



## ECOSYSTEMS

# Update of Dicrocoeliidae (Digenea) parasitizing rodents from the Americas with a description of a new *Platynosomoides* species from Argentina

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**Abstract:** Digeneans are common parasites of small mammals. Dicrocoeliidae is a family with a cosmopolitan distribution, with 18 genera previously recorded from mammals in the Americas, six of them parasitizing rodents in Argentina. In this study, an updated compilation is provided of Dicrocoeliidae from rodents in the Americas. Also, a new *Platynosomoides* species is described parasitizing the cricetid rodent *Akodon montensis* of the Atlantic Forest in Argentina. Digital repositories were used to search for Dicrocoeliidae from rodents in the Americas. Rodents were collected in four localities of the Atlantic Forest, Argentina. Digeneans were removed from the rodent's bile duct, and conventional studies were used for the morphological description. A total of 15 Dicrocoeliidae species were found parasitizing 18 rodent species from eight countries in the Americas. The new species of *Platynosomoides* from *Akodon montensis* differs from the other two species of genus by the size of body, testes, ovary, cecum length and position and length of the vitelline bands. Dicrocoeliidae show growing diversity, and the compilation of species in a rodent host base allows a clearer comparison and identification of new taxa in the future.

**Key words:** *Akodon montensis*, Argentina, Cricetidae, Dicrocoeliidae, *Platynosomoides*, Sigmodontinae.

## INTRODUCTION

The family Dicrocoeliidae Looss 1899, has a worldwide distribution, being composed of more than 400 species included in 48 genera, parasitizing the bile ducts and gall bladders of birds and placental mammals and, more rarely, reptiles and marsupials. Their life cycles usually involve snails and arthropods as first and second intermediate hosts, respectively (Yamaguti 1971, Pojmańska 2008). To date, 29 genera within this family were recorded in mammals, 18 of them distributed in the Americas. Among these, 11 genera have been previously registered in rodents, six of them in Argentina (Pojmańska

2008, Fernandes et al. 2015, Panisse et al. 2017, Guerreiro Martins et al. 2019b).

Regarding dicrocoelids, the diagnosis of the genera is based on a combination of morphological characters, such as location of genital pore, testes, vitelline bands, and size of the ventral sucker (Pojmańska 2008). In the last revision of this family, Pojmańska (2008) distinguished four subfamilies based on the relative position of gonads, vitelline bands, and uterus. However, molecular phylogeny does not support this proposal (Tkach et al. 2018, Hildebrand et al. 2019).

Despite several representative taxa of Dicrocoeliidae being included in molecular

studies, only three species parasitic of American rodents have sequences available in GenBank (Martínez-Ibeas et al. 2011, Pinto et al. 2018, Hildebrand et al. 2019). Several taxonomic keys have compiled digenean diversity around the world, with few of them mentioning the species (Yamaguti 1971, Gibson et al. 2002, Jones et al. 2005, Bray et al. 2008). The cricetid rodents deserve greater attention as hosts of these parasites, since in recent years there has been a growing diversity of genera and species not yet registered (Panisse et al. 2017, Guerreiro Martins et al. 2019a, b, Preisser & Falcón-Ordaz 2019).

In this study, an updated compilation is provided of Dicrocoeliidae from rodents in the Americas. Also, a new *Platynosomoides* species is described based on morphological characteristics, parasitizing the cricetid rodent *Akodon montensis* Thomas 1913 of the Atlantic Forest in Argentina.

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## MATERIALS AND METHODS

The compilation of species data of Dicrocoeliidae from American rodents was performed using the digital repositories Scielo, Redalyc, Scopus, Dialnet, Pubmed, and Google Academic. Reports were found using the descriptor words: Dicrocoeliidae, *Platynosomoides* sp., and Rodentia.

A total of 190 *Akodon montensis* specimens were collected by several collaborators (see Acknowledgments) between 2009 and 2013 in Misiones Province, Argentina: 80 from Campo Anexo M. Belgrano, INTA (26° 02'54.21"S; 53° 46'32.40"W); 82 from Parque Provincial Urugua-í (25°51'25.58"S; 54°09'59.87"W); 4 from Sendero de la Gruta, Parque Provincial Moconá (27°9'23.52"S;

53°54'10.26"W); and 24 from Reserva de Vida Silvestre Urugua-í, Fundación Vida Silvestre (25°58'32.29"S; 54° 07'00.08"W).

The research has been conducted according to Argentine laws. Sample collection was carried out during fieldwork under official permits granted by Ministerio de Ecología, RNR y Turismo, Provincia de Misiones (authorization #23 and #27. Guía Tránsito 000316, 000685 and 000699), in accordance with the recommendations in the Guide for the Care and Use of Laboratory Animals of the National Institutes of Health. Rodent specimens were collected following the procedures and protocols approved by national laws (Animal Protection National law 14.346 and references in the provincial permits) and Ethics Committee for Research on Laboratory Animals, Farm and Obtained from Nature of National Council of Scientific and Technical Research (CONICET). No endangered species were involved in this study.

Dicrocoelids were removed from the rodent's bile duct, subsequently fixed in 10% formalin, preserved in 70% ethanol, stained with hydrochloric carmine, dehydrated through an alcohol series, cleared in eugenol, and studied by light microscopy (Leica MZ6® and Olympus BX51®). Drawings were made with the aid of a drawing tube. One specimen was dried using the critical point method, examined using the scanning electron microscope (JEOL/JSMT 6360 LV®). Family and generic identification were made following the keys of Yamaguti (1971) and Bray et al. (2008).

Prevalence (P), mean intensity (MI), and mean abundance (MA) were calculated according to Bush et al. (1997). In the description, measurements of specimens are presented as follows: mean, standard deviation, and range in parentheses. All measurements are given in millimeters (mm) unless otherwise indicated.

The scales of figures are given in micrometers ( $\mu\text{m}$ ).

The nomenclatural acts have been registered in ZooBank, the online registration system for the ICZN. Type specimens were deposited in the helminthological collection of Museo de La Plata (MLP-He), La Plata, Buenos Aires, and hosts in the mammalogy collection of Centro Nacional Patagónico (CNP), Puerto Madryn, Chubut.

## RESULTS

An updated compilation of Dicrocoeliidae species parasitizing rodents in the Americas is provided in Table I. A total of 14 species were recorded from 18 host species in eight countries.

A total of 47 dicrocoelid specimens were found in the bile duct of 10 *Akodon montensis* and were identified as a new species of *Platynosomoides* described below.

### ***Platynosomoides lunaschiae* sp. nov. (Table II, Figs. 1-2)**

Description (based on 15 complete stained specimens): Plagiorchiida: Dicrocoeliidae. Fusiform body (Fig. 1a),  $2.18 \pm 0.33$  (1.79-2.84) long by  $1.16 \pm 0.21$  (0.92-1.59) wide. Tegument unspined covered by papillae (Figs. 2a-b). Oral sucker rounded,  $0.31 \pm 0.05$  (0.19-0.39) long by  $0.29 \pm 0.06$  (0.21-0.38) wide. Ventral sucker rounded,  $0.38 \pm 0.06$  (0.29-0.48) long by  $0.34 \pm 0.06$  (0.23-0.44) wide. Pharynx,  $0.13 \pm 0.01$  (0.11-0.15) long by  $0.12 \pm 0.01$  (0.9-0.13) wide. Esophagus short. Cecal bifurcation in the forebody, just anterior to the ventral sucker. Long ceca, extending up to three-quarters of the body (Fig. 1a). Rounded testis located immediately posterolateral to the ventral sucker. Right testis  $0.16 \pm 0.03$  (0.07-0.20) long by  $0.15 \pm 0.03$  (0.06-0.18) wide; left testis  $0.14 \pm 0.03$  (0.06-0.18) long by  $0.13 \pm 0.02$  (0.05-0.15) wide (Fig. 1a). Cirrus sac short, located between the ventral sucker and the cecal bifurcation,  $0.22$

long by  $0.1$  wide. Genital pore at level of pharynx (Fig. 1b). Ovary rounded,  $0.14 \pm 0.03$  (0.11-0.2) long by  $0.12 \pm 0.02$  (0.09-0.18) wide, located posterior to the right or left testis (Fig. 1c). Uterus intercecal, occupying the entire hindbody (Fig. 1a). Vitelline bands extracecal, extending from the level of the ventral sucker up to 2/3 of the body length, not overlapping the end of the ceca (Fig. 1a). Eggs  $32.43 \pm 1.69$  (29.04-34.98)  $\mu\text{m}$  long by  $17.62 \pm 2.02$  (14.51-20.8)  $\mu\text{m}$  wide.

### **Taxonomic summary**

**Type host:** *Akodon montensis* Thomas 1913

**Symbiotype:** with collection number in process, field numbers: CG 159. Other hosts: CNP 3724, 4069, 5191, 5255, 5274

**Site of infection:** Bile duct

**Type locality:** Parque Provincial Urugua-í, Misiones province, Argentina (25°51'25.58" S; 54°09'59.87" W)

**Other localities:** Campo Anexo M. Belgrano, Parque Provincial Moconá and Reserva de Vida Silvestre Urugua-í, Misiones province, Argentina

**Specimens deposited:** Holotype (No. 7324), Paratype (No. 7709) and a total of three Voucher specimens (Nos. 7573, 7710, 7711) were deposited at MLP-He

**Host-parasite data:** P=5.26%, IM=4.7 and AM=0.25. The values of P, MI, and MA in the different sampling areas were: Campo Anexo M. Belgrano P=1.2% (1/80), IM=5, and AM=0.1; Parque Provincial Urugua-í P=7.3% (6/82), IM=5.2, and AM=0.4; Sendero La Gruta, Parque Provincial Moconá P=25% (1/4), IM=2, and AM= 0.5; and Reserva de Vida Silvestre Urugua-í P=8.3% (2/24), IM=4.5, and AM=0.4

**Etymology:** to Dr. Lía I. Lunaschi in recognition of her work in the helminthological collection of Museo de La Plata and valuable contributions to knowledge of the digenean

**Recorded in URN as:** urn:lsid:zoobank.org:act:E3261D6F-09DC-45E2-B4FD-87253620B7F1

**Table I. Morphological features and measurements (mm) of Dicrocoeliidae species from rodents in the Americas.**

Species	<i>Athesmia heterolecithodes</i>	<i>Caballerolecythus ibunami</i>	<i>Canaania obesa</i> <sup>a</sup>	<i>Conspicuum minor</i> <sup>b</sup>	<i>Conspicuum pulchrum</i>	<i>Conspicuum thatcheri</i>	<i>Concinnum peromysci</i>
Author	(Braun 1899) Looss 1899	Lamothe-Argumedo, Falcón-Ordaz, García-Prieto & Fernández- Fernández 2005	Travassos 1944	Mañé-Garzón & Holcman- Spector 1975	(Travassos 1919) Bhalerao 1936	Rivillas, Caro, Carvajal & Vélez 2004	Neidert & Macy 1968
Reference	Martínez & Binda 1992	Lamothe-Argumedo et al. 2005	Maldonado Junior et al. 2010, Guerreiro Martins et al. 2019a	Sutton 1998	Travassos et al. 1969	Rivillas et al. 2004	Neidert & Ralph 1968
Synonymous	<i>Distomum heterolecithodes</i>	-	-	-	<i>Eurytrema pulchrum</i>	-	-
Host species	<i>Myocastor coypus</i> (Myocastoridae)	<i>Liomys irroratus</i> (Heteromyidae)	<i>Akodon azarae</i> , <i>A. cursor</i> , <i>A. montensis</i> , <i>Nectomys squamipes</i> , <i>Oligoryzomys nigripes</i> (Cricetidae)	<i>Scapteromys aquaticus</i> , <i>S. tumidus</i> (Cricetidae)	<i>Oxymycterus quaestor</i> (Cricetidae)	<i>Melanomys caliginosus</i> (Cricetidae)	<i>Peromyscus maniculatus</i> (Cricetidae)
Country	Argentina	Mexico	Argentina, Brazil	Argentina, Uruguay	Brazil	Colombia	United State
Site of infection	Bile duct	Bile duct	Bile ducts and the first part of small intestine	Bile duct	Bile duct	Liver	Pancreatic ducts and a few in the small intestine
Body length	6.95-7.50	6.00-6.90	2.20	0.83-1.62	3.00-3.80	1.12-2.66	2.66-3.19
Body width	1.77-1.96	0.26-0.40	1.30	0.35-0.63	1.50-2.0	0.49-1.13	0.86-1.10
Oral sucker diameter max	0.32	0.11-0.19	0.28	0.13-0.21	0.43-0.45	0.08-0.36	0.20-0.23
Oral sucker diameter min	0.32	0.10-0.16	0.22	0.13-0.20	0.43-0.45	0.13-0.37	0.19-0.23
Ventral sucker diameter max	0.36	0.10-0.19	0.84	0.24-0.44	0.62-0.70	0.15-0.63	0.23-0.32
Ventral sucker diameter min	0.36	0.09-0.19	0.73	0.23-0.35	0.62-0.70	0.28-0.69	0.23-0.30
Cirrus sac length	-	0.17-0.40	-	0.07-0.17	-	0.17-0.30	0.15-0.24
Cirrus sac width	-	0.04-0.10	-	0.07-0.09	-	0.10	0.06-0.10
Pharynx length	0.12	0.04-0.06	0.17	0.06-0.09	0.17-0.22	0.09-0.37	0.10-0.13
Pharynx width	-	0.04-0.07	-	0.08-0.12	0.17-0.22	0.07-0.38	0.10-0.13
Testes length	AT: 0.64-0.68 PT: 0.72-0.74	AT: 0.28-0.40; PT: 0.31-0.47	0.24-0.28	0.08-0.15	-	LT: 0.07-0.35; RT: 0.05-0.38	-
Testes width	-	AT: 0.16-0.25; PT: 0.18-0.28	0.31-0.33	0.06-0.09	-	LT: 0.06-0.22; RT: 0.05-0.24	-
Ovary length	0.21-0.36	0.21-0.28	0.26	0.06-0.10	-	0.12-0.17	0.11-0.16
Ovary width	-	0.15-0.20	0.33	0.04-0.11	-	0.12-0.17	0.13-0.21
Eggs length	0.031-0.036	0.024-0.030	0.02	0.027-0.034	0.041-0.045	0.030-0.038	0.05-0.06
Eggs width	0.020	0.013-0.017	0.03	0.016-0.020	0.018-0.022	0.013-0.019	0.033-0.039

AT: Anterior testis; PT: Posterior testis; RT: Right testis; LT: left testis. Measurements from <sup>a</sup>Maldonado Junior et al. (2010) in *A. montensis* and from <sup>b</sup>Sutton (1998) in *S. aquaticus*.

Table I. Continuation.

Species	<i>Dicrocoelium dendriticum</i>	<i>Lyperosomum intermedium</i>	<i>Platynosomum illiciens</i>	<i>Platynosomum minutum</i>	<i>Yungasicola travassosi</i>	<i>Zonorchis komareki</i>	<i>Zonorchis oxymycterae</i> <sup>c</sup>
Author	(Rudolphi 1819) Looss 1899	Denton & Kinsella 1972	(Braun 1901) Kossak 1910	Kifune & Uyema 1982	Gardner & Pérez-Ponce de Léon 2002	(McIntosh 1939) Travassos 1944	Sutton 1983
Reference	Martino et al. 2012	Denton & Kinsella 1972	Pinto et al. 2016	Kifune & Uyema 1982	Gardner & Pérez-Ponce de Léon 2002	McIntosh 1939	Sutton 1983, Guerreiro Martins et al. 2019a
Synonymous	<i>Distoma dendriticum</i> ,	-	<i>Eurytrema fastosum</i> , <i>Platynosomum fastosum</i> , <i>P. concinnum</i>	-	-	<i>Eurytrema komareki</i>	<i>Skrjabinus oxymycterae</i>
Host species	<i>Myocastor coypus</i> (Myocastoridae)	<i>Oryzomys palustris</i> (Cricetidae)	<i>Mus musculus</i> (Muridae)	<i>Proechimys longicaudatus</i> (Echimyidae)	<i>Akodon fumeus</i> (Cricetidae)	<i>Peromyscus gossypinus</i> (Cricetidae)	<i>Akodon azarae</i> ; <i>Oxymycterus rufus</i> (Cricetidae)
Country	Argentina	United State	Brazil	Peru	Bolivia	United State	Argentina
Site of infection	Liver	Pancreas	Bile duct	Bile duct, gall bladder	Gall bladder and bile ducts	Liver	Bile duct and small intestine
Body length	5.00-12.00	1.65-4.20	2.23-4.98	1.88-2.74	1.97-3.33	2.82	1.77-3.68
Body width	1.00-2.50	0.33-0.42	0.86-1.72	0.58-0.86	0.71-1.45	0.80	0.66-0.78
Oral sucker diameter max	0.40	0.13-0.15	0.24-0.42	0.23-0.28	0.21-0.34	0.20	0.19-0.29
Oral sucker diameter min	0.30	0.12-0.14	0.24-0.35	0.22-0.26	0.19-0.36	0.20	0.13-0.24
Ventral sucker diameter max	0.45	0.21	0.20-0.43	0.27-0.34	0.19-0.34	0.37	0.49-0.66
Ventral sucker diameter min	0.40	0.16	0.24-0.39	0.27-0.34	0.18-0.34	0.32	0.49-0.61
Cirrus sac length	0.50-0.60	0.11-0.15	0.28-0.48	-	0.10-0.28	-	-
Cirrus sac width	-	0.05-0.65	0.10-0.17	-	0.02-0.07	-	-
Pharynx length	0.13	0.07	0.08-0.15	-	0.09-0.16	0.10	0.12-0.16
Pharynx width	0.12	0.06	0.07-0.14	-	0.07-0.14	0.10	0.13-0.16
Testes length	1.00	0.24	LT: 0.34-0.88; RT: 0.35-0.89	-	LT: 0.11-0.23; RT: 0.09-0.21	0.09-0.20	0.14-0.18
Testes width	0.70	0.11	LT: 0.24-0.58; RT: 0.23-0.54	-	LT: 0.09-0.19; RT: 0.11-0.18	0.09-0.20	0.16-0.19
Ovary length	0.25	0.06-0.14	0.10-0.29	-	0.05-0.13	0.13-0.14	0.11-0.14
Ovary width	0.35	0.07-0.15	0.17-0.39	-	0.62-0.13	0.13-0.14	0.11-0.16
Eggs length	0.038-0.045	0.04-0.05	-	0.03-0.04	0.019-0.031	0.030	0.02
Eggs width	0.022-0.030	0.02-0.027	-	0.02	0.012-0.020	0.023	0.02-0.04

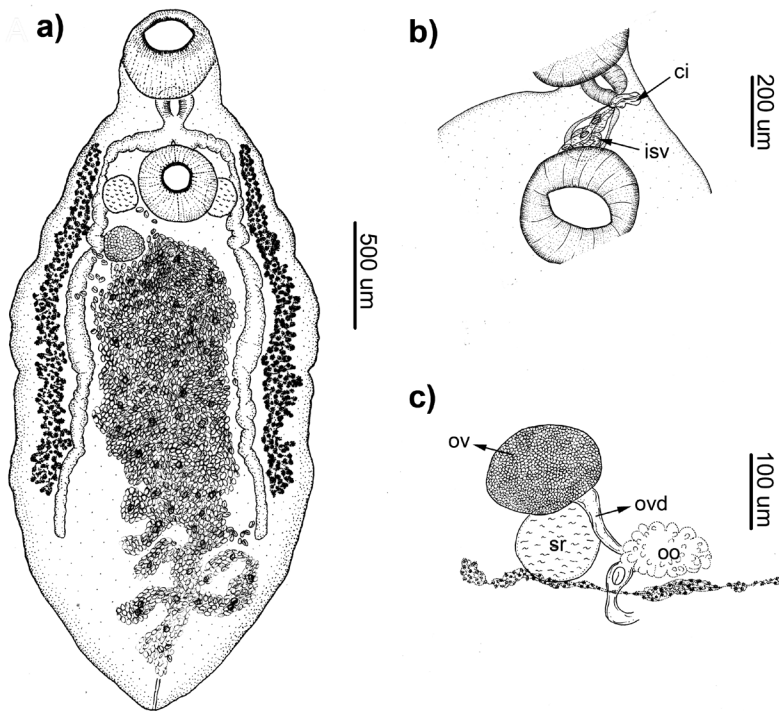
RT: Right testis; LT: left testis. Measurements from <sup>c</sup> Sutton (1983) in *O. rufus*.

**Remarks:** Only two nominal species are located in *Platynosomoides*: *P. muris* (Shcherbakova 1942) and *P. verschureni* (Baer 1901) (Pojmańska 2008) (Table II). *Platynosomoides lunaschiae* sp. nov. is distinguished from these two species by the body length (1.79-2.84 vs. 3.27-3.41; 3-4.5, respectively), length and width of testis (0.06-0.20 x 0.05-0.18 vs. 0.24-0.41 x 0.25-0.36; 0.32 x 0.23, respectively). The ovary in the new species is smaller than in *P. muris* (0.09-0.18 vs.

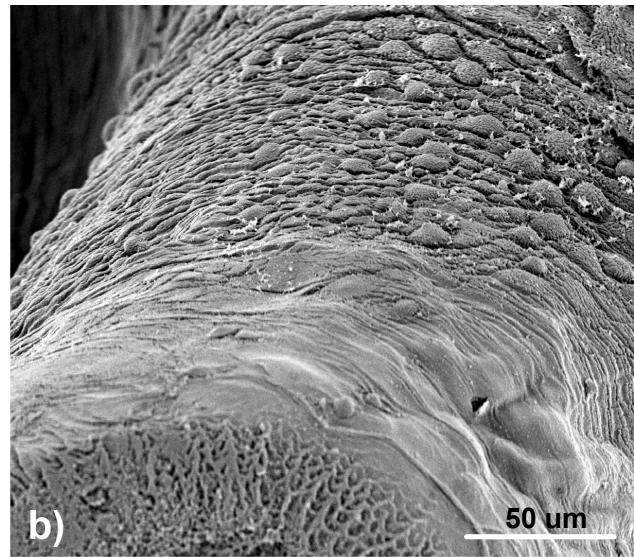
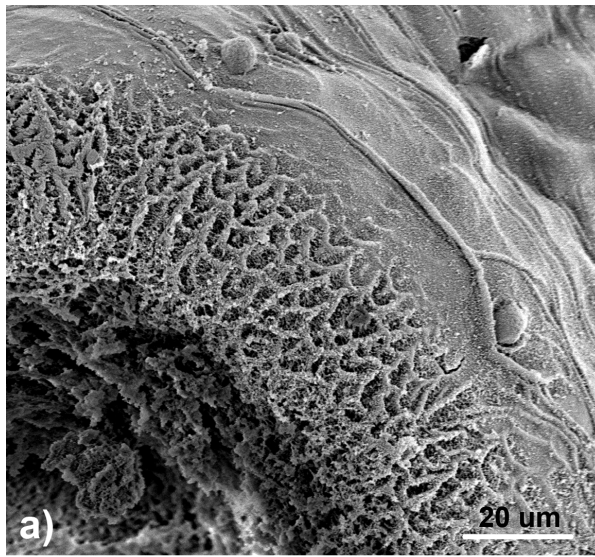
0.23-0.24). Also, in the new species the ovary and testis have similar size, whereas in *P. muris* the testes are larger than the ovary. In addition, *P. lunaschiae* sp. nov. has ceca and vitelline bands extending to three-quarters of the body, while in *P. muris* the ceca extend to the end of the body and the vitelline bands reach up to two-thirds of the body, and in *P. verschureni* the ceca and vitelline bands extend up to the middle of the body.

**Table II. Morphological features and measurements (mm) of *Platynosomoides* species.**

Species	<i>Platynosomoides muris</i>	<i>Platynosomoides verschureni</i>	<i>Platynosomoides lunaschiae</i> sp. nov.
Author	(Stcherbakova 1942)	(Baer 1959)	This paper
Species hosts	<i>Apodemus sylvaticus</i> ; <i>Leopoldamys siporanus</i> (Muridae)	<i>Crocidura olivieri</i> (Soricidae)	<i>Akodon montensis</i> (Cricetidae)
Country	Armenia; Russia; Malaysia	Democratic Republic of the Congo	Argentina
Continent	Asia	Africa	America
Site of infection	Liver	Bile duct	Bile duct
Body length	3.27-3.41	3.00-4.50	2.18 ± 0.33 (1.79-2.84)
Body width	1.22-1.80	0.71-0.90	1.16 ± 0.21 (0.92-1.59)
Oral sucker diameter max	0.23-0.27	0.25	0.31 ± 0.05 (0.19-0.39)
Oral sucker diameter min	0.22	0.23	0.29 ± 0.06 (0.21-0.38)
Ventral sucker diameter max	0.28	0.39-0.41	0.38 ± 0.06 (0.29-0.48)
Ventral sucker diameter min	0.25	-	0.34 ± 0.06 (0.23-0.44)
Cirrus sac length	0.23-0.28	0.23-0.26	0.22
Cirrus sac width	-	0.06-0.14	0.10
Pharynx length	-	0.14-0.15	0.13 ± 0.01 (0.11-0.15)
Pharynx width	-	0.12-0.14	0.12 ± 0.01 (0.09-0.13)
Right testis length	0.24-0.41	0.32	0.16 ± 0.03 (0.07-0.20)
Left testis length	0.24-0.41	0.32	0.14 ± 0.03 (0.06-0.18)
Right testis width	0.25-0.36	0.23	0.15 ± 0.03 (0.06-0.18)
Left testis width	0.25-0.36	0.23	0.13 ± 0.02 (0.05-0.15)
Ovary length	0.16-0.18	-	0.14 ± 0.03 (0.11-0.20)
Ovary width	0.23-0.24	0.18	0.12 ± 0.02 (0.09-0.18)
Eggs length	0.030-0.035	0.032-0.034	0.032 ± 0.001 (0.029-0.034)
Eggs width	0.018-0.020	0.018-0.021	0.017 ± 0.002 (0.014-0.020)



**Figure 1.** Drawing of *Platynosomoides lunaschiae* sp. nov. a) Complete adult specimen, ventral view. b) Detail of cirrus sac, with internal seminal vesicle (isv) and cirrus (ci). c) Detail of the ovarian complex, showing ovary (ov), oviduct (ovd), seminal receptacle (sr) and ootype (oo).



**Figure 2.** SEM images of *Platynosomoides lunaschiae* sp. nov. a), b) Details of tegument papillae, lateral view.

**DISCUSSION**

Dicrocoeliidae shows a high morphological diversity with 18 genera parasitizing mammals of the Americas, 11 of them in rodents (McIntosh 1939, Neidert & Ralph 1968, Lamothe-Argumedo et al. 2005, Pojmańska 2008, Fernandes et al. 2015, Panisse et al. 2017). Nine of these

genera were registered from the Neotropical region: *Athesmia* Looss 1899, *Caballerolecythus* Lamothe-Argumedo, Falcón-Ordaz, García-Prieto & Fernandez-Fernandez 2005, *Canaania* Travassos 1944, *Conspicuum* Bhalerao 1936, *Dicrocoelium* Dujardin 1845, *Platynosomoides* Yamaguti 1971, *Platynosomum* Looss 1907,

*Yungasicola* Gardner & Pérez-Ponce de León 2002, and *Zonorchis* Travassos 1944.

Dicrocoelids of American rodents are distributed in five host families: Cricetidae, Echimyidae, Heteromyidae, Muridae, and Myocastoridae, the first being the most frequent (Sutton 1983, Sutton & Damborenea 1996, Navone et al. 2009, Fernandes et al. 2015, Panisse et al. 2017, Guerreiro Martins et al. 2019b). Six dicrocoelid species (*Canaania obesa* Travassos 1944, *Conspicuum minor* Mañé-Garzón & Holcman-Spector 1975, *Conspicuum pulchrum* (Travassos 1919), *Platynosomoides* sp., *Yungasicola travassosi* Gardner & Pérez-Ponce de León 2002, *Zonorchis oxymycterae* Sutton 1983) were recorded parasitizing Akodontini rodents (Cricetidae) (Travassos et al. 1969, Sutton 1983, Sutton 1998, Maldonado Junior et al. 2010 Panisse et al. 2017).

Four dicrocoelid species have been recorded parasitizing the genus *Akodon*: *C. obesa* from *A. azarae*, *Akodon cursor* (Winge 1887) and *A. montensis* in Argentina and Brazil; *Platynosomoides* sp. from *A. montensis* in Argentina (Maldonado Junior et al. 2010 Panisse et al. 2017, Guerreiro Martins et al. 2019b); *Y. travassosi* from *Akodon fumeus* Thomas 1902 in Bolivia (Gardner & Pérez-Ponce de León 2002); and *Z. oxymycterae* from *A. azarae* in Argentina (Sutton 1983). Although *Platynosomoides* sp. was mentioned by Panisse et al. (2017) as the first record of this genus in Cricetidae and in America, no description was provided. Notably, the genus *Platynosomoides* has been reported parasitizing only two families of rodents, Muridae from Asia, and Soricidae from Africa (Stcherbakova 1942, Baer 1959).

The main morphological differences between *P. lunaschiae* sp. nov. and the other three dicrocoelid species reported from *Akodon* spp. are the distribution and length of the vitelline bands, and the position of the testes.

The new species is distinguished from *C. obesa* and *Z. oxymycterae* by the size of the ventral and oral suckers. *Platynosomoides lunaschiae* sp. nov. is also differentiated from *Y. travassosi* by cecum length and the size of the uterus. *Platynosomoides lunaschiae* sp. nov. was found in four geographic localities of the Atlantic Forest in Misiones Province, with low prevalence similar to those recorded for other dicrocoelids in the *Akodon* species (Navone et al. 2009, Maldonado Junior et al. 2010, Simões et al. 2011).

To date, few molecular studies have been performed on dicrocoelid species parasitizing rodents in the Americas (Table I). The only three species with data available in GenBank are *Dicrocoelium dendriticum*, *Lyperosomum intermedium* Denton & Kinsella 1972, and *Platynosomum illiciens* (Braun 1901) (Martínez-Ibeas et al. 2011, Pinto et al. 2018, Hildebrand et al. 2019). Regarding the new species, despite extracting DNA, no molecular results were obtained, possibly due to inadequate conservation of the specimens. However, the morphological and morphometric comparison of the present specimens and the previously described species support the erection of a new species.

The taxonomy of the Dicrocoeliidae has been controversial, with many species being transferred from one genus to another. For example, Pojmańska (2008) suggested the synonymy of *Zonorchis* with *Skrjabinus*. However, considering the position of the reproductive organs and the morphology and size of the ventral sucker, the present study considers both genera as valid, following Sitko (2013) and Hildebrand et al. (2019). In turn, Nguyen & Pham (2004) suggested that *Platynosomoides muris* should be transferred to the genus *Dictyonograptus*. This paper does not follow that proposal, since that species presents diagnostic features of *Platynosomoides* that agree with Pojmańska



(2008), such as vitelline bands extending from ventral sucker level to far beyond the ovary. *Platynosomoides verschureni* was originally described in the genus *Platynosomum* (Baer 1959), and Yamaguti (1971) later suggested that it should be referred to as *Platynosomoides*. Pojmańska (2008) agrees with this proposal, including the geographic distribution of the two species within the *Platynosomoides* genus.

Digenean-host associations occur within a complex system of biotic and abiotic factors. Three types of life cycle have been suggested for the family Dicrocoeliidae (Pojmańska 2008). Ecological aspects of the *Platynosomoides* species, such as dispersal ability, survival conditions, and adequate hosts, have not yet been studied. However, considering that the host species are terrestrial and omnivorous, feeding mainly on green vegetation, leaves, fruit, seeds, and arthropods (Houemenou et al. 2014, Latinne et al. 2014, Pardiñas et al. 2017, Schlitter et al. 2021), some invertebrates, such as mollusks and arthropods, may act as intermediate hosts of *P. lunaschiae* sp. nov. as occurs in other dicrocoelid species.

To date, *Athesmia heterolecithodes* (Braun 1899), *Canaania obesa*, *Conspicuum minor*, *Dicrocoelium dendriticum* (Rudolphi 1819), *Platynosomoides lunaschiae* sp. nov. and *Zonorchis oxymycterae* are the only Dicrocoeliidae of rodents recorded from Argentina (Martínez & Binda 1992, Sutton 1998, Martino et al. 2012, Panisse et al. 2017, Guerreiro Martins et al. 2019b). The records show a growth in knowledge of the diversity of digeneans from rodents in recent years. This is encouraging, since it may indicate that this increase is related to greater interest of taxonomists in these less-explored groups of helminths. This study provides an updated compilation of dicrocoelid species parasitizing rodents in the Americas with the description of a new species

of *Platynosomoides* from the Atlantic Forest, enlarging the host and geographic distribution for this family of Digenea.

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NBGM, GP and MRR collected the host specimens together with specialists in mammals and parasites (see Acknowledgments). NBGM, GP and MRR examined the viscera of specimen hosts. NBGM and GP contributed to data collection of the parasite specimens. NBGM, GP, MRR, JID and GTN identified the species. All authors discussed the result and contributed to the final manuscript.

