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NEW HOST RECORDS AND GEOGRAPHIC DISTRIBUTION OF SPECIES OF *Trichuris* (NEMATODA: TRICHURIIDAE) IN RODENTS FROM ARGENTINA WITH AN UPDATED SUMMARY OF RECORDS FROM AMERICA

María del Rosario Robles and Graciela T. Navone

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**ABSTRACT.** Species of *Trichuris* have a cosmopolitan distribution and parasitize a broad range of mammalian hosts. Although, the prevalence and intensity of this genus depends on many factors, the life cycles and characteristics of the environment have been the main aspect used to explain their geographical distribution. In this paper, we provide new host and geographical records for the species of *Trichuris* from Sigmodontinae rodents in Argentina. Moreover, we present comprehensive data about previous records of the genus from rodents in North and South America, and mainly in Argentina. A total of 563 specimens including in 25 species of rodents from 12 provinces and 43 localities from Northeast and Southern Argentina were sampled for *Trichuris*. Six species of *Trichuris* including 9 new hosts and 16 new geographical records were found. The prevalence of *Trichuris* in Misiones province is higher than in other geographical areas studied. This tropical-subtropical nematode group is recorded for the first time from the latitude 40° S. Nevertheless, more surveys are necessary to determine whether the scarcity of infections of *Trichuris* in regions of high latitude is due to the absence of sample effort or to environmental effects on the survival of infective stages.

**RESUMEN.** Nuevos registros hospedatorios y de distribución geográfica de especies de *Trichuris* (Nematoda: Trichuridiidae) de roedores de Argentina con un resumen actualizado de los registros en América. Las especies de *Trichuris* presentan una distribución cosmopolita y parasitan un amplio rango de hospedadores mamíferos. Aunque la prevalencia e intensidad parasitaria de estos nematodes dependen de diferentes factores, su ciclo de vida y las características del ambiente han sido los principales aspectos que explican su distribución geográfica. En este trabajo se brindan nuevos hospedadores y registros geográficos para las especies de *Trichuris* de roedores Sigmodontinae para la Argentina. Además, se presentan datos completos y organizados sobre previos registros del género en roedores del continente americano, y principalmente de Argentina. Un total de 563 especímenes incluidos en 25 especies de roedores procedentes de 12 provincias y 43 localidades del noreste y del sur de la Argentina fueron examinados con el fin de hallar especímenes de *Trichuris*. Se presentan seis especies de *Trichuris* incluyendo 9 nuevos hospedadores y 16 nuevos registros geográficos. La prevalencia de *Trichuris* en la provincia de Misiones es más alta que en otras áreas geográficas estudiadas. Este grupo de nematodes tropical-subtropical es registrado por primera vez por sobre los 40° S. De todos modos, son necesarios nuevos estudios para explicar si la escasez de infecciones de *Trichuris* en regiones de altas latitudes es debido a la ausencia de esfuerzo de muestreo o al resultado del efecto del ambiente sobre la supervivencia del estado infectivo.


INTRODUCTION

Species of *Trichuris* Roederer, 1761 (Nematoda: Trichuridae) have a cosmopolitan distribution and parasitize a broad range of mammalian hosts (Cafrune et al., 1999; Anderson, 2000). Among these, the most common species are *Trichuris trichiura* (Linnaeus, 1758) from humans, and *T. muris* (Schrank, 1788), *T. ovis* (Abildgaard, 1795), *T. suis* (Schrank 1788), and *T. vulpis* (Froelich, 1789) from synanthropic and domestic animals (e.g. Knight, 1971; Beer, 1976; Bundy and Cooper, 1989; Callejón et al., 2010). Although, the prevalence and intensity of *Trichuris* in a host population depend on many factors, host immunologic status, behavior, areas with inadequate sanitation (food and fecal deposition areas mixed); the characteristics of its life cycle and environmental limiting factors have been the main aspects used to explain the geographical distribution (Bundy et al., 1988; Bundy and Cooper, 1989, 1987; Grencis et al., 1993; Anderson, 2000).

Whipworm eggs are deposited from host feces to the soil where infective larvae develop within the egg. Development of this larval stage has been shown to be influenced by temperature. Following ingestion of infective eggs by the host, all subsequent larval development to the adult stage occurs in the mucosa of the caecum and colon (Beer, 1973; Bundy and Cooper, 1988, 1989). Infections by trichuriasis are more prevalent in warm and moist tropical regions than in other parts of the world, and occur mainly in North and South America (Bundy and Cooper, 1988, 1989). However, most records are from medical and veterinary surveys (e.g. Bundy and Cooper, 1988; Traub et al., 2004; Gamboa et al., 2005), and comparatively few studies have been carried out on natural infections of *Trichuris* from wild hosts. In addition, many geographical areas have not been surveyed for *Trichuris*. Current distribution of the genus might reflect the absence of sample effort rather than the absence of infection (Bundy and Cooper, 1989).

Argentina is the second largest country in South America by land area, after Brazil, and exhibits a wide variety of soil types and climatic conditions (Bertonatti and Corcuera, 2000). The generally temperate climate ranges from subtropical in the north to subpolar in the far south and these environments include different eco-regions. Under natural conditions the rate of development of *Trichuris* species in this country may differ significantly from the optima, depending on the geographical distribution.

In this country, 8 species of *Trichuris* have been described and recorded from rodents (Morini et al., 1955; Boero and Boehringer, 1967; Suriano and Navone, 1994; Robles et al., 2006; Robles, 2011; Robles et al., 2012b). The only two records of this genus from wild hosts in other orders are *Trichuris tenuis* Chandler, 1930 from *Lama glama* and *Vicugna vicugna* (Artiodactyla; Cafrune et al., 1999) and *T. campanula* Linstow, 1889 from *Oncifelis geoffroyi* (Carnivora; Beldomenico et al., 2005). In general, the information available from many mammalian hosts is poor, hidden and scattered, making it difficult to evaluate the distribution and geographical gaps of the species of *Trichuris*.

Several parasitological studies on Sigmodontinae rodents (Cricetidae) have been carried out in Argentina in recent years (e.g. Robles and Navone, 2010; Notarnicola and Navone, 2011; Digiani et al., 2012; Robles et al., 2012a, 2012c; Digiani et al., 2013) and among these, three dealt with the taxonomy of *Trichuris* (Robles and Navone, 2006; Robles et al., 2006; Robles, 2011). However, these are only partial records, because several host species and *Trichuris* species are still under study.

In this paper, we provide new host and geographical records for *Trichuris* species from sigmodontine rodents of Argentina. Moreover, we present comprehensive data on previous records of the genus from rodents in North and South America, mainly in Argentina.

MATERIALS AND METHODS

**Studied area**

This includes the Northeast of Argentina, approximately between 26° and 35° S, politically covering the eastern Formosa, Chaco and Santa Fe provinces, the northern Buenos Aires province and Misiones, Corrientes and Entre Rios provinces. Also, the studied
area includes the south of Argentina (Patagonia), approximately between 38° and 54° S, embracing Chubut, Neuquén, Río Negro, Santa Cruz and Tierra del Fuego provinces (see Appendix 1, supplementary material for additional details on localities).

**Hosts**

Sigmodontine rodents were trapped during different field works between 2007 and 2010 (see collectors and support in acknowledgements). Many specimens are still being studied, but partial results were analyzed. Species of hosts with a very low representation (<5) have not been considered in this paper (except Chelenmys macronyx with n = 3). A total of 563 specimens were examined for Trichuris. From the northeast area, 493 specimens belonging to 17 species from 29 localities and 7 provinces were examined as following: Akodon azarae (n = 118) [A. azarae bibianae (n = 12), A. azarae hunteri (n = 106)], Akodon philippynesi (n = 14), Brueceppatersonius sp. (n = 6), Calomys sp. (n = 13), Euryoryzomys russatus (n = 8), Holochilus brasiliensis (n = 5), H. chacarius (n = 13), Necromys lasiurus (n = 109), Necromys obscurus (n = 11), Nectomys squamipes (n = 5), Oligoryzomys flaveiscens (n = 37), O. fornesi (n = 10), O. nigripes (n = 71), Oxymycterus rufus (n = 45), Sapteromys aquaticus (n = 5), Sooretamys angouya (n = 8), Thaptomys nigrita (n = 15). From Patagonia we examined 70 specimens belonging to 8 species from 14 localities and 5 provinces as following: Abrothrix hirta (n = 12), A. olivacea (n = 19), Akodon dolores (n = 5), Chelenmys macronyx (n = 3), Eligmodontia morgani (n = 6), Euneomys sp. (n = 6), Oligoryzomys longicaudatus (n = 10), Phyllotis xanthopygus (n = 9) (see Appendix 1, supplementary material).

**Parasites**

Nematodes were collected from the large intestine and caecum and preserved in 70% ethanol. For identification, the worms were prepared and identified following Robles et al. (2006), Robles and Navone (2006) and Robles (2011). Voucher specimens were deposited in the Colección de Helmintología from Museo de La Plata, Argentina (CHMLP).

**Data analysis**

Quantitative parameters of prevalence (P = specimens parasitized/specimens examined *100), intensity (I = number of parasites in a single infected host), mean intensity (MI = number of parasites/specimens parasitized) and mean abundance (MA = number of parasites/specimens examined) were calculated according to Bush et al. (1997) for each host species and locality (Table 1). Prevalence, MI, I and MA for host species and studied area were given in the text. Prevalence differences were compared by the χ² test, and the data were analyzed by use of the Chi squared test employing the correction of Yates or by use of Fisher’s exact test (positive cases <5), considering significant at p < 0.05. Statistical analysis was performed with Epinfo™ 7.

**RESULTS**

Ten species of sigmodontine rodents from Argentina were parasitized with species of *Trichuris*. Three species of *Trichuris* were identified to the specific level, and at least 3 others were studied in detail, although these could not be identified to the species level (Table 1).

Published and new records for *Trichuris* in Argentina are shown in Fig. 1 (also see Tables 1 and 2 for species references). Records of *Trichuris* from the literature were summarized for Argentina in Table 2 and those for North and South America in Table 3.

Akodon azarae bibianae, A. azarae hunteri and N. lasiurus were parasitized with *Trichuris laevitestis* Suriano and Navone, 1994. A. azarae bibianae and N. lasiurus are new host records, and 11 localities are new geographical records (Table 1). The total P, MI and MA of *T. laevitestis* in all host species were 11.9%, 4.03 and 0.48, respectively; and in each host species: *A. azarae* 16.9%, 3.85 and 0.65 and *N. lasiurus* 6.42%, 4.57 and 0.29, respectively. *T. nigrita* were parasitized with a species of *Trichuris*. This host and Refugio Moconá represent new records for this nematode (Table 1). General features of these specimens suggest that they belong to *Trichuris navonae* Robles, 2011. However, some diagnostic measurements (in millimeters) such as spicule length (1.9-2.3), distal cloacal tube length (1.7-2.1), proximal cloacal tube lengths (1.2-1.7), present ranges higher than those previously recorded for *T. navonae* from *A. montensis* (1.3-2.1, 1-1.9, 0.75-1.5; respectively), verified through their ratios with the posterior portion of body and total body lengths. For this reason, these specimens are listed provisionally as *Trichuris cf. T. navonae* until more detailed morphometric analyses and molecular comparative studies determine whether they are cryptic species. The P, MI and
New hosts and geographical records for species of *Trichuris* in Argentina with data of Prevalence (P), Intensity (I), Mean Intensity (MI) and Mean Abundance (MA) by locality and host species; numbers and symbols refer to Fig. 1.

<table>
<thead>
<tr>
<th><em>Trichuris</em> species</th>
<th>Host species</th>
<th>Locality*</th>
<th>Prevalence</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 T. laevitesitis</td>
<td>A. azarae bivianae**</td>
<td>7 km S Puerto Las Palmas, Chaco**</td>
<td>25% (1/4) 2+ 0.5 (2/4)</td>
</tr>
<tr>
<td></td>
<td>INTA-IPAF NEA, Formosa**</td>
<td>Arroyo de las Brusquitas, Buenos Aires**</td>
<td>33.3% (1/3) 4+ 1.33 (4/3)</td>
</tr>
<tr>
<td></td>
<td>A. azarae hutenri*</td>
<td>Punta Indio, Buenos Aires**</td>
<td>37% (10/27) 1.9 (19/10) 0.7 (19/27)</td>
</tr>
<tr>
<td></td>
<td>Zárate, Buenos Aires**</td>
<td>Arroyo Caraballo, Entre Ríos**</td>
<td>9.1% (1/11) 2+ 0.2 (2/11)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Colonía Villa Elisa, Entre Ríos**</td>
<td>12.5% (3/24) 2 (6/3) 0.3 (6/24)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Oliveros, Santa Fe**</td>
<td>(1/1) 7+ 7 (7/1)</td>
</tr>
<tr>
<td></td>
<td>N. lasiusurus**</td>
<td>Finca La Adelita, Laguna Paiva, Corrientes**</td>
<td>14.3% (2/14) 1.5 (3/2) 0.2 (3/14)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pergamino, Buenos Aires**</td>
<td>12.5% (2/16) 3 (6/2) 0.4 (6/16)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Uranga, Santa Fe**</td>
<td>16.6% (3/18) 7.6 (23/3) 1.3 (23/18)</td>
</tr>
<tr>
<td>2 T. cf. navonae</td>
<td>T. nigrita**</td>
<td>Refugio Moconá, Misiones**</td>
<td>75% (3/4) 2 (6/3) 1.5 (6/4)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Desembocadura Arroyo Paranay-Guazú, Misiones</td>
<td>33% (3/9) 6+ 2 (6/3)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Balneario Municipal de Aristóbulo del Valle, Misiones</td>
<td>85.7% (6/7) 1.16 (7/6) 1 (7/7)</td>
</tr>
<tr>
<td>3 T. cf. T. pardinasi</td>
<td>P. xanthopygus xanthopygus**</td>
<td>Cerro Corona, Meseta de Sumuncurá, Río Negro**</td>
<td>(2/2) 10 (20/2) 10 (20/2)</td>
</tr>
<tr>
<td>4 Trichuris sp. 1</td>
<td>H. chacarius**</td>
<td>INTA-IPAF NEA, Formosa**</td>
<td>23.1% (3/13) 18.6 (56/3) 4.3 (56/13)</td>
</tr>
<tr>
<td>5 Trichuris sp. 2</td>
<td>S. angouya**</td>
<td>Refugio Moconá, Misiones</td>
<td>50% (2/4) 7 (14/2) 3.5 (14/4)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reserva de Uso Múltiples Guarani, Misiones**</td>
<td>(2/2) 1 (2/2) 1 (2/2)</td>
</tr>
<tr>
<td>6 Trichuris sp. 3</td>
<td>C. macrionyx**</td>
<td>Cañadón de la Madera, Sierra de Tepuel, Chubut**</td>
<td>33.3% (1/3) 10+ 3.3 (10/3)</td>
</tr>
<tr>
<td>7 Trichuris sp. 4</td>
<td>N. obscurus**</td>
<td>Arroyo de las Brusquitas, Buenos Aires**</td>
<td>36.4% (4/11) 1.5 (6/4) 0.5 (6/11)</td>
</tr>
<tr>
<td>† Trichuris sp.</td>
<td>E. russatus*</td>
<td>Arroyo Paíso, Misiones</td>
<td>(1/1) 1+ 1 (1/1)</td>
</tr>
<tr>
<td>† Trichuris sp.</td>
<td>S. aquaticusb</td>
<td>Estancia San Nicolás, Corrientes**</td>
<td>20% (1/5) 1+ 0.2 (1/5)</td>
</tr>
</tbody>
</table>

* See complete data in supplementary material; ** denotes a new host and/or a new locality records.

Robles and Navone, 2006; Suriano and Navone, 1994; Robles, 2011. * shared record; + intensity.
MA of T. cf. T. navonae in the population of T. nigrita were 66.6%, 1.9 and 1.26, respectively.

Phyllotis xanthopygus xanthopygus were parasitized with another species of Trichuris. This host subspecies represents a new host record for this nematode. In addition, these results add a new locality and province, Cerro Corona and Río Negro, respectively (Table 1). General features of these specimens suggest that they belong to Trichuris pardinasi Robles, Navone and Notarnicola, 2006. However, some morphometrical discrepancies (in millimeters) such as spicule lengths were observed (2.5-3.3 in P. x. xanthopygus vs. 3.6-5.2 in P. bonariensis and P. x. vaccarum). For this reason, these specimens are listed provisionally as Trichuris cf. T. pardinasi. It would be useful to obtain new samples and data from other sources (i.e. genetic presence of a spicular tube, a spinose spicular sheath (spines very small, densely arranged), and a slightly protusive or nonprotusive vulva. The Trichuris specimens from the first 3 host species listed above are mainly characterized by the absence of a spicular tube, a spinose spicular sheath (spines very small, densely arranged), and a slightly protusive or nonprotusive vulva. The Trichuris specimens from C. macronyx are characterized by the presence of a spicular tube, a spinose spicular sheath (spines very small, densely arranged), and a protusive vulva; along with morphometric characters. Morphologically these specimens correspond to 4 different species of Trichuris, suggesting the presence of 2 new species, one from S. angouya and one from H. chacarius; and 2 preliminary unidentified species, one from N. obscurus and one C. macronyx. Until new samples are obtained and molecular comparative studies are concluded these species are listed here as Trichuris sp. The P, MI and MA of the species of Trichuris were in S. angouya, 50%, 4 and 2, respectively; in N. obscurus, 36.4%, 1.5 and 0.54, respectively; in H. chacarius, 16.6%, 18.6 and 3.11, respectively; and in C. macronyx 33%, 10 and 3.33, respectively.

Fig. 1. Previous and new records for the species of Trichuris in Argentina. Localities are detailed in Tables 1 and 2. New records are marked with a circle.
Table 2

Host and geographical data for the species of *Trichuris* previously recorded from rodents in Argentina; numbers and symbols refer to Fig. 1.

<table>
<thead>
<tr>
<th><em>Trichuris</em> species</th>
<th>Host species</th>
<th>Locality</th>
<th>Coord S</th>
<th>Coord W</th>
<th>Province</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 <em>T. laevitestis</em></td>
<td><em>Akodon azame hunteri</em></td>
<td>Punta Lara</td>
<td>34°47'30&quot;</td>
<td>58°0'5&quot;</td>
<td>Buenos Aires</td>
<td>Suriano and Navone, 1994</td>
</tr>
<tr>
<td></td>
<td></td>
<td>La Balandra</td>
<td>34°55'51&quot;</td>
<td>57°43'0.6&quot;</td>
<td>Buenos Aires</td>
<td>Robles and Navone, 2006</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reserva Otamendi</td>
<td>34°09'</td>
<td>58°57'</td>
<td>Buenos Aires</td>
<td>Robles and Navone, 2006</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cerro de la Gloria</td>
<td>36°06'</td>
<td>57°46'</td>
<td>Buenos Aires</td>
<td>Robles and Navone, 2006</td>
</tr>
<tr>
<td></td>
<td><em>Scapteromys aquaticus</em></td>
<td>Punta Lara</td>
<td>34°47'30&quot;</td>
<td>58°0'5&quot;</td>
<td>Buenos Aires</td>
<td>Suriano and Navone, 1994</td>
</tr>
<tr>
<td></td>
<td></td>
<td>La Balandra</td>
<td>34°55'51&quot;</td>
<td>57°43'0.6&quot;</td>
<td>Buenos Aires</td>
<td>Robles and Navone, 2006</td>
</tr>
<tr>
<td></td>
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<td>Los Talas</td>
<td>34°52'05&quot;</td>
<td>57°49'20&quot;</td>
<td>Buenos Aires</td>
<td>Robles and Navone, 2006</td>
</tr>
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<td></td>
<td></td>
<td>Palo Blanco</td>
<td>34°52'24&quot;</td>
<td>57°48'47&quot;</td>
<td>Buenos Aires</td>
<td>Robles and Navone, 2006</td>
</tr>
<tr>
<td>2 <em>T. navonae</em></td>
<td><em>Akodon montensis</em></td>
<td>Balneario Municipal de Aristóbulo del Valle</td>
<td>27°05'17&quot;</td>
<td>54°57'9&quot;</td>
<td>Misiones</td>
<td>Robles, 2011</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Club Pesca Paranay-Guazú</td>
<td>26°40'32&quot;</td>
<td>54°48'51&quot;</td>
<td>Misiones</td>
<td>Robles, 2011</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Desembocadura arroyo Paranay-Guazú</td>
<td>26°40'39&quot;</td>
<td>54°50'8&quot;</td>
<td>Misiones</td>
<td>Robles, 2011</td>
</tr>
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<td></td>
<td></td>
<td>Arroyo Salamanca</td>
<td>26°36'53&quot;</td>
<td>54°46'51&quot;</td>
<td>Misiones</td>
<td>Robles, 2011</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Salto El Paraíso, arroyo Paraíso</td>
<td>27°13'49&quot;</td>
<td>54°02'24&quot;</td>
<td>Misiones</td>
<td>Robles, 2011</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Arroyo Oveja Negra - Ruta 21</td>
<td>27°8'20&quot;</td>
<td>53°55'31&quot;</td>
<td>Misiones</td>
<td>Robles, 2011</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Parque Provincial Cruce Caballero</td>
<td>26°30'50&quot;</td>
<td>53°59'54&quot;</td>
<td>Misiones</td>
<td>Robles, 2011</td>
</tr>
<tr>
<td></td>
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<td>Parque Provincial Moconá**</td>
<td>27°9'23&quot;</td>
<td>53°54'10&quot;</td>
<td>Misiones</td>
<td>Robles, 2011</td>
</tr>
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<td></td>
<td></td>
<td>Puerto Península</td>
<td>29°40'</td>
<td>54°38'</td>
<td>Misiones</td>
<td>Robles, 2011</td>
</tr>
<tr>
<td>3 <em>T. pardinasi</em></td>
<td><em>Phyllotis bonariensis</em></td>
<td>Cerro Destierro, Sierra de la Ventana</td>
<td>38°1'25&quot;</td>
<td>62°54'39&quot;</td>
<td>Buenos Aires</td>
<td>Robles et al, 2006</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Abra de la Ventana, Sierra de la Ventana</td>
<td>38°4'3&quot;</td>
<td>62°1'17&quot;</td>
<td>Buenos Aires</td>
<td>Robles et al, 2006</td>
</tr>
<tr>
<td>3 <em>T. pardinasi</em></td>
<td><em>Phyllotis xanthopygus vaccarum</em></td>
<td>Pampa de Achala</td>
<td>31°37'19&quot;</td>
<td>64°54'39&quot;</td>
<td>Córdoba</td>
<td>Robles et al, 2006</td>
</tr>
</tbody>
</table>
NEW RECORDS OF Trichuris IN ARGENTINEAN RODENTS

Euryoryzomys russatus and S. aquaticus from Ea. San Nicolás were each parasitized with a Trichuris sp., constituting a new host and a new geographical record, respectively (Table 1). In both cases, species identification was not possible due to the absence of males. The P, MI and MA of the species of Trichuris in each host species were 12.5%, 1, 0.13 and 20%, 1, 0.2, respectively.

Specimens of Trichuris were not distributed homogeneously among the host species and study areas. The prevalence between species pairs: A. azarae with N. lasiurus, T. nigrita and S. angouya; N. lasiurus with N. obscurus, T. nigrita and S. angouya; T. nigrita with E. russatus and H. chacarius were significantly different (p < 0.05). On the other hand, the prevalence between other host species pairs studied did not differ significantly. Moreover, the prevalence between the two studied areas, Northeast (P 9.53%) and South (P 4.41%) of Argentina, were not significantly different (p = 0.25).

In summary, we recorded 9 new hosts (7 species and 2 subspecies) and 16 new geographical records for Trichuris, enlarging significantly their distributional range (Table 1).

A total of 8 species of Trichuris from 11 rodent species have been recorded in Argentina since 1955 (Morini et al., 1955; Boero and Boehringer, 1967; Suriano and Navone, 1994; Rossin and Malizia, 2005; Robles and Navone, 2006; Rossin et al., 2010; Robles et al., 2012). These species are distributed approximately from 25° 12’S to 43° 51’S and from 70° 43’W to 53° 54’W (Tables 1 and 2). A total of 24 species of Trichuris from 33 rodent species have been recorded in the Americas since 1955. These species are distributed from Manitoba (N) (Canada) to Texas (S) and from California (W) to Maryland (E) (USA); and in South America from Trinidad (N) (Republic of Trinidad and Tobago) to La Pampa (S) (Argentina) and from Minas Gerais (W) (Brazil) to La Hauyca (E) (Chile) (Table 3) (Lent and Freitas, 1936; Chandler, 1945; Tiner, 1950; Cameron and Reesal, 1951; Morini, et al. 1955; Read, 1956; Boero and Boehringer, 1967; Kenneth and Lepp, 1972; Barus et al., 1975; Babero et al.,
Table 3

Host and geographical data previously recorded for species of *Trichuris* from rodents in America excluding Argentinean records.

<table>
<thead>
<tr>
<th><em>Trichuris</em> species</th>
<th>Host species</th>
<th>Host family</th>
<th>Locality</th>
<th>Country</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>T. leporis</em> (Froelich, 1789)</td>
<td><em>Spermophilus richardsonii</em> §</td>
<td>Sciuridae</td>
<td>Manitoba</td>
<td>Canada</td>
</tr>
<tr>
<td><em>T. gracilis</em> (Rudolphi, 1819)</td>
<td><em>Dasyprocta leporina</em>, <em>D. fuliginosa</em></td>
<td>Dasyproctidae</td>
<td>State of Amazonas</td>
<td>Brazil</td>
</tr>
<tr>
<td><em>T. opaca</em> Barker et Noyes, 1915</td>
<td><em>Ondatra zibethicus</em>, <em>Microtus pennsylvanicus</em></td>
<td>Cricetidae</td>
<td>Nebraska, Wisconsin, Ohio, Wyoming, Maryland</td>
<td>USA</td>
</tr>
<tr>
<td><em>T. fossor</em> Hall, 1916</td>
<td><em>Thomomys talpoides</em>, <em>T. bottae</em></td>
<td>Geomyidae</td>
<td>California, Wyoming</td>
<td>USA</td>
</tr>
<tr>
<td><em>T. myocastoris</em> Enigk, 1933</td>
<td><em>Myocastor coypus</em></td>
<td>Myocastoridae</td>
<td>San Pablo</td>
<td>Brazil</td>
</tr>
<tr>
<td><em>T. citelli</em> Chandler, 1945</td>
<td><em>Spermophilus beecheyi</em> $#$</td>
<td>Sciuridae</td>
<td>California</td>
<td>USA</td>
</tr>
<tr>
<td><em>T. perognathi</em> Chandler, 1945</td>
<td><em>Perognathus californicus</em>, <em>P. pennicillata</em></td>
<td>Heteromyidae</td>
<td>California</td>
<td>USA</td>
</tr>
<tr>
<td><em>T. neotomae</em> Chandler, 1945</td>
<td><em>Neotoma fuscipes</em></td>
<td>Cricetidae</td>
<td>California</td>
<td>USA</td>
</tr>
<tr>
<td><em>T. peromysci</em> Chandler, 1946</td>
<td><em>Peromyscus californicus</em></td>
<td>Cricetidae</td>
<td>California</td>
<td>USA</td>
</tr>
<tr>
<td><em>T. madisonensis</em> Tiner, 1950</td>
<td><em>Tamias striatus</em></td>
<td>Sciuridae</td>
<td>Wisconsin</td>
<td>USA</td>
</tr>
<tr>
<td><em>T. dipodomys</em> (Read, 1956)</td>
<td><em>Dipodomys ordii</em>, <em>D. phillipsi</em></td>
<td>Heteromyidae</td>
<td>New Mexico, Utah</td>
<td>USA</td>
</tr>
<tr>
<td><em>T. bradleyi</em> Babero, Cattan and Cabello, 1975</td>
<td><em>Octodon degus</em></td>
<td>Octodontidae</td>
<td>Santiago</td>
<td>Chile</td>
</tr>
<tr>
<td><em>T. chilensis</em> Babero, Cattan and Cabello, 1976</td>
<td><em>Abrothrix longipilus</em> $#$</td>
<td>Cricetidae</td>
<td>Santiago</td>
<td>Chile</td>
</tr>
<tr>
<td><em>T. fulvi</em> Babero et Murua, 1987</td>
<td><em>Ctenomys fulvus phillipiensis</em></td>
<td>Ctenomyidae</td>
<td>San Pedro de Atacama</td>
<td>Chile</td>
</tr>
<tr>
<td><em>T. elatoris</em> Pfaffnberger and Best, 1989</td>
<td><em>Dipodomys elator</em>, <em>D. merriami</em>, <em>D. ordii</em></td>
<td>Heteromyidae</td>
<td>Texas</td>
<td>Mexico</td>
</tr>
<tr>
<td><em>T. robusti</em> Babero and Murua, 1990</td>
<td><em>Ctenomys robustus</em></td>
<td>Ctenomyidae</td>
<td>La Hauyca</td>
<td>Chile</td>
</tr>
<tr>
<td><em>T. travassosi</em> Correa Gomes, Lanfredi, Pinto and Souza, 1992</td>
<td><em>Oligoryzomys nigripes</em> $#$</td>
<td>Cricetidae</td>
<td>Rio Grande do Sul</td>
<td>Brazil</td>
</tr>
</tbody>
</table>
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### DISCUSSION

Each species of *Trichuris* geographically located in Argentina can be distinguished by diagnostic features. In several cases (e.g., *Trichuris* specimens obtained from *C. macronyx, E. russatus, N. obscurus,* and *S. aquaticus*), observed differences in morphological and metric traits prevent us a confident specific assignation. Two possible new species were found from *S. angouya* and *H. chacarius* each one. However, new and more detailed studies and material are necessary to clarify the alpha taxonomy of *Trichuris* in Argentina.

To date, a total of 24 species of *Trichuris* have been described from 10 families of rodents in America, Caviidae (1 species), Cricetidae (8), Ctenomyidae (4), Dasyproctidae (1), Echymyidae (1), Geomyidae (1), Heteromyidae (3), Myocastoridae (1), Octodontidae (1), and Sciuridae (3). Of these, 8 species have been reported from Argentina, including *Trichuris dolichotis* Morini, Boero and Rodriguez, 1955, *T. myocastoris* Enigk, 1933, *T. laevitestis T. bursacaudata* Suriano and Navone, 1994, *T. pampeana* Suriano and Navone, 1994, *T. pardinasi, T. navonae, T. cf. T. thrichomysi* Lopes Torres et al., 2012 (Morini et al., 1955; Boero and Boehringer, 1967; Suriano and Navone, 1994; Robles et al., 2006; Robles, 2011; Robles et al., 2012b) and 4 additional species, not identified to specific level, mentioned in this paper (Tables 1, 2 and 3).

Furthermore, a total of 9 species of *Trichuris* have been recorded from 14 sigmodontines (*A. azarae, A. montensis, A. hirta, C. macronyx, E. russatus, H. chacarius, O. nigripes, P. bonariensis, P. xanthopygus, N. lasiurus, N. obscurus, T. nigrita, S. aquaticus,* and *S. angouya; Tables 1, 2 and 3*). Sigmodontine rodents are distributed predominantly in South America, with a few species having a Central and North American distribution, and this subfamily includes approximately 400 species (Patton et al., in press). Despite the large number of potential host species, only about 3.5% of sigmodontine rodent species have been recorded as hosts for species of *Trichuris*. Among these hosts, 86% of infections were recorded in Argentina (Morini et al., 1955; Boero and Boehringer, 1967; Suriano and Navone, 1994; Robles and Navone, 2006; Robles et al., 2010; Robles, 2011; Robles et al., 2012b). This number may represent only a small fraction of the species of *Trichuris* that occurs in sigmodontine rodents, and additional surveys of this group should yield both new species and records.

The distribution of *Trichuris* species among the species of sigmodontine rodents in the surveyed localities showed a range of prevalence between 9.1-85.7% (samples of 2 or < specimens were not considered). Although the prevalence values given for some localities may be questionable because of the low number of specimens examined, these data give a new overview of the regional distribution of *Trichuris*. *Trichuris* cf. *T. navonae*
and *Trichuris* sp. from 3 localities in Misiones showed the highest prevalence (85.7%, 75% and 50%) (Table 1). However, *T. laevisetis* from *A. a. hunteri* of Arroyo Caraballo (I = 35, MA = 8.8) and *Trichuris* sp. from *H. chacarius* of INTA-IPAF NEA (MI = 18.6, MA = 4.3) showed the highest intensities.

The significant differences observed in the prevalences of the species of *Trichuris* among host species probably relate to a combination of factors, including host immunologic status, behavior of the host species and characteristics of environment where the eggs were deposited. However, the prevalences between the two studied areas, northeast and south of Argentina, were not significantly different (p > 0.05). Since this is a limited study, these results are not conclusive and surely new data on the soil and microenvironment characters, home range and behavior of host species, and experimental studies will lead to clearer hypotheses about the limiting factors of *Trichuris* present in wild mammals and extreme geographical areas.

Because of this, a previous hypothesis about the global geographical distribution (tropical and subtropical areas) of genus *Trichuris* should be revisited. To date, different studies have demonstrated that the embryonation period varies between 9-37 days and 25-35 °C for *T. trichiura, T. muris* and *T. vulpis* (Beer, 1971, 1976). A field survey in southern England found that egg development in *T. suis* was greatly retarded at ground temperatures of 4-20° C, with an embryonation period of 434-630 days (Burden and Hammet, 1979). Moreover, species of *Trichuris* have been infrequently recorded in high latitudes (Tiner, 1950; Burden and Hammet, 1979; Sardella and Fugassa, 2009). These examples may explain why trichuriasis in humans is presently almost unknown in cold regions; and in the same way, in rodents.

Patagonia presents unique environment characteristics, comprising a series of plateaus and high plains, a vegetation in open patches, and a temperate climate, which ranges from subtropical in the north to subpolar in the far south and at higher elevations (e.g. Soriano, 1956; León et al., 1998). To date, in the subpolar areas there have been no previous records of *Trichuris* in Patagonia, except in archaeological samples (Sardella and Fugassa, 2009). However, in this survey, a population of this tropical-subtropical nematode is recorded for the first time from 40° S (*T. cf. T. pardinasi* and *Trichuris* sp., see Table 1).

In the context of the hypothesis above referred to the absence of *Trichuris* in the north, west and south of Argentina is consistent with a lower degree of sampling effort with respect to other areas in the country (Fig. 1). Parasitological studies have been carried out in the northeast area of Argentina for a long time, while these studies in Patagonian area have begun recently. It is likely that future studies will reveal the presence of more species and a more accurate host and geographical distribution, mainly in the southern portion of the country.

Consequently, more surveys on different host groups are necessary to determine whether the scarcity of infections of the genus *Trichuris* in regions of high latitude is due to the absence of sample effort or to environmental effects on the survival of infective stages.

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**LITERATURE CITED**


BABERO BB and RB MURUA. 1990. A new species of whipworm from a South American hystricomorph...
NEW RECORDS OF *Trichuris* IN ARGENTINEAN RODENTS


VON LINSTOW, K. 1906. Description of *Trichuris skrjabini* n. sp. (Nematoda: Trichurinae) from a Brazilian rodent, by light and scanning electron microscopy. Memorias do Instituto Oswaldo Cruz 87:1-10.


### ONLINE SUPPLEMENTARY MATERIAL

### APPENDIX 1

List of examined rodents