Revista Mexicana de Biodiversidad

Revista Mexicana de Biodiversidad 91 (2020): e913287

Taxonomy and systematics

Helminths from Sigmodontinae rodents (Muroidea: Cricetidae) in Humid Chaco ecoregion (Argentina): a list of species, host and geographical distribution

Helmintos de roedores Sigmodontinae (Muroidea: Cricetidae) en la ecorregión del Chaco Húmedo (Argentina): lista de especies, hospedadores y distribución geográfica

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Received: 14 November 2019; accepted: 8 May 2020

Abstract

The aims of this paper were to list the helminths from sympatric rodent species (Muroidea, Cricetidae) in Corrientes city, Humid Chaco ecoregion, Argentina and summarise the record and ecological data on six host species. Fourteen species of helminths were found in 6 rodent assemblages. Five new hosts and 12 new geographical reports from Humid Chaco ecoregion are provided. The higher prevalence values corresponded to *Stilestrongylus stilesi*, *Hassalstrongylus mazzai*, *H. argentinus and Mazzanema fortuita*, and the higher mean abundance and mean intensity values corresponded to *S. stilesi* from *Necromys lasiurus*. Nippostrongylinae was the dominant group within each host species. The ecological descriptors of component communities are given. The highest value of richness index was observed for *N. lasiurus* (S = 6). The diversity index reached values between the range 1.11 in *Holochilus chacarius* and 0.16 in *Akodon azarae*. The equitability index shows the highest values for *Oligoryzomys flavescens* (0.96) and *H. chacarius* (0.81). The highest value index of dominance of Berger-Parker was observed for *A. azarae* (0.96) followed by *N. lasiurus* (0.86). This study contributes to the taxonomic and ecological of the parasite-host relationships, providing substantial information to one of the ecoregions most affected by anthropic actions in Argentina.

Keywords: Acanthocephala; Cestoda; Corrientes; Nematoda

ISSN versión electrónica: 2007-8706; Universidad Nacional Autónoma de México, Instituto de Biología. https://doi.org/10.22201/ib.20078706e.2020.91.3287

Resumen

Los objetivos de este trabajo fueron presentar una lista de helmintos de especies de roedores simpátricos (Muroidea, Cricetidae) de la ciudad de Corrientes, ecorregión del Chaco Húmedo, Argentina, y recopilar registros y datos ecológicos de las especies hospedadoras. Catorce especies de helmintos fueron hallados en un ensamble de 6 roedores. Cinco nuevos hospedadores y 12 nuevos registros geográficos son reportados para la región del Chaco Húmedo. El mayor valor de prevalencia corresponde a *Stilestrongylus stilesi*, *Hassalstrongylus mazzai*, *H. argentinus* y *Mazzanema fortuita*, y los mayores valores de abundancia media e intensidad media corresponde a *S. stilesi* de *Necromys lasiurus*. Los Nippostrongylinae fue el grupo dominante en todas las especies de roedores. Se presentan los descriptores ecológicos de la comunidad componente (riqueza, número total de especímenes parásitos, índice de diversidad, equitatibilidad y dominancia). El valor más elevado del índice de riqueza fue observado para *N. lasiurus* (S = 6). El índice de diversidad alcanzó valores entre 1.11 en *Holochilus chacarius* y 0.16 in *Akodon azarae*. El índice de equitatibilidad presentó valores mayores para *Oligoryzomys flavescens* (0.96) y *H. chacarius* (0.81). Los valores más altos de dominancia de Berger-Parker fueron observados en *A. azarae* (0.96), seguido por *N. lasiurus* (0.86). El presente trabajo contribuye al estudio taxonómico y ecológico de las relaciones parásito-hospedador, proporcionando información sustancial a una de las ecorregiones más afectadas por las acciones antrópicas en Argentina.

Palabras clave: Acanthocephala; Cestoda; Corrientes; Nematoda

Introduction

Parasite biodiversity can be studied at different levels. The levels can be at the host individual, at the host species, or the community hosts, or by geographic areas (Poulin & Morand, 2004). The subfamily Sigmodontinae is endemic of the American continent and includes around 400 living species (Patton et al., 2015); and approximately 110 species are recognized for Argentina (Galliari et al., 1996; Pardiñas et al., 2006; Teta et al., 2018). Since these rodents present a wide diversity in their diets, high taxonomic complexity, wide geographic distribution, variety of microhabitats and particular intraspecific behavior, they are excellent models to evaluate their parasitic fauna (D'Elía, 2003; Pardiñas et al., 2006).

Corrientes city is located in the Humid Chaco ecoregion. This is one of the ecoregions most affected by anthropic actions in Argentina; the transformation of the landscape is constant. As a result, biological diversity suffers a permanent decrease (Burkart, 2006).

In Argentina, studies on parasites from Sigmodontinae rodents are primarily focused on description of species or redescription of species (Digiani et al., 2003, 2012; Notarnicola, 2005; Notarnicola et al., 2002; Robles, 2011; Robles & Navone, 2007a, b). Only a few studies have been conducted on host and geographical distribution of helminthspecies from rodents, one associated with the wetlands of the Río de la Plata in Delta e Islas del Paraná ecoregion (Buenos Aires province) and other with the Selva Paranaense ecoregion (Misiones province) (Navone et al., 2009; Panisse et al., 2017); and only one describes the helminths from a common rodent, *Akodon azarae*, from an agroecosystem in Buenos Aires province (Miño et al., 2018).

Although some authors have studied helminths species from a few species of rodents distributed in different ecoregions of Corrientes province (Guerreiro-Martins et al., 2015; Notarnicola, 2004; Robles & Navone, 2010, 2014), it is necessary to make progress on their knowledge as soon as possible, since the marked phenomenon of agriculture and urbanization is significant in the northeast of Argentina, and the loss of natural habitats is a great threat to biodiversity (Hanski, 2011).

The aims of this paper were to list the helminths from sympatric rodent species (Muroidea, Cricetidae) in Corrientes city located on Humid Chaco ecoregion, Argentina and summarise the record and ecological data on 6 host species.

Materials and methods

This study was carried out in 2 localities in Humid Chaco ecoregion: Corrientes city (27º28' S, 58º50' W) and San Cayetano village (27°34'15" S, 58°41'41" W), Corrientes province, Argentina. This ecoregion is extended from the east of Chaco and Formosa, to the north of Santa Fe and Corrientes provinces. This area is characterized by subtropical climate without dry season and an extremely flat plain, with very gentle slopes in the west-east direction (Brown et al., 2006).

Rodents samplings were conducted in the years 2011, 2013 and 2014, in 2 seasons: cold (Autumn-Winter) and warm (Spring-Summer). The samples were performed in the 2 localities characterized by woodland, riparian thickets, freshwater marshes and flooded grasslands. The vegetation consists of patches of herbs, shrubs and small woody species (García et al., 2013). Rats were captured in live traps and pitfall traps. Live traps were baited with

oatmeal mixed with vanilla essence. The trapping was carried out over the period of 6 days in 2011 and over 10 days during the fall and winter in 2013 and 2014 with a sampling effort of 1300 trap nights (sampling effort of 300 trap nights in 2011, 500 in 2013 and 500 in 2014 in both localities) (Jones et al., 1996).

The research was conducted in compliance with Argentine laws. Sample collection was carried out during fieldwork under official permits granted by the Dirección de Flora y Fauna, Ministerio de Turismo de Corrientes. This study was carried out following the recommendations in the Guide for the Care and Use of Laboratory Animals of the National Institutes of Health. The specimens, obtained using methods for live capture, were studied and sacrificed following the procedures and protocols suggested by AVMA Guidelines on Euthanasia (2013) and approved by national laws (Animal Protection National Law 14.346 and references in the provincial permits) and by the Ethics Committee for Research on Laboratory Animals, Farm and Obtained from Nature of the National Council of Scientific and Technical Research (CONICET) and, subsequently, by the Science and Technology Secretary of Universidad Nacional del Nordeste (UNNE), Argentina (F008/09). No endangered species were involved in this study.

The rodents' abdominal cavity, liver, stomach, small and large intestine and cecum were examined for parasites. Helminths were fixed in 5% formalin and preserved in 70% ethanol. The nematods were cleared with lactophenol, whereas cestods and acanthocephalans were stained with hydrochloric carmine, dehydrated through an alcohol series, cleared in eugenol, mounted in Canada balsam and studied by light microscopy. Helminths were identified following the keys from Anderson et al. (2009) and Gibbons (2010) for Nematoda, Khalil et al. (1994) for Cestoda, Yamaguti (1963) for Acanthocephala, among other specific literature. The nomenclature followed Durette-Desset and Chabaud (1993), and Durette-Desset and Digiani (2012) for Strongylida (Nematoda).

Helminth specimens were deposited in the Parasitological Collection of the Facultad de Ciencias Exactas y Naturales y Agrimensura (UNNEPhel), Corrientes, and in the Helminthological Collection of the Museo de La Plata (MLP-He), La Plata, Buenos Aires, Argentina. Rodent specimens will be deposited in the Mammal Collection of the Centro Nacional Patagónico (CNP) (numbers in process), Puerto Madryn, Chubut province, Argentina.

Relative density index (RDI) for each host was calculated. Prevalence (P), mean abundance (MA) and mean intensity (MI) of each component population were calculated (Bush et al., 1997). Relative dominance (RD) of each infracommunity was estimated (Rohde et al., 1995). The specific richness (S), total number of specimens of parasites (TNP), the Shannon and Wiener diversity index (H'), the equitability index (E) and simple dominance index of Berger-Parker (D) (Magurran, 2004) of each community were calculated using the PAST program of Hammer et al. (2001).

Results

A total of 14 species composed by Nematoda (Heligmonellidae, Onchocercidae, Rictulariidae, Oxyuridae), Cestoda (Hymenolepididae, Taeniidae) and Acanthocephala (Moniliformidae) were recovered from 89 rodents of the following species: *Akodon azarae* (Fischer) (n = 7), *Necromys lasiurus* (Lund) (n = 40), *Oxymycterus rufus* (G. Fischer) (n = 23) (Tribe Akodontini); *Holochilus chacarius* (Thomas) (n = 2), *Oligoryzomys flavescens* (Waterhouse) (n = 15), *O. nigripes* (Olfers) (n = 2) (Tribe Oryzomyini).

Table 1 shows the helminth species with their respective ecological data. Five new host records and 12 new locality records are provided.

Phylum Nematoda Rudolphi, 1808
Class Secernentea Von Linstow, 1905
Order Strongylida Diesing, 1851
Superfamily Heligmosomoidea Travassos, 1914
Family Heligmonellidae Skrjabin and Schikobalova, 1952
Subfamily Nippostrongylinae Durette-Desset, 1971
Genus *Stilestrongylus* Freitas, Lent and Almeida, 1937
Stilestrongylus sp.

Description. Species of *Stilestrongylus* are, with only one exception, parasites of Sigmodontinae, and are characterized by a dissymmetrical caudal bursa, a hypertrophied genital cone (65 × 68 mm) and a synlophe with more than 24 subequal ridges at mid-body. However, the following combination of characters: synlophe with 29-31 ridges, bursa with a pattern of type 2-2-1, spicules with a subterminal projection, and females with non-invaginated tail, does not allow, at first sight, the assignment of these specimens to any of the known species of the genus. A deeper study of the specimens is needed before a specific assignment can be made.

Taxonomic summary

Material examined: *Oligoryzomys flavescens* and *Oligoryzomys nigripes*

Deposited specimens: UNNEPhel 150

Site of infection: small intestine.

Table 1
Ecological descriptors of the component population.

Host species	*Akodon azarae* (n = 7)				*H. chacarius* (n = 2)				*N. lasiurus* (n = 40)				*O. flavescens* (n = 15)				*O. nigripes* (n = 2)				*O. rufus* (n = 23)			
Parasite species	P	MI	MA	RD	P	MI	MA	RD	P	MI	MA	RD	P	MI	MA	RD	P	MI	MA	RD	P	MI	MA	RD
S. stilesi	57	57.5	32.8	96.2	100	20.5	20.5	27.1	92.5	126.3	120	86												
Stilestrongylus sp.													80	101.5	81.2	60.7	50	238	119	81.2				
H. mazzai					100	41.5	41.5	54.9																
H. argentinus					100	7	7	9.2																
M. fortuita					100	6.5	6.5	8.6																
S. delta																					13	9.8	5.1	74.2
S. alata									65	18.6	17.7	12.6												
S. kinsellai													80	65.5	52.4	39.2	50	55	27.5	18.7				
S. carlitosi	28	2.2	1.2	3.7																				
P. zygodontomys†									25	0.9	0.8	0.6												
L. oxymycteri†																					13	1.5	0.8	11.9
R. akodontis†									20	0.9	0.8	0.6									43	1.8	0.9	13.8
T. taeniaeformis‡									2.5	0.02	0.02	0.01												
Moniliformis sp.†									2.5	0.07	0.07	0.05												

Abbreviations. P: Prevalence, MA: mean abundance, MI: mean intensity, and RD: relative dominance of each helminth species. †Helminths with heteroxenous life cycle. ‡ Strobilocercus larva.

Remarks

There are 26 species of *Stilestrongylus* described to date. In Argentina, 14 species of *Stilestrongylus* were mentioned from different hosts and ecoregions. In *O. flavescens* were reported*: Stilestrongylus flavescens* Sutton & Durette-Desset 1991 and *Stilestrongylus oryzomysi* Sutton & Durette-Desset 1991, both in the Delta e Islas del Paraná ecoregion (Navone et al., 2009; Sutton & Durette-Desset, 1991). Whereas in *O. nigripes* were reported: *S. flavescens* and *Stilestrongylus lanfrediae* Souza, Digiani, Simões, Luque, Rodrigues-Silva & Maldonado Jr., 2009, in the Delta e Islas del Paraná and Selva Paranaense ecoregions respectively (Navone et al., 2009; Panisse et al., 2017). Humid Chaco represents a new ecoregion record for this taxon.

Stilestrongylus stilesi Freitas, Lent and Almeida, 1937

Description. The morphological characters observed in the specimens mostly agree with the original description and subsequent redescription given by Notarnicola et al. (2010), i.e., synlophe with 29-31 subequal ridges; males with bursa dissymmetrical with right lobe larger, bursal pattern of type 2-3 on the right lobe and 2-2-1 on the left lobe, particular morphology of right ray 5 hypertrophied and with reinforced margins, genital cone characteristically curved and hypertrophied 137.8 × 58 ± 19.1 µm, spicules 740-970 µm long, and gubernaculum 37 ± 7 µm long and 23.3 ± 6.1 µm wide, females monodelphic, with vulva situated at 78.7 ± 16 µm from caudal extremity, tail 50.5 ± 12.3 µm long, and eggs 57.8 ± 8.5 µm long and 32.3 ± 3.5 µm wide.

Taxonomic summary

Material examined: *Necromys lasiurus, Holochilus chacarius* and *Akodon azarae*.

Deposited specimens: UNNEPhel 149.

Site of infection: small intestine.

Remarks

Stilestrongylus stilesi is the type species of the genus *Stilestrongylus* Freitas, Lent & Almeida 1937, and was originally described parasitizing *Holochilus chacarius* from the locality of San Martín de Tabacal, in the Orán Departament, Salta province, Argentina, and was redescribed by Notarnicola et al. (2010) on material from the same host species and locality. This is the first record of *S. stilesi* in *Akodon azarae* and *Necromys lasiurus* and for Humid Chaco ecoregion, enlarging the host and geographical range of the species.

Genus *Suttonema* Digiani & Durette-Desset, 2003

Suttonema delta Digiani & Durette-Desset, 2003

Description. The morphological characters of the specimens agree with the original description given by Digiani and Durette-Desset (2003), i.e., synlophe at mid-body with 9-12 ridges of 2 different types (small, rounded ridges without cuticular support on the dorsal side, pointed ridges of unequal size with cuticular struts on the ventral side and in lateral fields), presence of comaretes on the left ventral and ventral fields, males with bursa dissymmetrical with hypertrophied right lobe and pattern of type 1-4, and spicules 290 µm long, females monodelphic, with vulva situated at 77.5 ± 67.9 µm from caudal extremity, tail 54.5 ± 56.7 µm long, and eggs 46.8 ± 12 µm long and 24.3 ± 5.6 µm wide.

Taxonomic summary

Material examined: *Oxymycterus rufus*
Deposited specimens: UNNEPhel 154
Site of infection: small intestine.

Remarks

This species was described by Digiani and Durette-Desset (2003), as the type species of the genus *Suttonema* Digiani & Durette-Desset 2003, parasitizing *Oxymycterus rufus* from the locality of Isla Talavera, Buenos Aires province, Argentina. *Suttonema* sp. was reported from *Oxymycterus rufus* by Navone et al. (2009). The present finding is the first record of the species for the Humid Chaco ecoregion, enlarging its geographical range.

Genus *Hassalstrongylus* Durette-Desset, 1971
Hassalstrongylus mazzai (Freitas, Lent & Almeida, 1937)
(= *Heligmonoides mazzai* Freitas, Lent & Almeida, 1937)

Description. These specimens have been assigned to *H. mazzai* in accordance with the description given by Freitas et al. (1937) and subsequent redescriptions, i.e., synlophe with 19 unequal ridges at mid-body, males with bursa usually fully opened, slightly dissymmetrical, with right lobe more or less longer than left lobe and dorsal lobe reduced, spicules thin, subequal, alate, 185-190 µm long, ending in simple pointed tips, females monodelphic, with vulva situated at 79 ± 12.7 µm from caudal extremity, tail 58 ± 10.3 µm long, and eggs 51.5 ± 9.4 µm long and 26.2 ± 5 µm wide.

Taxonomic summary

Material examined: *Holochilus chacarius*
Deposited specimens: UNNEPhel 151
Site of infection: small intestine.

Remarks

This species was formerly described by Freitas et al. (1937) (as *Heligmonoides mazzai*) parasitizing *Holochilus chacarius* from the locality of San Martín de Tabacal, Orán Departament, Salta province, Argentina. Durette-Desset (1971) proposed the combination *Hassalstrongylus mazzai* although without studying the synlophe. Finally, Digiani et al. (2015), based on new material from the type host species and type locality, redescribed the species, providing characters of the synlophe in both sexes, and designated neotypes, since the original type material was unavailable. These latter authors also recorded the species in the locality of Selvas del Río de Oro, Libertador General San Martín Departament, Chaco province, Argentina. These findings extend the distribution to a new locality in Humid Chaco ecoregion.

Hassalstrongylus argentinus (Freitas, Lent & Almeida, 1937)
(= *Longistriata argentina* Freitas, Lent & Almeida, 1937)

Description. These specimens have been assigned to *H. argentinus* in accordance with the description given by Freitas et al. (1937) and subsequent redescriptions, i.e., synlophe with 19-21 ridges at mid-body, males with bursa subsymmetrical or slightly dissymmetrical with right lobe larger and dorsal lobe developed, usually folded ventrally, spicules thick, subequal, with spicule tips simple, females monodelphic, with vulva situated at 77.2 ± 16.6 µm from caudal extremity, tail 60.3 ± 11.4 µm long, and eggs 53 ± 3,5 µm long and 30.3 ± 3.8 µm wide.

Taxonomic summary

Material examined: *Holochilus chacarius*
Deposited specimens: UNNEPhel 152
Site of infection: small intestine.

Remarks

This species was formerly described by Freitas et al. (1937) (as *Longistriata argentina*) parasitizing *Holochilus chacarius* from the locality of San Martín de Tabacal, Orán Departament, Salta, Argentina. Durette-Desset (1971) proposed the combination *Hassalstrongylus argentinus* based on the description of the synlophe on one male type (Durette-Desset, 1968). Finally, Digiani et al. (2015), based on new material from the type host species and type locality, provided the description of the synlophe in both sexes. These authors also provided a new locality record from Selvas del Río de Oro, Departamento Libertador General San Martín, Chaco province, Argentina. These findings extend the distribution to a new locality in Humid Chaco ecoregion.

Genus *Mazzanema* Digiani, Notarnicola & Paulos, 2013
Mazzanema fortuita (Freitas, Lent & Almeida, 1937)
(= *Longistriata fortuita* Freitas, Lent & Almeida, 1937)

Description. These specimens have been assigned to *M. fortuita* in accordance with the description given by Freitas et al. (1937), and subsequent redescriptions, i.e., synlophe with 14-19 ridges unequal in size at mid-body, males with bursa subsymmetrical, with dorsal lobe well developed, usually closed and difficult to spread out, spicules subequal, alate, ending in simple, pointed tips, gubernaculum 25 ± 5.4 µm long and 13.3 ± 4 µm wide, females monodelphic, with vulva situated at 109 ± 20.7 µm from caudal extremity, tail 50.6 ± 10.3 µm long, and eggs 60 ± 7.4 µm long and 33.8 ± 6.5 µm wide.

Taxonomic summary

Material examined: *Holochilus chacarius*
Deposited specimens: UNNEPhel 153
Site of infection: small intestine.

Remarks

This species was formerly described by Freitas et al. (1937) (as *Longistriata fortuita*) on a single male parasitizing this same host from San Martín de Tabacal, Orán, Salta Departament, Argentina. Digiani et al. (2013), based on new material obtained from the type host species and type locality, redescribed the species, providing a complete description of the female and the synlophe in both sexes, at the time that proposed the combination *Mazzanema fortuita* and designated neotypes for the species. The present finding constitutes the first report for Humid Chaco ecoregion, Argentina.

Order Oxyurida Chabaud, 1974
Superfamily Oxyuroidea Cobbold, 1864
Family Oxyuridae Cobbold, 1864
Genus *Syphacia* Seurat, 1916
Syphacia alata Quentin, 1968

Description. The morphological characters observed in the specimens agree with the original description given by Quentin (1968), i.e., cephalic plate rounded in the male and elongated laterally in the female, absence of deirids in both sexes, cervical alae well developed in females and absent in males, males with 3 equidistant cuticle mamelons, accessory hook of the gubernaculum fully ornamented, spicule 75 ± 5.5 µm long and gubernaculum 35 ± 5 µm long, females with vulva not protrusive, tail 821 ± 240 µm long, and eggs elliptical, operculated, 99 ± 4 long and 29 ± 2 µm wide.

Taxonomic summary

Material examined: *Necromys lasiurus*
Deposited specimens: UNNEPhel 155
Site of infection: large intestine and caecum.

Remarks

The present species was originally described from *N. lasiurus* and cited for *O. nigripes* and *Sigmodontomys alfari* (Allen) from Brazil (Quentin, 1968, 1969). In Argentina, it was mentioned for *N. lasiurus* from Corrientes, Formosa, Misiones, Santa Fe and Buenos Aires provinces as well as in *Thaptomys nigrita* (Lichtenstein) from Misiones (Panisse et al., 2017; Robles, 2010). The present finding is a new locality in Humid Chaco ecoregion.

Syphacia carlitosi Robles & Navone, 2007

Description. The specimens were identified as *Syphacia carlitosi* by the morphological characters mentioned by Robles & Navone (2007a), i.e., cephalic plate laterally elongated, absence of deirids in both sexes, cervical alae well developed present in females, ?? with 3 mamelons not equidistant, accessory hook of gubernaculum with ornamentation on lateral edges and tail relatively long, females with vulva not protrusive, tail 470 ± 381 µm long, and eggs elliptical, operculated, 99.5 ± 49 lond and 3.3 ± 2.8 µm wide.

Taxonomic summary

Material examined: *Akodon azarae*
Deposited specimens: UNNEPhel 157
Site of infection: large intestine and caecum.

Remarks

This species was formerly described parasitizing *Akodon azarae* from El Colorado, Formosa, and later from other congeneric rodents and several localities in Entre Ríos, Buenos Aires, Santa Fe, Misiones and Corrientes (Panisse et al., 2017; Robles & Navone 2007a), as well as from Brazil (Simões et al., 2011). These findings extend the distribution to a new locality in Humid Chaco ecoregion.

Syphacia kinsellai Robles & Navone, 2007

Description. These specimens were assigned to the specie *Syphacia kinsellai* in agree with the original description given by Robles and Navone (2007b), i.e., cephalic plate laterally elongated, presence of deirids in females, absence of cervical and lateral alae, males with 3 equidistant cuticle mamelons, accessory hook of the gubernaculum fully ornamented, spicule 130 ± 3.8 µm long and gubernaculum 60.9 ± 5.8 µm long, females with vulva not protrusive, tail 686.3 ± 98.7 µm long, and eggs elliptical, operculated, 108.5 ± 3.9 long and 35.7 ± 2.6 µm wide.

Taxonomic summary

Material examined: *Oligoryzomys flavescens* and *Oligoryzomys nigripes*

Deposited specimens: UNNEPhel 156

Site of infection: stomach, small intestine, large intestine and caecum.

Remarks

This species was described from *Oligoryzomys nigripes* in 2 localities of Misiones province, Argentina (Robles & Navone, 2007b). Also, *S. kinsellai* was recorded in the same host species from Brazil (Simões et al., 2011). *Oligoryzomys flavescens* represents a new host record, and a new locality record in Humid Chaco ecoregion.

Order Spirurida Chitwood, 1933
Superfamily Rictularioidea Hall, 1913
Family Rictulariidae Railliet, 1916
Genus *Pterygodermatites* Wedl, 1861
Pterygodermatites (Paucipectines) cf *zygodontomis* Quentin, 1967

Description. In the present study, only female specimens have been obtained. The morphological characters observed in the specimens agree with the original description given by Quentin (1967) and redescription by Costa et al. (2017), i.e., triangular apical oral opening, 6 labial papillae, amphids between lateral and dorsal labial papillae and presence of 3 esophageal teeth, esophagus 2.7 ± 0.3 mm long divided into glandular and muscular portions, presence of 2 rows of 80 ventral cuticular spines in females and 41 in males, 9 pairs of caudal papillae and phasmids between eighth and nineth pair of papillae, vulva situated at 3.2 ± 0.5 mm from anterior extremity, eggs 36.7 ± 3.3 µm long and 28.4 ± 2.3 µm wide.

Taxonomic summary

Material examined: *Necromys lasiurus*

Deposited specimens: UNNEPhel 158

Site of infection: small intestine.

Remarks

Pterygodermatites zygodontomis was originally described by Quentin (1967) from *N. lasiurus* collected in Brazil. Later, Quentin (1969) suggested the subgenus *Pterygodermatites* (*Paucipectines*) based on the morphology of the apical mouth and genital papillae. In the Neotropical region, 11 species were included in this subgenus. In Argentina, 6 species were described, 4 from edentates and marsupials: *P.* (*P) chaetophracti* Navone & Lombardero, 1980, *P.* (*P) argentinensis* Ezquiaga et al., 2017, *P.* (*P.) kozeki* Chabaud & Bain, 1981 and *P.* (*P.) spinicaudatis* Navone & Suriano, 1992, and 2 from sigmodontine rodents: *P. (P) massoiai* Sutton, 1979 and *P.* (*P) azarai* Sutton, 1984. This is the first record of this species in *Necromys lasiurus* from Argentina.

Superfamily Filarioidea Weinland, 1858
Family Onchocercidae Leiper, 1911
Genus *Litomosoides Chandler, 1931*
Litomosoides oxymycteri Notarnicola, Bain & Navone, 2000

Description. The specimens have been assigned to *L. oxymycteri* in accordance with the description given by Notarnicola et al. (2000), i.e., 2 cephalic papillae ventral, salient amphids, buccal cavity tubular, buccal capsule with a thickened ring at midlength with posterior edge pointed backward, esophagus undivided, males with 5 pairs of cloacal papillae, pair 3 more ventral than lateral and pair 4 joined on the median longitudinal ventral line, unpaired precloacal papilla, left spicule with handle as long as lamina, membranous folded alae at anterior half of lamina, right spicule not heavily sclerotized, left spicule 305 ± 7 µm long with the handle 140 µm long, right spicule 81.5 ± 2.1 µm long, females with vulva 1337.5 ± 68.4 µm from anterior extremity, and tail 365 ± 15 µm long.

Taxonomic summary

Material examined: *Oxymycterus rufus*

Deposited specimens: UNNEPhel 159

Site of infection: abdominal cavity.

Remarks

This species was described by Notarnicola et al. (2000) in *Oxymycterus rufus* from 3 localities from Buenos Aires and one locality from Corrientes province (Navone et al., 2009; Notarnicola, 2004; Notarnicola et al., 2000). These findings extend the distribution to a new locality in Humid Chaco ecoregion.

Class Cestoda
Subclass Eucestoda
Order Cyclophyllidea van Beneden in Braun, 1900
Family Hymenolepididae Ariola, 1899
Genus *Rodentolepis* Spasskii, 1954
Rodentolepis akodontis Rêgo, 1967

Description. The morphological characters from the specimens agree with the original description given by Rêgo (1967), i.e., scolex armed with particular shape and length of hooks in the rostellum, cirrus-sac short, strobila with numerous proglottids and progressive maturation, scolex well-developed 165.4 ± 25.2 x 127 ± 30.5 µm with 4 rounded suckers 65.6 ± 8.9 x 56.2 ± 11 µm, rostellum 83.8 ± 25.1 µm long and 58.8 ± 13 µm wide armed with a crown of 24-28 hooks.

Taxonomic summary

Material examined: *Oxymycterus rufus* and *Necromys lasiurus*

Deposited specimens: UNNEPhel 160
Site of infection: small intestine.

Remarks

Rodentolepis akodontis was described parasitizing *N. lasiurus* (= *A. arviculoides*) (Rêgo, 1967), *A. montensis*, *A. cursor* and *O. nigripes* from Brazil (Simões et al., 2011). In Argentina, this species was reported from *Oxymycterus rufus* in several localities from Corrientes, Entre Ríos and Buenos Aires provinces (Guerreiro-Martins et al., 2015), and from *Akodon montensis* from Misiones (Panisse et al., 2017). This is the first record parasitizing *N. lasiurus* in Argentina and this finding extends the distribution to a new locality in Humid Chaco ecoregion.

Family Taeniidae Ludwig, 1886
Genus *Taenia* Linnaeus, 1758
Taenia taeniaeformis Batsch, 1786

Description. Only one specimen has been found, a cyst with a larval stage inside: the strobilocercus. The morphological characters agree with the descriptions given by Miño et al. (2013) and Fitte et al. (2017). The strobilocercus include a well-developed scolex with 4 rounded suckers 391.8 ± 54 µm and a rostellum 937.8 ± 245.6 µm armed with 2 alternating crowns of hooks with 2 different size 352 ± 85.5 µm and 218 ± 44.8 µm, and a long segmented body ended in a bladder.

Taxonomic summary

Material examined: *Necromys lasiurus*
Deposited specimens: UNNEPhel 161
Site of infection: liver

Remarks

Larvae of *T. taeniaeformis* were found in *Rattus* spp. (Fitte et al., 2017; Hancke et al., 2011), *Ctenomys talarum* (Rossin et al., 2004) and *Akodon azarae* (Miño et al., 2013) in Buenos Aires Argentina, and in *O. nigripes* (Simões et al., 2011) from Brazil. This is the first record for *Necromys lasiurus*, and a new locality for Humid Chaco ecoregion.

Phylum Acanthocephala
Class Archiacanthocephala Meyer, 1931
Order Moniliformida Schmidt, 1972
Family Moniliformidae Van Cleave, 1924
Genus *Moniliformis* Travassos, 1915
Moniliformis sp.

Description. The specimens have been assigned to *Moniliformis* sp. in accordance with the description given by Travassos (1915) and Amin (1987), i.e., long, cylindrical and pseudo-segmented body, sexual dimorphism exhibited in general body size, proboscis cylindrical with long rows of hooks, proboscis retractor muscles inserted into the posteroventral end of receptacle. It was not possible to identify at the species level because it has been found parasitizing a single individual. Since some diagnostic structures at a specific level are not observable, a deeper study of the specimens is needed before a specific assignation.

Taxonomic summary

Material examined: *Necromys lasiurus*
Deposited specimens: MLP-He 7527
Site of infection: small intestine.

Remarks

Up to 8 species of *Moniliformis* have been described in rodents, the unique species cited for Argentina is *Moniliformis amini* Guerreiro Martins, Robles & Navone, 2017 from the sigmodontine rodent *Abrothrix olivaceus* (Waterhouse) (Guerreiro-Martins et al., 2017). This is the first record of this genus parasitizing *Necromys lasiurus* in Argentina.

Table 1 details the ecological descriptors of the component populations with values of P, MA, MI, and RD of the helminth species registered. The highest P values correspond to *S. stilesi*, *H. mazzai*, *H. argentinus* and *M. fortuita* parasitizing *H. chacarius*, followed by *S. stilesi* from *N. lasiurus*. The highest MA and MI values correspond to *S. stilesi* from *N. lasiurus* and *Stilestrongylus* sp. from *O. nigripes* The Nippostrongylinae was the dominant group within each host species with the highest values observed for *S. stilesi* from *A. azarae* (RD = 96.2), followed by *Stilestrongylus* sp. from *O. nigripes* (RD = 81.2), and *S. delta* from *O. rufus* (RD = 74.2).

Table 2 shows the results of ecological descriptors of the component communities: richness, total number of specimens of parasites, diversity index, equitability and dominance. The highest value of S index was observed for *N. lasiurus* (S = 6) and *H. chacarius* (S = 4), followed by *O. rufus* (S = 3), *A. azarae*, *O. flavescens* and *O. nigripes* (S = 2). *Necromys lasiurus* presented the highest total number of parasites (5,583) followed by *O. flavescens* with 2,005, while the remaining species display less than 300. The H' reached values between the range 1.11 in *H. chacarius* and 0.16 in *A. azarae*. The equitability index shows the highest values for *O. flavescens* (0.96) and *H. chacarius* (0.81). The highest value index of dominance of Berger-Parker was observed for *A. azarae* (0.96) followed by *N. lasiurus* (0.86).

Table 2
Ecological descriptors of helminth communities from Sigmodontinae rodents.

	A. azarae	*H. chacarius*	*N. lasiurus*	*O. flavescens*	*O. nigripes*	*O. rufus*
S	2	4	6	2	2	3
TNP	239	151	5,583	2,005	293	160
H`	0.16	1.11	0.45	0.66	0.48	0.74
Eq	0.23	0.81	0.25	0.96	0.69	0.68
D	0.96	0.54	0.86	0.61	0.81	0.74

S: Species richness, TNP: total number of parasites, H`: Shannon and Wiener diversity index, Eq: equitability, D: dominance.

Discussion

In this work, we found 14 helminths species parasitizing 6 of 20 species of Sigmodontinae rodents registered for Humid Chaco ecoregion and we describe, for the first time, their parasite fauna. Moreover, 5 new associations were reported: *S. stilesi* - *A. azarae*; *S. stilesi*, *T. taeniaeformis*, *Moniliformis* sp. - *N. lasiurus* and *S. kinsellai* - *O. flavescens*.

Navone et al. (2009) and Panisse et al. (2017) studied helminths from assemblages of Sigmodontinae rodents in environment such as Wetlands and Forest. The helminth communities reported herein were markedly different to those recorded by Navone et al. (2009), considering that the rodent assemblage is similar. In this context, 4 of 6 rodent species were shared with the study from the wetlands (*O. rufus*, *O. flavescens*, *A. azarae*, *O. nigripes*), and 7 of 23 helminths taxa were here found (*Rodentolepis* sp., *L. oxymycteri*, *Syphacia* sp.- from *A. azarae*, *S. kinsellai*, *Stilestrongylus* sp. 1 and 2. - from *A. azarae*, *O. flavescens* and *O. nigripes*, *Suttonema* sp.).

The other case of a parasitological study from sigmodontine assemblage, carried out in Selva Paranaense also showed different results. Gomes et al. (2003) and Simões et al. (2011) showed an assemblage of 4 and 3 Sigmodontinae species with 9 and 18 helminths species reported from Brazil, respectively. Panisse et al. (2017) reported an assemblage of 7 Sigmodontinae species and 25 species of helminthes from Argentina. In this case, the present report shared only one species (*O. nigripes*) with these surveys, and only 3 helminth species (*S. kinsellai* - from *O. nigripes*, *S. carlitosi*, *R.* cf. *akodontis* - from *A. montensis*).

The Delta and Paraná Islands ecoregion is a mosaic of wetland macrosystems of river origin and the Selva Paranaense is seasonal moist and dry broad-leaf tropical forests, tropical and subtropical grasslands, savannas, and shrublands, and mangrove forests; while the present study was carried out in the Humid Chaco ecorregion, which is a sunken block, filled with sediments from the Pilcomayo, Bermejo and Juramento rivers and generates an irregular local topography, with raised ridges with respect to the surrounding areas. In this framework, the contrasting characteristics of the ecoregions determine each type of host assemblage, and clearly influence the distribution of their parasite assemblage.

In addition, in this paper the richness values are lower than those reported by Navone et al. (2009): *O. rufus* S = 3 vs. 8, *O. flavescens* S = 2 vs. 5, *O. nigripes* S = 2 vs. 3 and *A. azarae* S = 2 vs. 5, and from that by Panisse et al. (2017): *O. nigripes* S = 2 vs. 6 in Argentina and by Simões et al. (2011) *O. nigripes* S = 2 vs. 12 in Brazil.

The component population and helminth community of *N. lasiurus* has been described in detail in this work for the first time. A marked difference in the richness of parasitic species between *N. lasiurus* (S = 6) and the remaining host species analyzed was observed (Table 2).

Only 4 helminth species were shared among the rodent hosts in this study: *S. stilesi*, *Stilestrongylus* sp., *S. kinsellai* and *R. akodontis* (Table 1). *Stilestrongylus stilesi* was a species shared by 3 host species (*N. lasiurus*, *A. azarae* and *H. chacarius*). This nematode was present in *H. chacarius* with a prevalence of 100%, however only 2 specimens of this rodent were analyzed. This nippostrongyline species also was present with high prevalence (P = 92%) in *N. lasiurus*, in which a greater number of specimens were analyzed (n = 40), showing that *S. stilesi* is a frequent and abundant species in the environment. *Oligoryzomys nigripes* and *O. flavescens* display the same helminth assemblage (*Stilestrongylus* sp. and *S. kinsellai*), therefore, these parasites seem to be specific at a generic level. More helminth species were described from both *Oligoryzomys* species, such as *Tapironema coronatum*, *Hassalstrongylus epsilon*, *Guerrerostrongylus zetta*, *Stilestrongylus lanfrediae*, *S. flavescens*, *Litomosoides navonae*, *L. bonaerensis*, *Protospirura numidica criceticola*, among

others (Digiani et al., 2012; Navone et al., 2009; Panisse et al., 2017; Souza et al., 2009), being the prevalence and mean abundance variable depending on the geographic area. *Rodentolepis akodontis* was shared by *N. lasiurus* and *O. rufus* with a prevalence of 20 and 43% respectively. This species has been reported within a wide range of hosts (*A. montensis*, *A. cursor*, *O. nigripes*, *S. aquaticus*, *O. rufus*, *D. kempi*) and a wide geographical distribution, but with prevalence values not exceeding the 50% (Cardoso et al., 2016; Guerreiro-Martins et al., 2015; Navone et al., 2009; Simões et al., 2011, 2012). Considering that *R. akodontis* has a wide geographic and host distribution, the variations would be related to local conditions that favor the presence and abundance of intermediate hosts.

In conclusion, these results expand the taxonomic knowledge of the parasitic fauna of Cricetid rodents in Humid Chaco ecoregion and provide new records of geographic distribution and host species range. This knowledge, in addition to providing important information on the parasitic biodiversity in each biome, can be used as effective aids in developing strategies and mechanisms for minimizing parasitic disease consequent to expected changes in the environment (Patz et al., 2000).

Acknowledgements

We especially want to thank the team of the Laboratorio Biología de los Parásitos for their assistance during the field sampling. The work in Estación Biológica de Corrientes (San Cayetano) was authorized by Martin Kowalewski from Museo Argentino de Ciencias Naturales “Bernardino Rivadavia”. Financial support was provided by General Secretary of Science and Technology of the Universidad Nacional del Nordeste (PI 16F/006) and Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET).

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