 55–59 for *R. molararai*) (Appendices I–IV). Morphologically, *R. scorzai* can be distinguished from all other species by possessing vitellarian follicles that overlap with the vagina rather than being interrupted before reaching the vaginal area, and poral and aporal testes clustered in somewhat 3 columns rather than in 1 or 2 columns (Fig. 11B, C).

We were unable to examine the type material used in the original description by López-Neyra and Díaz-Ungriá (1958). López-Neyra and Díaz-Ungriá (1958, p. 10) described *R. scorzai* as being 30 mm long with 78 proglottides, mature proglottis 1,200–2,000 long by 1,150–1,320 wide, and 86–98 testes. Based on the original description, none of these meristic and morphometric attributes, which were examined in 3 populations inhabiting 3 distinct hosts, deviate from those described originally (Appendix IV). Moreover, our data show that the specimens studied form a concise meristic and morphometric group (Appendix IV).

Rhinebothroides scorzai has been reported in *Paratrygon aiereba*, *Potamotrygon orbignyi*, and *P. motoro* (Brooks and Amato, 1992; Brooks, 1995). In this study, no additional host was reported for this species of *Rhinebothroides*.

The biogeographical distribution of *R. scorzai* may also be limited. *Rhinebothroides scorzai* has previously been reported from the upper Paraguay and the delta of the Orinoco River (Brooks and Amato, 1992; Brooks, 1995). The only new locality record reported in this study is the lower Rio Amazonas, in *Potamotrygon motoro* and *P. orbignyi*. Rego and Dias (1976) reported *R. scorzai* in *Potamotrygon motoro* and *Paratrygon aiereba* from the upper Paraguay system, in the vicinity of Sa-

FIGURE 8. *Rhinebothroides molarai*. **A.** Immature specimen (USNPC 73545). **B.** Detail of bothrium—immature specimen (USNPC 73545). **C.** Scolex of mature specimens. **D.** Cirrus sac region. Bars = 100 μ m.

lobra, Mato Grosso do Sul, Brazil. However, their illustrations of proglottides of *R. scorzai* (figs. 4, 5 in Rego and Dias [1976]) are not in agreement with the general morphology of that species. In *R. scorzai*, the poral and aporal testes are arranged approximately in 3 columns, the poral testes reach the vaginal region, the poral ovarian lobe advances beyond the posterior

margin of the cirrus sac, the aporal ovarian lobe overlaps the aporal testes, and the vitelline follicles overlap the vagina. In the proglottis illustrated by Rego and Dias (1976), the testes are arranged in a single column anteriorly, which is divided into 2 columns posteriorly, the poral testes do not reach the vaginal region, the poral ovarian lobe reaches only to the level

FIGURE 9. *Rhinebothroides moralarai*. **A.** Mature proglottis (specimen from Rio Negro). **B.** Mature proglottis from holotype (USNPC 73544). Bars = 100 μ m.

FIGURE 10. Variation in vaginal morphology of *Rhinebothroides moralarai*. A. Holotype (USNPC 73544). B. Paratype (HWML 20255). Bars = 100 μ m.

of the posterior margin of the cirrus sac, the aporal ovarian lobes do not extend anteriorly to the aporal testes, and the vitelline follicles do not overlap the vagina. In these characters, their illustrations more closely resemble *R. freitasi* than *R. scorzai*. The number of testes reported by Rego and Dias (1976) (80–85) are in agreement with the number reported for *R. scorzai* (Appendix IV) but reach the upper limit of the number of testes reported for *R. freitasi* (Appendix I). We were unable to examine the specimens of *R. scorzai* reported by Rego and Dias (1979). Reexamination of these specimens might reveal that their record for *R. scorzai* inhabiting *Potamotrygon motoro* and *Paratrygon aiereba* from upper Paraguay is erroneous. If this is so, *R. scorzai* is restricted to the Orinoco and Amazon basins, and a different species may be present in the upper Paraguay.

Key to the species of *Rhinebothroides*

- 1a. Poral end of cirrus sac surrounded by darkly staining glandular cells, whole atrium bearing microtriches, vas deferens inserted at the midportion of cirrus sac *R. glandularis*
- 1b. Darkly staining glandular cells surrounding poral end of cirrus sac not present, atrium bearing at most only a few microtriches, vas deferens inserted at the anterior portion of cirrus sac near genital pore 2
- 2a. Bothridia quadrate, cirrus bearing spines *R. moralarai*
- 2b. Bothridia diamond shape, cirrus bearing microtriches 3
- 3a. Strobila with 5–25 segments, testes forming single or double columns, genital atrium not lined with microtriches, vitellaria not reaching vaginal area *R. freitasi*
- 3b. Strobila with 35–86 segments, testes forming triple columns, genital atrium partially covered by microtriches *R. scorzai*

DISCUSSION

Brooks et al. (1981) provided the only other systematic account of *Rhinebothroides*, recognizing 6 nominal species. The seventh nominal species was added by Brooks and Amato (1992). However, species of *Rhinebothroides* have been recognized and described from as few as a single specimen, e.g., *Rhinebothrium scorzai* by López-Neyra and Díaz-Ungriá (1958), to as many as 70 specimens, e.g., *Rhinebothroides mclennanae* by Brooks and Amato (1992), and collected in most cases from a single locality and from a single species of host. As would be expected from the limitations resulting from these collections, the morphological and meristic variability within and among populations of *Rhinebothroides* spp. were poorly understood.

The taxonomy of *Rhinebothroides* spp. has been based mainly on the number of bothridial loculi, number of testes, distribution of vitelline follicles, morphological attributes of the vagina (coiled vs. straight), ovary (extension of poral lobe in relation to cirrus sac), and strobila (craspedote vs. acraspedote). Because of the wider sampling of hosts and localities encompassed by this study, information on intra- and interspecific variation surfaced, and a critical evaluation of the validity of the nominal species led to a new interpretation of the characters traditionally used in the taxonomy of this group. We found that these characters are highly variable within and among populations of any given species of *Rhinebothroides*. Most morphometric and meristic characters overlap among previously defined nominal species (Appendices I–IV). This led us to seek characters that were consistent throughout populations and that could clearly define morphotypes and, in turn, define what we considered to be valid species. As a result, we recognize only

FIGURE 11. *Rhinebothroides scorzai*. **A.** Scolex of mature specimens. **B.** Cirrus sac region. **C.** Mature proglottis (HWML 21015). **D.** Gravid proglottis in initial stage of development; note reduction of aporal ovarian lobe (USNPC 75704). Bars = 100 μ m.

4 valid species for this genus: *R. freitasi*, *R. glandularis*, *R. moralarai*, and *R. scorzai*.

This study adds 8 additional host records to the checklists of freshwater potamotrygonids examined for these parasites

(Brooks and Amato, 1992; Brooks, 1995), namely, *Plesiotrygon iwamae*, *Potamotrygon henlei*, *P. leopoldi*, *P. ocellata*, *P. schroederi*, *P. scobina*, *P. signata*, and an undescribed species of *Potamotrygon* from the upper Rio Negro. In addition, we

FIGURE 12. Variation in vaginal morphology of *Rhinebothroides scorzai*. **A.** Voucher (HWML 21014). **B.** Voucher (HWML 21015). Bars = 100 μm.

add 7 new localities: Rio Parnaíba (northeastern part of Brazil), lower Rio Amazonas, and tributaries of Ilha de Marajó, Rio Tocantins, Rio Xingu, Rio Negro, and Rio Branco were sampled for the first time.

Although this work contributes substantially to the taxonomy of *Rhinebothroides*, much remains to be done. For example, species of *Potamotrygon* endemic to the lower Paraná basin, e.g., *P. hystrix*, *P. brachyura*, and *P. castexi*, among others, are yet to be examined for parasites. Further efforts in areas and hosts not yet sampled for these organisms will contribute to our knowledge of the biology and diversity of phyllobothriids inhabiting freshwater potamotrygonid and may reveal a clearer picture of how characters vary within species of *Rhinebothroides*.

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APPENDIX I. Measurements obtained for *Rhinebothroides freitasi* according to host and geographic area.

Population	Immature specimens		Mature specimens		No. of loculi
	Size (mm)	No. of segments	Size (mm)	No. of segments	
Amazonas*†	—	—	—	—	61–73 (67.7 ± 6, n = 3)
Upper Solimões‡§	4.8–8.3 (6.8 ± 1.5, n = 6)	8–16 (11.7 ± 2.7, n = 6)	7–19 (10.6 ± 4.9, n = 5)	9–20 (13.6 ± 4.4, n = 5)	63–77 (71 ± 7, n = 3)
Venezuela*	5.2–10.2 (7.2 ± 2.2, n = 4)	7–11 (10 ± 2, n = 4)	7.1–35.6 (20 ± 11, n = 10)	9–25 (16 ± 6, n = 10)	51–69 (58.5 ± 5.6, n = 9)
Maracaibo #	6.3–9.8 (8.4 ± 1.6, n = 4)	10–13 (11 ± 1, n = 5)	12	14	49 (n = 2)
Corumbá **	—	—	7.1–23 (14.6 ± 5.5, n = 6)	7–23 (16.7 ± 5.4, n = 6)	71–73 (72 ± 1.4, n = 2)
Argentina	—	—	8–17.3 (11.3 ± 2.6, n = 11)	8–14 (11 ± 2, n = 11)	>61
Bela Vista††	—	8	9–10.8 (9.8 ± 1, n = 3)	10–11 (10 ± 1, n = 3)	—
Belém	—	5 (n = 3)	3.6–11.4 (6.8 ± 1.8, n = 21)	5–10 (7 ± 2, n = 21)	53–61 (57 ± 3, n = 8)
Belém*	—	—	3.2–9.5 (5.8 ± 2.2, n = 6)	5–10 (7 ± 2, n = 8)	57
Marabá‡‡	—	—	7.5–19.6 (13.1 ± 4.7, n = 6)	8–15 (11 ± 2, n = 6)	61
Rio Branco	3.28	5	4.46–10.5 (6.9 ± 2.2, n = 6)	5–10 (7 ± 2, n = 5)	—
Rio Negro	4.2–4.7	6–7 (6 ± 1, n = 3)	3–8 (5.6 ± 2, n = 7)	5–9 (7 ± 1.3, n = 7)	51–61 (57 ± 4, n = 8)
Lower Solimões§§	12.6–13.1	37,236	—	—	—
Lower Solimões	5–6.4	41,974	12	21	59
Lower Solimões	—	—	5–6.2 (5.7 ± 0.6, n = 3)	6–7 (7 ± 1, n = 3)	59–61
Venezuela*	—	—	37,110	13–14	61
Xingu##	—	—	4.3–15.8 (7.2 ± 3.6, n = 11)	5–15 (8 ± 3, n = 11)	61–65 (63 ± 2, n = 5)

* *Potamotrygon orbignyi*.

† Rego (1979) (type specimens).

‡ *Potamotrygon constellata*.

§ Maye et al. (1981).

|| Brooks et al. (1981).

Potamotrygon yepesi.|| *Potamotrygon motoro*.

** Brooks and Amato (1992).

†† *Potamotrygon falkneri*.‡‡ *P. henlei*.§§ *Potamotrygon schroederi*.||| *Potamotrygon scobina*.## *Potamotrygon leopoldi*.

APPENDIX I. Extended.

Population	Mature proglottides		Gravid proglottides	
	Width	Genital pore position	Length	Width
Amazonas*†	215.2–242.9	487.9–583.8	2,957–3,419.7 (3,151.1 ± 240.2, n = 3)	299.4–373.4 (345.1 ± 40, n = 3)
Upper Solimões‡§	357–869.9 (515.7 ± 170.3, n = 7)	231–530 (414.3 ± 102.6, n = 6)	1,308.8–3,625.6 (2,384.2 ± 775.1, n = 7)	642.8–1,025.7 (868.6 ± 159.2, n = 7)
Venezuela*	320–765.7 (530.1 ± 135.9, n = 23)	336–516.3 (431.2 ± 49.5, n = 23)	1,986.5–4,703 (3,113.4 ± 742.6, n = 18)	404.1–695.8 (564.7 ± 86.9, n = 18)
Maracaibo #	539.1–561 (551.2 ± 11.1, n = 3)	252.9–347.6 (313.3 ± 52.4, n = 3)	—	—
Corumbá **	244.4–468.1 (380.3 ± 79.1, n = 6)	316.3–450 (369.4 ± 49.6, n = 6)	879.2–3,278.5 (2,198.8 ± 842.7, n = 11)	331.8–527.1 (452.7 ± 56.8, n = 11)
Argentina	333–571 (434.2 ± 67.8, n = 18)	277–509.2 (397.7 ± 66.6, n = 18)	2,289–3,244.2 (2,808.9 ± 355.1, n = 11)	430.5–660.2 (514.7 ± 63, n = 11)
Bela Vista††	279.5–396 (324.7 ± 62.5, n = 3)	568–672.5 (621.4 ± 43.3, n = 4)	2,387.5	509.4
Belém	199.5–404.3 (297.1 ± 51.9, n = 21)	230–491.8 (401.2 ± 75.7, n = 20)	1,914.2–3,194.7 (2,447.2 ± 373.2, n = 22)	205.4–584.6 (352.1 ± 76.8, n = 22)
Belém*	206.2–417.4 (278.8 ± 65.3, n = 9)	254.8–557.1 (417.7 ± 114.3, n = 9)	1,633.5–2,972.6 (2,136.4 ± 580.1, n = 4)	238.1–420.4 (333.2 ± 75, n = 4)
Marabá‡‡	339.5–532.6 (429.8 ± 60.9, n = 10)	388.8–785.8 (531.5 ± 107.4, n = 10)	2,421–3,392.5 (2,872.1 ± 320.1, n = 6)	308.8–528.2 (453.8 ± 82.7, n = 6)
Rio Branco	274.4–533.1 (383.8 ± 100.3, n = 6)	271.6–485.7 (355.6 ± 79.6, n = 5)	1,500.6–3,375 (2,356.7 ± 804.9, n = 6)	403.8–514.3 (463.6 ± 50.2, n = 6)
Rio Negro	199.7–411.1 (299.7 ± 72, n = 7)	245.6–538.6 (390 ± 87.5, n = 7)	2,588.4–3,593.7 (3,048.6 ± 508, n = 3)	301.9–503.3 (405.8 ± 101, n = 3)
Lower Solimões§§	508.3–620.4 (548.1 ± 43.8, n = 5)	487–587.1 (539.2 ± 37, n = 5)	3,729.5–4,480.7 (4,140.6 ± 294, n = 5)	649.4–873.2 (765.2 ± 82.7, n = 5)
Lower Solimões	359.4	550.4	—	—
Lower Solimões	209.1–251.8 (236.5 ± 23.8, n = 3)	277–352.8 (307.7 ± 39.9, n = 3)	1,747.4–2,389.7 (2,022.3 ± 300.3, n = 4)	279.3–450.6 (346.6 ± 76.2, n = 4)
Venezuela*	368.1–433.4 (399.8 ± 25.8, n = 6)	335.3–505.4 (386.3 ± 63.7, n = 6)	1,431.8–2,284.9 (1,911.1 ± 436.2, n = 3)	400–466.1 (439.2 ± 34.7, n = 3)
Xingu##	197.1–387.7 (255.8 ± 56.9, n = 10)	308.8–512.5 (393.3 ± 65.7, n = 10)	1,864.8–2,818.1 (2,238.4 ± 347, n = 10)	235.9–385.5 (279.4 ± 44, n = 10)

APPENDIX I. Extended.

Immature proglottides			Mature proglottides
Length	Width	Genital pore position	Length
—	—	—	2,358.1–3,110.9
877.2–1,962.1 (1,310.2 ± 290.8, n = 16)	223.3–543.2 (392.1 ± 95.4, n = 16)	229.2–470.7 (318.1 ± 76.8, n = 16)	1,062–2,052 (1,780.2 ± 341.9, n = 7)
960.1–1,961.9 (1,426.1 ± 268.1, n = 15)	227.3–690.3 (386.9 ± 119.7, n = 15)	260–437 (340.8 ± 62.5, n = 15)	1,477.1–2,506 (2,010 ± 286.4, n = 23)
639.9–1,527 (1,169.8 ± 253.1, n = 15)	197–574.1 (408.1 ± 110, n = 15)	185.6–435.9 (286.7 ± 60.3, n = 15)	1,031.9–1,540.7 (1,324.6 ± 262.9, n = 3)
—	—	—	1,078.4–2,010.6 (1,475.4 ± 390.5, n = 6)
—	—	—	1,374.6–2,590.9 (1,888 ± 328.5, n = 18)
1,494.5–2,018.4	346.5–480.3	379–614	1,986.6–3,585.1 (2,912.1 ± 729.7, n = 4)
861.7–2,709.2 (1,372.6 ± 558.5, n = 9)	178.6–308.2 (257.2 ± 42.7, n = 9)	235–535.7 (353.9 ± 97.3, n = 9)	1,023–2,116.5 (1,653.4 ± 320.2, n = 21)
574.1–1,511.9 (1,176.1 ± 349.7, n = 6)	195.1–275.4 (225.6 ± 27, n = 6)	132.1–398.2 (292.2 ± 92, n = 6)	995.8–2,184.5 (1,706.5 ± 409.1, n = 9)
1,307.5–1,519.4	289.2–359.8	323–442.8	1,721.2–2,669.1 (2,189.2 ± 291.7, n = 10)
—	—	—	1,132.8–1,985.5 (1,515.4 ± 309.5, n = 6)
1,961.2	145.8	449.7	1,018.9–2,277.3 (1,710.7 ± 472.2, n = 7)
—	—	—	2,593.6–3,355.5 (2,956.6 ± 345.6, n = 5)
1,050–1,825	28–350	320–450	1,996
—	—	—	1,184.6–1,508.2 (1,299.5 ± 181.1, n = 3)
—	—	—	1,315.5–2,343.5 (1,661.2 ± 396.1, n = 6)
966.8–2,096.1 (1,323.1 ± 457.4, n = 5)	168.8–393.1 (280.6 ± 85.2, n = 5)	221.9–539.6 (331.7 ± 125.5, n = 5)	1,136.5–2,055.1 (1,501.7 ± 333, n = 10)

APPENDIX I. Extended.

Gravid proglottides Genital pore position	Testes number			Testes dimensions	
	Preporal	Antiporal	Total	Length	Width
473–612.4 (534.8 ± 71, n = 3)	25	27	52	53.8–75 (60.1 ± 6.8, n = 10)	47.9–59.3 (54.3 ± 3.2, n = 10)
275.2–890.9 (476 ± 207.3, n = 7)	17–38 (29 ± 6, n = 24)	21–47 (33 ± 7, n = 24)	38–79 (62 ± 13, n = 24)	36.5–75.4 (58.4 ± 8.6, n = 35)	32.1–56.8 (47.3 ± 6.9, n = 35)
345.3–771.2 (527.9 ± 97.7, n = 18)	20–33 (25 ± 3, n = 43)	20–31 (26 ± 3, n = 43)	42–61 (51 ± 5, n = 43)	45.2–91 (68.3 ± 10.7, n = 95)	43.4–86 (63.9 ± 9.7, n = 95)
—	20–34 (26 ± 4, n = 16)	15–31 (25 ± 4, n = 16)	35–63 (51 ± 7, n = 16)	45.1–131.1 (75.6 ± 24.3, n = 25)	43.4–89.3 (59.4 ± 11.4, n = 25)
250.8–563.5 (443.6 ± 84.1, n = 11)	15–30 (21 ± 4, n = 16)	13–31 (21 ± 5, n = 16)	28–59 (42 ± 8, n = 16)	34.9–80.8 (57 ± 9.2, n = 30)	27.7–70.3 (44 ± 8.9, n = 30)
383.3–686.2 (542.7 ± 94, n = 11)	11–25 (18 ± 3, n = 28)	14–26 (20 ± 3, n = 28)	29–50 (38 ± 5, n = 28)	47.7–78.9 (67.2 ± 6.5, n = 50)	47.4–74.1 (58.8 ± 7.2, n = 50)
663.6	24–29 (28 ± 2, n = 8)	28–35 (30 ± 2, n = 8)	53–64 (58 ± 3, n = 8)	61–84.1 (72.6 ± 5.8, n = 15)	42.8–59.4 (53.5 ± 5.5, n = 15)
431.6–689.9 (519.3 ± 62.7, n = 22)	9–25 (17 ± 3, n = 54)	11–26 (18 ± 3, n = 54)	21–51 (35 ± 6, n = 54)	44–84.4 (65.7 ± 8.7, n = 113)	37.3–76.9 (54.1 ± 9, n = 113)
434.4–531.4 (491 ± 40.7, n = 4)	14–21 (17 ± 2, n = 16)	14–21 (17 ± 2, n = 16)	29–42 (34 ± 3, n = 16)	45.1–90.1 (62.2 ± 9.5, n = 60)	37.5–79.7 (52.1 ± 10.7, n = 60)
568.7–672 (616.9 ± 38.4, n = 6)	16–35 (26 ± 6, n = 17)	17–36 (26 ± 6, n = 17)	33–68 (52 ± 12, n = 17)	63–105.6 (80.5 ± 10.4, n = 40)	53–90.1 (71.3 ± 9, n = 40)
394.3–640 (506.6 ± 115.1, n = 6)	17–26 (20 ± 3, n = 8)	16–27 (21 ± 4, n = 8)	33–53 (41 ± 6.4, n = 8)	53.8–89.5 (70.7 ± 11.8, n = 25)	41.5–85.5 (60.8 ± 12.3, n = 25)
553.1–623.6 (590 ± 35.4, n = 3)	10–23 (18 ± 4, n = 15)	10–27 (18 ± 5, n = 15)	20–48 (36 ± 8, n = 15)	56.1–99.8 (75.6 ± 11.5, n = 30)	46.3–74.8 (57.2 ± 6.7, n = 30)
563.4–735 (644.8 ± 65.1, n = 5)	24–36 (30 ± 4, n = 11)	26–37 (31 ± 3, n = 11)	50–69 (61 ± 7, n = 11)	83.6–113.4 (93.8 ± 8.7, n = 10)	78.4–91.4 (84.3 ± 4.4, n = 10)
—	20–25 (23 ± 2, n = 7)	19–24 (21 ± 2, n = 7)	39–47 (44 ± 3, n = 7)	66.8–90.2 (78.7 ± 9, n = 10)	45.6–75.4 (58.4 ± 8.8, n = 10)
351.6–540 (475.1 ± 84.2, n = 4)	17–20 (19 ± 1, n = 6)	14–20 (17 ± 3, n = 6)	32–40 (36 ± 4, n = 6)	42.7–63.6 (52.6 ± 5, n = 15)	32.2–51.5 (42 ± 6.1, n = 15)
381.9–551.1 (466.5 ± 119.6, n = 2)	16–22 (20 ± 2, n = 10)	17–24 (20 ± 2, n = 10)	33–46 (40 ± 4, n = 10)	47.1–74.8 (63.2 ± 7.3, n = 25)	37.6–70 (50.6 ± 8, n = 25)
393.5–575 (483.8 ± 52, n = 10)	11–24 (17 ± 3, n = 28)	11–24 (17 ± 4, n = 28)	23–46 (34 ± 7, n = 28)	43.7–81.4 (59.6 ± 9.3, n = 55)	30.1–69.6 (49.8 ± 8.7, n = 55)

APPENDIX I. Extended.

Population	Cirrus sac in mature proglottides		Cirrus sac in gravid proglottides	
	Length	Width	Length	Width
Amazonas*†	268.3–284	50.9–64.6	322.2–396.2 (366.3 ± 39, n = 3)	81.2–96.3 (88.2 ± 7.6, n = 3)
Upper Solimões‡§	260.4–429.8 (302.4 ± 63.7, n = 6)	37.2–77.7 (59.9 ± 17.8, n = 6)	283.4–576.3 (425 ± 140.3, n = 4)	51.8–111.4 (76.8 ± 26.3, n = 4)
Venezuela*	221.7–430.2 (313.3 ± 58.9, n = 18)	47.2–95.4 (68.7 ± 11.9, n = 18)	339.5–1,491.1 (542.1 ± 260, n = 16)	66.1–236 (97.8 ± 39.2, n = 16)
Maracaibo #	318.1–341.7 (331.2 ± 12, n = 3)	77.3–86.2 (80.5 ± 5, n = 3)	—	—
Corumbá¶**	275.6–346.8 (310.6 ± 26.7, n = 6)	42–60.1 (50.6 ± 7.2, n = 6)	331.9–493 (403.4 ± 47.9, n = 11)	64.8–112.7 (86.1 ± 17, n = 11)
Argentina¶¶	240.3–414.9 (321.5 ± 52.3, n = 18)	49.7–84.4 (68.1 ± 11.2, n = 18)	413.8–548.1 (485.4 ± 36.4, n = 11)	89.9–118.9 (102.7 ± 8.6, n = 11)
Bela Vista††	323.3–389.3 (358.3 ± 29.7, n = 4)	79.5–105.5 (92.3 ± 10.8, n = 4)	389.6	132.1
Belém¶¶	184.6–343.1 (278 ± 47.1, n = 17)	44.9–73.6 (59.5 ± 9.1, n = 17)	298.5–472 (390.1 ± 49.7, n = 21)	60.9–120.5 (84.2 ± 14.3, n = 21)
Belém*	241.6–345.2 (285 ± 37.5, n = 8)	61.4–82.5 (69.4 ± 6.8, n = 8)	319.3–474.7 (377.7 ± 67.4, n = 4)	72.2–87.6 (80.2 ± 6.4, n = 4)
Marabá‡‡	290.1–432.6 (352 ± 50, n = 9)	68–93.8 (80.7 ± 8, n = 9)	392.8–603.7 (478.5 ± 76, n = 6)	78.3–107.6 (92.7 ± 9.8, n = 6)
Rio Branco¶¶	246.5–395.5 (341.5 ± 82.6, n = 3)	65.5–96.7 (76.3 ± 17.7, n = 3)	314.6–521.8 (423.9 ± 94.4, n = 5)	86.1–119.7 (101.2 ± 14, n = 5)
Rio Negro¶¶	258.1–348.8 (314 ± 39, n = 4)	57.4–81.7 (65.8 ± 11.4, n = 4)	363.7–490.5 (427.2 ± 63.4, n = 3)	87.1–95.3 (91.1 ± 4.1, n = 3)
Lower Solimões§§	337.3–423.6 (384.6 ± 39.9, n = 5)	69.6–90 (80.7 ± 8.6, n = 5)	472.9–632.3 (537.2 ± 65, n = 5)	95.9–146.3 (120.9 ± 19.7, n = 5)
Lower Solimões	296.7–321	63.2–77.6	—	—
Lower Solimões¶¶	161–193	41–44	221.5–324.2 (292 ± 48, n = 4)	55.6–72.4 (65 ± 7.4, n = 4)
Venezuela*	204.2–342.4 (248 ± 46.6, n = 7)	56.2–88.4 (69.4 ± 11, n = 7)	316.3–353.5 (336.4 ± 15.5, n = 4)	70.7–75.6 (73.1 ± 2, n = 4)
Xingu##	236.4–438.6 (286 ± 63, n = 9)	49.4–83.7 (60.1 ± 10, n = 9)	310.8–485.2 (398.5 ± 49, n = 10)	55.1–95.8 (78.7 ± 13, n = 10)

APPENDIX II. Measurements obtained for *Rhinebothroides glandularis* according to host and geographic area.

Population	Immature spp.		Mature spp.		No. of loculi
	Size (mm)	No. of segments	Size (mm)	No. of segments	
Venezuela*†	—	—	9.6–28.4 (20 ± 6, n = 13)	17–34 (30 ± 5, n = 13)	49–53 (51 ± 2.8, n = 2)
Corumbá‡§	—	—	7.6–14.6 (11.3 ± 2.7, n = 8)	12–23 (17.7 ± 4.4, n = 8)	53
Rio Branco‡	—	—	7.1–9.4	12	—
Rio Negro‡	4.5–5.8 (5.2 ± 1, n = 3)	10–14 (12 ± 2, n = 3)	5.9–10.5 (7.9 ± 1.6, n = 6)	12–17 (14 ± 2, n = 6)	59–65 (62.5 ± 3, n = 4)
Rio Negro*	—	—	6.2	13	67
Solimões‡	—	—	5.7–21.8 (11.4 ± 4.9, n = 19)	9–22 (15.7 ± 4.2, n = 19)	57–63 (59 ± 3, n = 3)
Solimões	—	—	15.1	21	—
Marabá#	—	—	11.1–24.1 (18 ± 4.9, n = 9)	18–28 (23 ± 3, n = 9)	55–63 (60.3 ± 4.6, n = 3)
Belém‡	4.4–6 (5 ± 1, n = 3)	9–10 (9.5 ± 1, n = 2)	4.5–18 (10.1 ± 3.7, n = 18)	8–18 (13.5 ± 3, n = 18)	57–71 (61.6 ± 3.7, n = 10)
Belém*	—	—	8.2–13.5	14–18	—
Argentina‡	—	—	9–20 (13 ± 4, n = 9)	13–21 (17 ± 3, n = 9)	59–61
Teresina¶	—	—	8.7–22	19–31	59
Venezuela**	3.5–3.8	7–15	—	—	—

* *Potamotrygon orbignyi*.

† Brooks et al. (1981).

‡ *Potamotrygon motoro*.

§ Brooks and Amato (1992).

|| *Potamotrygon scobina*.# *Potamotrygon henlei*.¶ *Potamotrygon signata*.** *Potamotrygon* sp.

APPENDIX I. Extended.

Poral ovarian lobe	Aporal ovarian lobe	Ovarian isthmus
259.6–338.4	751.3–845.9	142.2–197.9
174.6–332.9 (247.8 ± 48.5, n = 9)	381.8–873.5 (602 ± 142.1, n = 8)	188.6–437.5 (276.1 ± 85.9, n = 9)
149.2–387.1 (252.8 ± 56.8, n = 33)	591–1,232.5 (911 ± 165, n = 33)	75–325.9 (228.9 ± 59.7, n = 33)
110–160 (128 ± 27.8, n = 3)	490–741.7 (646.5 ± 136.6, n = 3)	159–220 (193.4 ± 31.2, n = 3)
204.2–263.5 (235.6 ± 19.6, n = 8)	434.6–1,149.2 (751 ± 257, n = 8)	65.5–249.9 (157.6 ± 60.3, n = 8)
167.8–314.9 (259.4 ± 42.4, n = 18)	798.7–1,258.9 (1,011.5 ± 134.4, n = 18)	148.2–280.4 (215.3 ± 40.5, n = 18)
284.8–440.1 (368.9 ± 78.4, n = 3)	844–918 (872.2 ± 40, n = 3)	189.8–305.5 (232 ± 63.9, n = 3)
156.1–330.5 (262.2 ± 49.7, n = 22)	364.6–871 (610.5 ± 117, n = 22)	80.8–248.6 (149.1 ± 45.3, n = 22)
131.4–379.3 (250.5 ± 80.2, n = 14)	349.3–835.9 (585 ± 150, n = 14)	69.6–315.8 (155.1 ± 57, n = 14)
259.3–474 (343.9 ± 69.3, n = 12)	256–1,000 (748 ± 201, n = 12)	151.7–511 (275.6 ± 92.8, n = 12)
145.1–372 (223.3 ± 86.4, n = 6)	403–707.8 (502 ± 112.4, n = 6)	126.4–330 (202.6 ± 72.8, n = 6)
157.3–319.5 (241.2 ± 63.9, n = 5)	348.5–734.9 (593.2 ± 152.2, n = 5)	155.9–247.2 (184.4 ± 38.3, n = 5)
174.3–385.4 (272.2 ± 82.6, n = 6)	1,341.6–2,107.7 (1,623 ± 286, n = 6)	139–265.6 (200.2 ± 41, n = 6)
291.3–332	677–751.8	93–199.3
198–464	208–458	113–142
211–759.1 (328 ± 194, n = 7)	196.5–1,124.2 (715.8 ± 288.6, n = 7)	145.9–256.8 (184.1 ± 38.4, n = 7)
173.8–300.4 (232.3 ± 39.4, n = 11)	414.2–859.3 (580 ± 4, n = 11)	91.4–238.1 (139.5 ± 42.5, n = 11)

APPENDIX II. Extended.

Immature proglottides			Mature proglottides
Length	Width	Genital pore position	Length
1,080.8–1,528.1 (1,319 ± 225.1, n = 3)	326.8–509.9 (411.2 ± 92.4, n = 3)	327–452 (403.5 ± 67.1, n = 3)	1,019.5–2,125 (1,675 ± 284, n = 27)
1,190.5–1,579.3 (1,445.6 ± 221, n = 3)	160.5–260.9 (221.6 ± 53.6, n = 3)	302–447 (393.4 ± 79.6, n = 3)	1,120.5–1,529.2 (1,299 ± 141, n = 6)
—	—	—	1,219.4–1,488.2 (1,357.4 ± 134.5, n = 3)
1,094.2–1,533.3 (1,313.7 ± 310.5, n = 2)	252–296.3 (274.1 ± 31.3, n = 2)	324–479.1 (401.5 ± 109.7, n = 2)	738.6–1,413 (1,138.5 ± 278.3, n = 8)
—	—	—	1,130
—	—	—	963.1–2,158.5 (1,437 ± 254.7, n = 26)
1,385.6	288.6	428	1,822.1–1,825.7
819.6–1,616.4 (1,211.2 ± 309.6, n = 6)	144.6–380.9 (270 ± 85.3, n = 6)	259.8–608.5 (412.9 ± 136.1, n = 6)	1,021.4–1,843.7 (1,445.9 ± 228.4, n = 13)
1,142.8	213.1	353	1,106.1–1,926.9 (1,495.8 ± 193.2, n = 28)
—	—	—	1,332–1,383
—	—	—	1,244–1,759 (1,511 ± 174, n = 12)
—	—	—	655.7–1,319.5 (1,038.7 ± 343.5, n = 3)
—	—	—	—

APPENDIX II. Extended.

Population	Mature proglottides		Gravid proglottides	
	Width	Genital pore position	Length	Width
Venezuela*†	375.4–568 (457.3 ± 55, n = 27)	306–618.3 (466.4 ± 79.3, n = 27)	1,660.3–2,578.7 (2,041.5 ± 274.3, n = 18)	448.1–662.1 (538.8 ± 54.5, n = 18)
Corumbá‡§	215.4–379.1 (293.2 ± 61.3, n = 6)	335–376.3 (353.4 ± 16.6, n = 6)	1,533.6–1,974 (1,735.4 ± 160.1, n = 11)	271.2–466.6 (364.1 ± 65, n = 11)
Rio Branco‡	339.9–445.2 (410.1 ± 60.8, n = 3)	395.1–489.9 (429.5 ± 52.5, n = 3)	2,094.5	435.4
Rio Negro‡	277.9–413.8 (354.6 ± 52.9, n = 8)	190–819.3 (447 ± 182.8, n = 8)	1,170.8–1,796.1 (1,450 ± 203.8, n = 6)	386.3–490.6 (427.2 ± 43.1, n = 6)
Rio Negro*	370	380	—	—
Solimões‡	271.5–599.1 (393.7 ± 71.7, n = 26)	293.1–560.1 (413.7 ± 71.1, n = 26)	1,245.9–2,392.7 (1,708.2 ± 274.2, n = 20)	381.9–659.6 (485.6 ± 76.1, n = 20)
Solimões	346.7–483.1	610.6–625	1,687.8	538.6
Marabá#	276.5–471.9 (366 ± 72, n = 13)	302–523.7 (426.7 ± 64.4, n = 13)	1,189.3–2,292.5 (1,692.9 ± 225.7, n = 25)	309.9–586.4 (465.6 ± 71.6, n = 25)
Belém‡	197.5–484.5 (331.2 ± 74.2, n = 28)	344–543.9 (456.8 ± 58.2, n = 28)	1,471.3–2,479 (1,897.6 ± 251.2, n = 22)	262.9–596.6 (442.2 ± 69.6, n = 22)
Belém*	264–321.5	399.6–580	1,418.6–1,594.3	418.8–424
Argentina‡	229–443 (352 ± 63, n = 12)	340–579 (429 ± 66, n = 12)	1,572–2,010 (1,769 ± 133, n = 13)	389–574 (461 ± 50, n = 13)
Teresina¶	435.6–510.7 (484.4 ± 42.3, n = 3)	199–315.1 (272.8 ± 64.1, n = 3)	1,138–1,654.7	737.6–766.5
Venezuela**	—	—	—	—

APPENDIX II. Extended.

Population	Cirrus sac in mature proglottides		Cirrus sac in gravid proglottides	
	Length	Width	Length	Width
Venezuela*†	215–394.4 (328 ± 51, n = 15)	69.9–144 (93 ± 11, n = 15)	318.6–469.1 (390.1 ± 47.6, n = 18)	70.3–126.3 (102.8 ± 17.1, n = 18)
Corumbá‡§	187.3–273.9 (232 ± 32.6, n = 7)	54.3–65.5 (60.7 ± 4.1, n = 7)	249.1–367.1 (315 ± 31.4, n = 11)	58.7–90.2 (71.6 ± 9.2, n = 11)
Rio Branco‡	255.3–266.3	69.4–74.6	386.9	119.1
Rio Negro‡	236.6–311.1 (264.3 ± 29.6, n = 7)	60.2–93.7 (73.3 ± 12.4, n = 7)	278.4–388.5 (346.1 ± 42.1, n = 6)	86–114.7 (99.5 ± 12.5, n = 6)
Rio Negro*	234.6	68.4	—	—
Solimões‡	195–403.2 (293.2 ± 58.8, n = 22)	39.7–97.6 (76.1 ± 15.6, n = 22)	261.2–507.5 (383.9 ± 64.7, n = 20)	63.9–142.6 (101 ± 17.3, n = 20)
Solimões	317.3–351.9	89.2–105.3	413.3	118.8
Marabá#	222.4–339 (261.6 ± 36.2, n = 13)	53.7–84.6 (72.5 ± 10.7, n = 13)	237.3–422.5 (335.7 ± 51.4, n = 25)	79.1–125.8 (97.8 ± 13.6, n = 25)
Belém‡	201.8–408.8 (267 ± 51, n = 25)	57.1–108.1 (79.8 ± 12.6, n = 25)	196.7–489.4 (373.75 ± 66.6, n = 22)	62.1–134.2 (103.5 ± 17.1, n = 22)
Belém*	227.4–247.3	47.2–63.6	323.9	112.2
Argentina‡	207–305 (267 ± 34, n = 10)	61–83 (72 ± 8, n = 10)	290–437 (362 ± 44, n = 13)	78–108 (90 ± 9, n = 13)
Teresina¶	338–346	62.5–100.8	396.9–453.5	110.8–133.2
Venezuela**	—	—	—	—

APPENDIX II. Extended.

Gravid proglottides Genital pore position	Testes number			Testes diameter	
	Preporal	Antiporal	Total	Length	Width
439.8–615.6 (518.9 ± 54, n = 18)	16–29 (22 ± 3, n = 48)	15–27 (22 ± 2, n = 48)	34–53 (43 ± 4, n = 48)	38.9–87.8 (70 ± 9.7, n = 90)	40.4–79.6 (61.5 ± 8.3, n = 90)
415.2–564.3 (478.9 ± 44.6, n = 11)	12–21 (16 ± 3, n = 23)	11–21 (15 ± 3, n = 23)	23–41 (31 ± 5, n = 23)	29.3–68.8 (45.4 ± 9.8, n = 40)	29.9–49.2 (38.2 ± 4.7, n = 40)
560.3	14–19 (16 ± 2, n = 4)	13–16 (15 ± 1, n = 4)	29–35 (31 ± 3, n = 4)	59.6–94.7 (70.7 ± 11.5, n = 10)	41.8–58.3 (54.1 ± 4.9, n = 10)
339.8–467.8 (395.3 ± 44.1, n = 6)	13–34 (19 ± 4, n = 21)	13–23 (18 ± 2, n = 21)	27–50 (37 ± 5, n = 21)	50.2–75.7 (60.6 ± 7.5, n = 25)	30.8–69.4 (51 ± 10.2, n = 25)
—	17–22 (19 ± 3, n = 3)	20–25 (22 ± 3, n = 3)	37–47 (41 ± 6, n = 3)	—	—
354–656 (481.7 ± 68, n = 20)	11–24 (17.5 ± 3, n = 61)	10–25 (18 ± 3, n = 61)	21–48 (35 ± 5, n = 61)	50.4–97.5 (67.5 ± 9.7, n = 103)	36.2–71.7 (54.8 ± 7.6, n = 103)
571	13–16 (15 ± 2, n = 3)	14–18 (16 ± 2, n = 3)	27–34 (31 ± 4, n = 3)	78.4–99.6 (87.72 ± 7.9, n = 5)	62.5–74.5 (69.56 ± 4.5, n = 5)
347–633 (471.9 ± 51.9, n = 25)	11–26 (18 ± 3, n = 35)	11–25 (19 ± 3, n = 35)	22–48 (37 ± 6, n = 35)	50.2–84.3 (65.4 ± 8.1, n = 65)	42.6–69.1 (56.4 ± 5, n = 65)
407–674.1 (530.6 ± 68.1, n = 22)	10–20 (15 ± 2, n = 57)	7–19 (15 ± 2, n = 57)	17–39 (30 ± 4, n = 57)	46.9–99.6 (65.7 ± 10.5, n = 105)	40.2–83.9 (56.2 ± 10.3, n = 105)
397.4–466	15–19 (17 ± 2, n = 5)	18–20 (19 ± 1, n = 5)	33–39 (36 ± 3, n = 5)	50.5–63.3 (56.5 ± 4.1, n = 10)	40.8–59.1 (49.2 ± 4.6, n = 10)
429–530 (482 ± 36, n = 13)	10–20 (14 ± 2, n = 27)	11–22 (14 ± 2, n = 27)	23–38 (28 ± 4, n = 27)	50–93 (71 ± 9, n = 45)	38–74 (57 ± 9, n = 45)
245.4–501.1	27	28	55	41.4–101.2 (67.6 ± 20.1, n = 10)	26.6–43.9 (36.3 ± 5.8, n = 10)
—	17–26 (22 ± 3, n = 6)	13–27 (20 ± 5, n = 6)	30–49 (42 ± 7, n = 6)	—	—

APPENDIX II. Extended.

Ovary		
Poral ovarian lobe	Aporal ovarian lobe	Ovarian isthmus
65–578.4 (378.6 ± 89.7, n = 42)	175–972 (725.3 ± 148.5, n = 42)	75–280.8 (184 ± 36.7, n = 42)
66.5–155.8 (121.7 ± 25.2, n = 11)	18.2–29.5 (22.5 ± 3.5, n = 20)	10.7–18 (14.1 ± 2.1, n = 20)
300–366.9	620–674.1	197.2–200
169.1–449.2 (315.9 ± 102.3, n = 9)	336.8–787.8 (616.1 ± 155.5, n = 9)	89.6–174.8 (138 ± 29.5, n = 9)
350.4	575.7	188.3
159.4–430 (334.2 ± 77.1, n = 29)	491.8–910.9 (684.3 ± 114.8, n = 29)	99.5–200 (150.7 ± 27.1, n = 29)
533.2–564.1	872.3–966.8	136.5–211.8
255–465.7 (337.6 ± 65.3, n = 25)	539.1–904.1 (703.9 ± 102, n = 25)	81.7–252.5 (165.5 ± 37.3, n = 25)
157.2–466 (379 ± 71.4, n = 24)	231.2–974.6 (701.4 ± 142.6, n = 24)	42.5–188.3 (128.7 ± 33.4, n = 24)
238.4–430 (359 ± 84.3, n = 4)	605.8–820 (704.5 ± 98.4, n = 4)	103.1–150 (127.5 ± 19.2, n = 4)
234–442 (344 ± 52, n = 14)	506–901 (727 ± 103, n = 14)	85–189 (143 ± 28, n = 14)
158–249.6 (210.6 ± 47.3, n = 3)	346.3–544.9 (473.3 ± 110.3, n = 3)	183.3–227.7 (205.9 ± 22.2, n = 3)
—	—	—

APPENDIX III. Measurements obtained for *Rhinebothroides moralarai* according to host and geographic distribution.

Parameter	Population	
	Rio Magdalena*†	Upper Rio Negro‡
Immature specimens		
Size (mm)	—	—
Number of segments	—	5–15 (n = 2)
Mature specimens		
Size (mm)	10.3–19	—
Number of segments	14–29 (20 ± 8, n = 3)	28–45 (36 ± 5, n = 8)
Scolex		
Number of loci	51–63 (57 ± 5, n = 5)	49–55 (51 ± 2, n = 8)
Immature proglottid		
Length	—	1,274–1,323 (n = 2)
Width	—	435–597 (n = 2)
Genital pore position	—	243–263 (n = 2)
Mature proglottid		
Length	1,118.7–2,175 (1,613.5 ± 527.8, n = 4)	1,194–2,097 (1,539 ± 221, n = 29)
Width	342–870 (615.9 ± 272.7, n = 4)	259–626 (483 ± 95, n = 29)
Genital pore position	256–420 (346.6 ± 70.6, n = 4)	248–474 (332 ± 58, n = 29)
Gravid proglottid		
Length	1,522.1–2,407.4 (1,965.5 ± 429.3, n = 4)	1,508–1,969 (1,779 ± 168, n = 9)
Width	410.8–870 (626 ± 188.2, n = 4)	484–676 (602 ± 58, n = 9)
Genital pore position	320–515.7 (416.4 ± 80.8, n = 4)	304–493 (401 ± 70, n = 9)
Testes number		
Poral	26–34 (29 ± 2, n = 6)	20–36 (27 ± 3, n = 43)
Antiporal	28–31 (30 ± 1, n = 6)	17–34 (27 ± 3, n = 43)
Total	55–63 (59 ± 3, n = 6)	43–69 (55 ± 6, n = 43)
Testes diameter		
Length	56.3–120 (85.3 ± 24, n = 10)	52–116 (81 ± 13, n = 80)
Width	38.9–105 (65.7 ± 25.7, n = 10)	49–95 (66 ± 10, n = 80)
Cirrus sac in mature proglottid		
Length	220.1–550 (382.3 ± 166.8, n = 4)	260–492 (390 ± 59, n = 26)
Width	47–150 (88.2 ± 47.3, n = 4)	64–126 (98 ± 17, n = 26)
Cirrus sac in gravid proglottid		
Length	344.8–665	434–632 (126 ± 12, n = 10)
Width	61.8–165	109–150 (126 ± 12, n = 10)
Ovary dimensions		
Poral lobe	150–270.4 (186.1 ± 48.8, n = 5)	125–336 (193 ± 50, n = 32)
Aporal lobe	521.9–1,200 (853.6 ± 318.2, n = 5)	574–1,096 (810 ± 138, n = 32)
Isthmus	103.6–380 (236.1 ± 115.4, n = 5)	120–313 (196 ± 46, n = 32)

* *Potamotrygon magnalanae*.

† Specimens collected by Brooks and Thorson (1976).

‡ *Potamotrygon* sp. (upper Rio Negro).

APPENDIX IV. Measurements obtained for *Rhinebothroides scorzai* according to host and geographic distribution.

Parameter	Population		
	Venezuela*†‡§	Belém†	Belém‡
Immature specimens			
Size (mm)	—	7.5–11.1 (8.9 ± 1.9, n = 3)	—
Number of segments	—	33–44 (39 ± 5, n = 3)	—
Mature specimens			
Size (mm)	15.1–36.8 (21.2 ± 7.5, n = 8)	12.1–51 (34.5 ± 20.1, n = 3)	14.3–32.8 (25.5 ± 8.2, n = 4)
Number of segments	35–53 (43 ± 6, n = 8)	50–86 (70 ± 18, n = 3)	49–84 (60.5 ± 16, n = 4)
Scolex			
Number of loci	—	63–127 (98.5 ± 29.9, n = 4)	117
Immature proglottid			
Length	1,317.6	611.8–639.4 (625.6 ± 19.5, n = 2)	736.9–1,314 (1,035.5 ± 242.8, n = 5)
Width	332.2	560.3–565.1 (562.7 ± 3.4, n = 2)	392–807.4 (572.7 ± 152.2, n = 5)
Genital pore position	245.1	108–126.2 (117.1 ± 12.9, n = 2)	146.1–262 (182.4 ± 46.4, n = 5)
Mature proglottid			
Length	1,359–1,913.4 (1,629.4 ± 177.1, n = 19)	776.7–2,119.1 (1,373.3 ± 356.9, n = 17)	866.5–3,300 (1,554.5 ± 824.5, n = 11)
Width	360.9–927.2 (583.2 ± 128.8, n = 19)	465.1–1,212.5 (744.2 ± 238.5, n = 17)	454–829.7 (676 ± 143, n = 11)
Genital pore position	238–369.2 (319.6 ± 35.9, n = 19)	123–538.9 (268.6 ± 95.4, n = 17)	124–977 (344.8 ± 275.1, n = 11)
Gravid proglottid			
Length	1,221.9–2,799.1 (2,212.3 ± 514.7, n = 13)	875–2,556.4 (1,579.6 ± 426.5, n = 13)	1,198.8–2,785.8 (1,730.8 ± 493, n = 8)
Width	469.5–1,166.9 (753.5 ± 230.9, n = 13)	661.7–1,268.2 (971.9 ± 172.6, n = 13)	665.9–819.3 (742.2 ± 57.6, n = 8)
Genital pore position	265–772.3 (499.6 ± 165.7, n = 13)	179–399 (295.3 ± 67, n = 13)	148.1–607.1 (341.5 ± 166, n = 8)
Teste number			
Poral	30–47 (38 ± 5, n = 26)	32–53 (39 ± 5, n = 31)	32–44 (39 ± 3, n = 16)
Antiporal	27–49 (37 ± 5, n = 26)	30–48 (41 ± 4, n = 31)	33–46 (40 ± 4, n = 16)
Total	59–93 (75 ± 9, n = 26)	65–98 (80 ± 9, n = 31)	65–89 (79 ± 7, n = 16)
Testes diameter			
Length	69–175 (111.7 ± 22.7, n = 65)	56.5–137.7 (92.8 ± 16.8, n = 60)	54–125 (90.8 ± 18.2, n = 40)
Width	48.5–134 (90.3 ± 19.6, n = 65)	35.6–102.4 (70.8 ± 15.7, n = 60)	42.1–98 (64.2 ± 12.4, n = 40)
Cirrus sac in mature proglottid			
Length	346.3–547.9 (430.3 ± 50.2, n = 16)	210.8–446.4 (320.2 ± 61.6, n = 17)	228–463.1 (314.6 ± 62.3, n = 11)
Width	81.4–137.3 (112.5 ± 16, n = 16)	55–118.5 (94.6 ± 17.1, n = 17)	73–158.1 (99.9 ± 23.1, n = 11)
Cirrus sac in gravid proglottid			
Length	439.8–605 (529.8 ± 58.7, n = 13)	303.3–560.4 (442.8 ± 80.6, n = 13)	300.1–562.9 (439.6 ± 99.4, n = 8)
Width	101.2–181.8 (140.7 ± 23.9, n = 13)	116.2–186.9 (139.2 ± 22.2, n = 13)	111.5–146.2 (135.6 ± 13.3, n = 8)
Ovary dimensions			
Poral lobe	152.8–491.7 (302.6 ± 74.2, n = 29)	108.3–429.2 (248.3 ± 70, n = 19)	135.7–485.6 (253.4 ± 118.6, n = 14)
Aporal lobe	421.6–830.6 (598.5 ± 120.6, n = 29)	288.5–817.2 (476.9 ± 116.9, n = 19)	252.3–879.8 (465.9 ± 202.8, n = 14)
Isthmus	247.8–763.4 (498.9 ± 118.8, n = 29)	221.4–841.5 (506.4 ± 189.3, n = 19)	270.4–608.4 (449.6 ± 108, n = 14)

* *Paratrygon atereba*.† *Potamotrygon motoro*.‡ *Potamotrygon orbignyi*.

§ Specimens collected by Books et al. (1981).