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NEW SPECIES OF *TRICHURIS* (NEMATODA: TRICHURIDAE) FROM *AKODON MONTENSIS* THOMAS, 1913, OF THE PARANAENSE FOREST IN ARGENTINA

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ABSTRACT: Species of *Trichuris* (Nematoda: Trichuridae) parasitize a broad range of mammalian hosts. To date, 21 *Trichuris* species infecting nine families of rodents have been found in North and South America. *Trichuris navonae* n. sp. is described on the basis of specimens recovered from a species of forest-dwelling mice, *Akodon montensis* (Cricetidae: Sigmodontinae), from nine localities of Misiones Province, Argentina. A comparison with all the species of *Trichuris* from North and South American rodents is given. The separation of the new species of *Trichuris* is based on morphologic and morphometrica features, such as the absence of a spicular tube, the presence of a cylindrical spicular sheath with sharp spines, a non-protrusive vulva, a long anterior-posterior portion of the body, a lengthy spicule, and a proximal and distal cloacal tube. This is the third record of this genus in rodents of the Sigmodontinae from Argentina and the fifth record from South American rodents. Despite the large number of potential host species, only about 1.9% of sigmodontine rodent species have been reported as hosts of *Trichuris* spp. It is suggested that this number represents but a small fraction of *Trichuris* spp. that occur in sigmodontine rodents, and that additional survey of this group should yield additional species.

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). For many years, *Trichuris* species have been described with a narrow range of anatomic and biometric characteristics. Moreover, they have been insufficiently compared with their congeneric species (Schwartz, 1926; Chandler, 1930; Knight, 1984; Babero and Murua, 1990).

The presence or absence of the spicular tube, the length of the spicule and the cloacal tube, the shape of the proximal and distal cloacal tube, and the vulvar morphology, along with the classic morphometric characteristics, have been used as features with high discriminatory value for differentiating species of *Trichuris* (Gomes et al., 1992; Spakulová, 1994; Suriano and Navone, 1994; Rossin and Malizia, 2005; Robles et al., 2006). Some studies have used scanning electron microscopy (SEM) as a diagnostic tool (Kikuchi, 1974a, 1974b; Tenora et al., 1993, 1997; Lanfredi et al., 1995; Robles and Navone, 2006; Robles et al., 2006), and others have used isoenzymatic patterns and molecular approaches for identification of these nematodes (Cutillas et al., 1996, 2002, 2004, 2007).

To date, 21 *Trichuris* species have been described from nine families of North and South American rodents: Caviidae, Cricetidae, Ctenomyidae, Dasyproctidae, Geomyidae, Heteromyidae, Myocastoridae, Octodontidae, and Sciuridae. Of these, five species have been reported from Argentina, including *Trichuris dolichotis* Morini, Boero, and Rodriguez, 1955, from *Dolichotis patagonum* (Zimmermann, 1780), *Trichuris laevitestis* Suriano and Navone, 1994, from *Scapteromys aquaticus* Thomas, 1920, and *Akodon azarae* (Fischer, 1829), *Trichuris bursacaudata* Suriano and Navone, 1994, from *Ctenomys talarum* Thomas, 1898, *Trichuris pampeana* Suriano and Navone, 1994, from *Ctenomys azarae* Thomas, 1903, and *Trichuris pardinasi* Robles, Navone and Notarnicola, 2006, from *Phyllotis xanthopygus* (Waterhouse, 1837) (Morini et al., 1955; Suriano and Navone, 1994; Robles et al., 2006). Only four species have been recorded from rodents of the Sigmodontinae. These include *Trichuris chilensis* Babero, Cattan and Cabello, 1976, from Chile, *Trichuris travassosi* Gomes, Lanfredi, Pinto and Souza, 1992, from Brazil, and *T. laevitestis* and *T. pardinasi* from Argentina (Babero et al., 1976; Gomes et al., 1992; Suriano and Navone, 1994; Robles et al., 2006).

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The purpose of the present paper is to describe a new species of *Trichuris* on the basis of specimens recovered from *Akodon montensis* Thomas, 1913 (Cricetidae: Sigmodontinae) from the Paranaense Forest in Misiones Province, Argentina.

MATERIAL AND METHODS

Nematodes were collected from the ceca of 28 specimens of *A. montensis:* 12 from Balneario Municipal de Aristóbulo del Valle, arroyo Cuña Pirú (BC)–Departamento Cainguás; 5 from Club Pesca Paranay–Guazú (CP); 2 from Desembocadura Arroyo Paranay–Guazú (AP); 2 from Arroyo Salamanca, Reserva Natural Solar del Che (AS)–Departamento Montecarlo; 2 from Salto El Paraíso, Arroyo Paraíso (SP); 1 from Arroyo Oveja Negra–Ruta 21 (AO)–Departamento Guaraní; 2 from Parque Provincial Cruce Caballero (CC); 1 from Parque Provincial Moconá (PM)–Departamento San Pedro, and 1 from Puerto Península (PP)–Departamento Iguazú, Misiones Province, Argentina. These hosts were captured by the author and several collaborators (see Acknowledgments) between May 2005 and September 2009.

Akodon montensis occurs from east Paraguay, southeast Brazil, and northeast Argentina (Pardiñas et al., 2003, Pardiñas et al., 2008). In Argentina, these mice inhabit primary and secondary grown forests from Misiones Province (Massoia and Fornes, 1962; D'Elía, 2003), where the climate is subtropical, with no marked dry season (Giraudo et al., 2003). This area is designated as the Paranaense Forest (Burkart et al., 1999) and is part of the Atlantic forest, which stretches for several thousand kilometers along the east coast of Brazil and continues inland to parts of Paraguay and Argentina. The Paranaense Forest represents an important area of high biodiversity (Ecott, 2002; Giraudo et al., 2003).

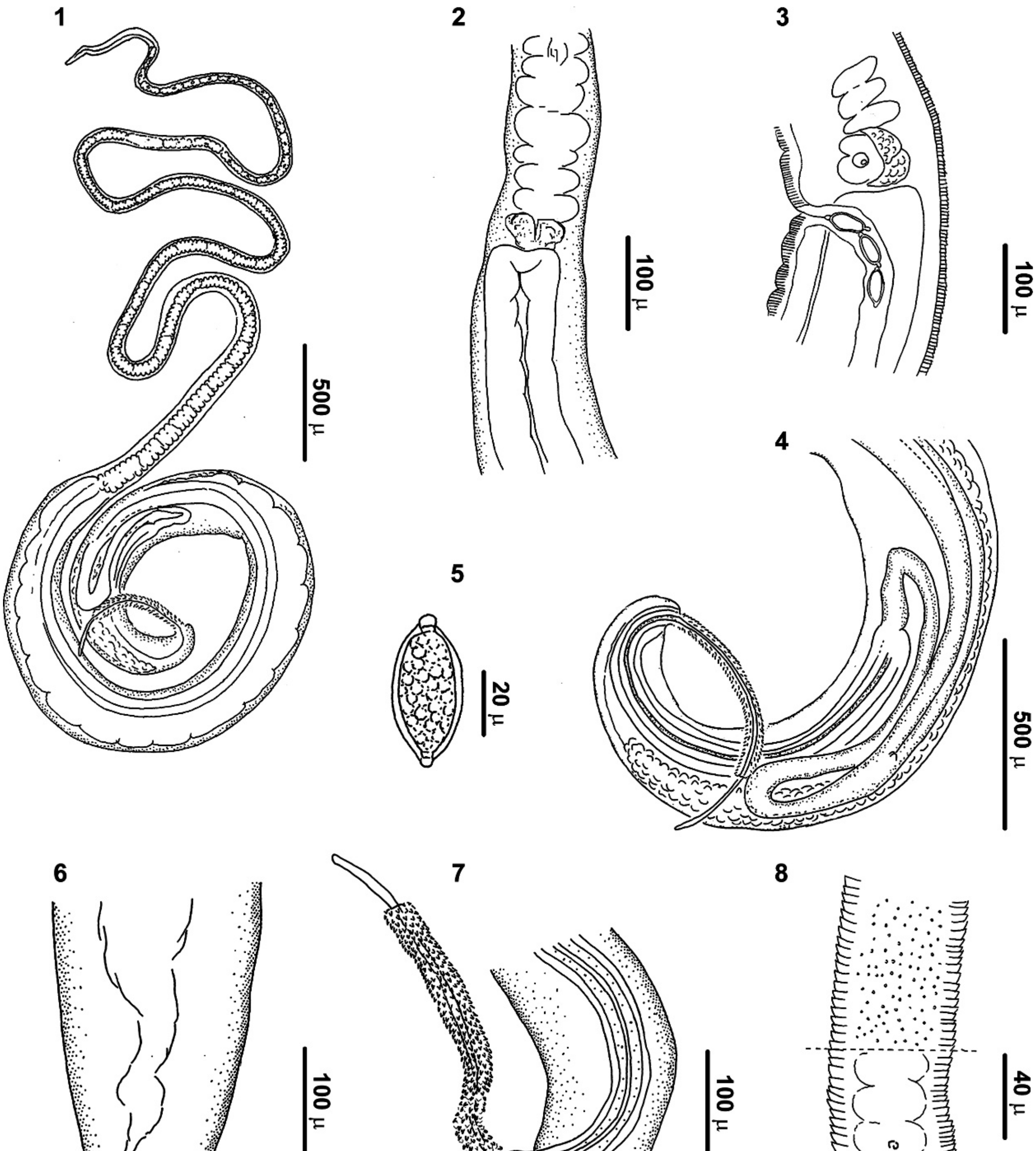
Nematodes were preserved in 70% ethanol, and more than 40 specimens were cleared in lactophenol, then studied using a light microscope. Drawings were made with the aid of a drawing tube. Eight specimens were dehydrated in ethanol series (75%, 80%, 85%, 90%, 96%, 100%), dried using the critical point method, and examined with the aid of a scanning electron microscopy (Jeol 6360 LVLV, Tokyo, Japan).

Measurements are presented as follows: holotype male, allotype female, and paratypes with mean, standard deviations, and range in parentheses. All measurements are given in millimeters. The scales of figures are given in micrometers. Specimens of nematodes were deposited in the Helminthological Collection of Museo de La Plata (MLP), La Plata, Buenos Aires, and hosts in Mastozoological Collections of the Centro Nacional Patagónico (CNP), Puerto Madryn, Chubut, and Mastozoological Collections of MLP.

DESCRIPTION

Trichuris navonae n. sp.
(Figs. 1–14, Table I)

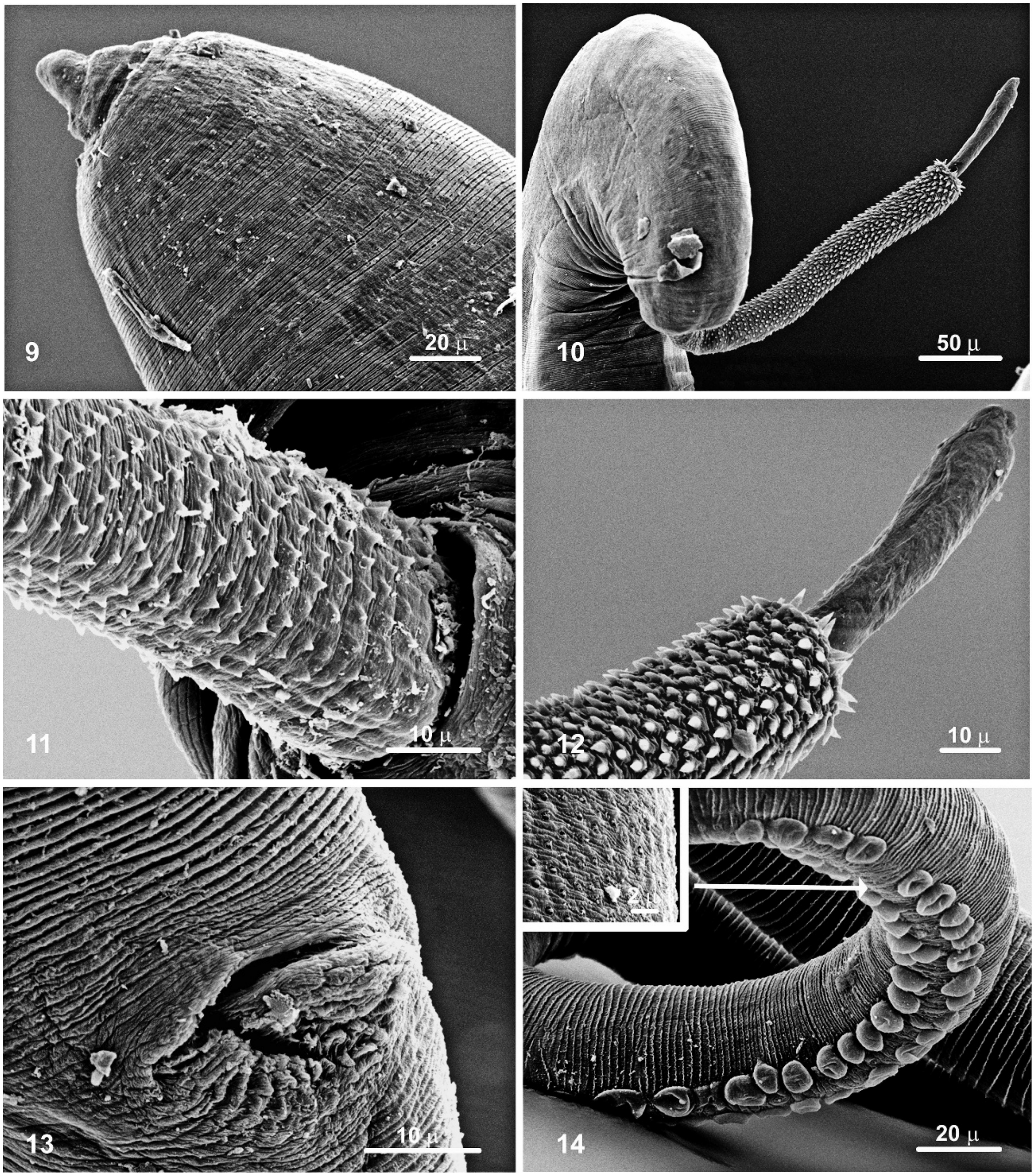
Diagnosis: Cuticle with fine transversal striation. Anterior part of body long, narrow, tapered, and whip-like; posterior part of body broad, and



FIGURES 1–8. *Trichuris navonae* n. sp. (**1**) Complete male specimen. (**2**) Male, esophagus-intestine junction and proximal portion of testis, lateral view. (**3**) Female, esophagus-intestine junction and vulva, lateral view. (**4**) Male, posterior end, spiny spicular sheath, spicule and proximal and distal cloacal tube, lateral view. (**5**) Egg. (**6**) Female, posterior end, lateral view. (**7**) Male, detail of the posterior extremity, lateral view. (**8**) Bacillary band, middle region view.

handle-like (Fig. 1). Ratio between anterior and posterior body length 1:1.2–1:1.4 in males and females. Stichosome with 1 row of stichocytes, and 1 pair of conspicuous cells at esophagus-intestinal junction level (Figs. 2, 3). Male without spicular tube. Proximal cloacal tube, united laterally to distal cloacal tube (Fig. 4). Spicular sheath cylindrical with spines distributed from proximal to distal portion; distal spines very sharpened and joined together (Figs. 7, 10–12). Testis ends near final third of distal cloacal tube, showing different degree of convolutions (Figs. 1, 4). Cloaca subterminal with 1 pair of paracloacal papillae, not ornamented. Female with nonprotrusive vulva located at esophagus-intestinal junction level (Figs. 3, 13). Anus subterminal, with long caudal end finished with terminal torsion (Figs. 6, 9).

Bacillary band located laterally in anterior portion of body (Figs. 8, 13, 14). Bacillary band 0.06–0.09 from anterior end of body and extends to



FIGURES 9–14. Scanning electron micrographs of *Trichuris navonae* n. sp. (**9**) Female, posterior end, lateral view. (**10**) Male, posterior end, dorsal view. (**11**) Male, detail of the proximal portion of spiny spicular sheath. (**12**) Male, detail of the distal portion of spiny spicular sheath. (**13**) Female, detail of non-protusive vulva, ventral view. (**14**) Cuticular inflations bordering the bacillary band, with detail of bacillary glands.

body width region of 0.1–0.19. With SEM, cuticular inflations appear bordering bacillary band at 0.25–0.31 from anterior end of body, forming low rings of thick walls and very reduced interior cavity (Fig. 14). These structures limit laterally to abundant and visible bacillary glands with conspicuous pore (Figs. 8, 14). Cuticle around vulvar aperture with transversally striated pattern (Figs. 3, 13).

Male (25 specimens): Body length 13.75, 11.64 ± 1.53 (9.75–15.02). Anterior portion of body 8.55, 6.69 ± 0.87 (5.5–8.5) long and thick portion of body 5.2, 4.88 ± 0.79 (3.97–6.75) long (Fig. 1). Anterior body width 0.06, 0.047 ± 0.01 (0.027–0.062), maximum posterior body width 0.34, 0.25 ± 0.039 (0.2–0.34), width at esophagus-intestinal junction level 0.1, 0.14 ± 0.025 (0.1–0.2) (Fig. 2). Total length of esophagus 8.55, 6.68 ± 0.89 (5.32–8.5), muscular portion 0.4, 0.43 ± 0.086 (0.3–0.62) long, stichosome portion 8.15, 6.24 ± 0.89 (5–8.15) long. Spicule length 1.8, 1.63 ± 0.18 (1.3–2) (Fig. 4). Spicular sheath densely spinose 1.59, 1.53 ± 1.2 (0.9–2) long (Figs. 4, 7, 10–12). Proximal cloacal tube 0.8, 1.11 ± 0.18 (0.8–1.4) long, distal cloacal tube 1.35, 1.32 ± 0.25 (1–1.9) long (Fig. 4). Ratio between total body length and posterior portion length 2.64, 2.37 ±

TABLE I. Main morphological features and measurements of 22 *Trichuris* species from American rodents.

Species:	*T. gracilis* (Rudolphi, 1819)	*T. opaca* Barker and Noyes, 1915	*T. fossor* Hall, 1916	*T. myocastoris* Enigk, 1933	*T. citelli* Chandler, 1945	*T. perognathi* Chandler, 1945
Reference:	Cameron and Reesal, 1951	Tiner, 1950	Chandler, 1945; Kenneth and Lepp, 1972	Lent and Freitas, 1936; Barus et al., 1975; Correa et al., 1992	Chandler, 1945	Chandler, 1945
Type host:	*Dasyprocta leporina**	*Ondatra zibethicus cinnamominius*	*Thomomys talpoides*†	*Myocastor coypus*	*Spermophilus beecheyi*‡	*Perognathus californicus californicus*
Other hosts:	—	*Microtus p. pennsylvanicus Ondatra z. zibethicus*	*Thomomys bottae bottae*	—	—	*Perognathus pennicillata*
Host family:	Dasyproctidae	Cricetidae	Geomyidae	Myocastoridae	Sciuridae	Heteromyidae
Localities:	(Trinidad) (Brazil)	Nebraska, Wisconsin, Ohio, Wyoming, Maryland (EEUU)	California, Wyoming (EEUU)	San Pablo (Brazil)	California (EEUU)	California (EEUU)
Male (N) (mm)	—	—	16	—	—	—
Body length	—	21.8–24.9	22–35	27.89–39.77	34.5–38.5	25–30
Anterior portion of body	—	13.1–14.5	12–21	19.02–26.7	21.5–24.5	—
Posterior portion of body	—	8.7–10.4	—	—	12.5–14.5	—
Anterior width	—	0.098–0.102	0.078–0.104	0.10–0.48	0.075	0.09
Esoph.-intes. junction width	—	0.16–0.17	—	—	0.35	—
Maximum posterior width	—	0.286–0.305	0.3–0.425	—	0.6	0.350
Spicular tube	—	Absent	?	Absent	Present	Present
Spicule length	—	1.20–1.36	0.97–1.35	2.96–4.5	1.3–2.1	0.9–1.15
Spicular sheath	—	With distal spherical bulge spiny	With distal spherical bulge spiny	Cylindrical and spiny	With distal spherical bulge spiny	Cylindrical and spiny
Cloacal tube#	—	1.7–2.10	2.5	—	1.5–1.9	2.00
Proximal clocal tube	—	—	—	1.29–1.72	—	—
Distal cloacal tube	—	—	—	1.26–2.63	1–1.3	0.4
Ratio post.–ant. of body	—	—	1:0.5–1:0.6	1:0.46–1:0.48	3:5–4:7	—
Female (N) (mm)	—	—	25	—	—	—
Body length	38.5–39.6	29.2–40.9	25–47	30.25–45.24	45	46–47
Anterior portion of body	21.52–27.44	14.3–15.1	14–25	22.28–31.82	26–27.5	21–23
Posterior portion of body	15.1–18.4	7.6–8.6	—	—	18–19.5	—
Anterior width	0.1–0.14	0.095	0.104–0.13	—	—	—
Esoph.-intes. junction width	0.3–0.4	0.15–0.23	—	—	0.35–0.4	—
Maximum posterior width	0.6–0.7	0.436–0.5	0.3–0.62	—	—	0.55
Distance between esoph.-intes. and vulva	0.07	0.05–0.2	0.037–0.087	—	0	—
Vulva	Not protrusive or lips slightly protruding	Not protrusive	Not protrusive	Not protrusive	Slightly protruding	With a cuticular evagination
Eggs length	0.05–0.059	0.059–0.062	0.069–0.077	0.05–0.065	0.070–0.074	0.065–0.067
Eggs width	0.023–0.028	0.029	0.030–0.038	0.024–0.030	0.033–0.035	0.031–0.033
Ratio post.–ant. of body	—	1.7:1–1.9:1	1: 0.48–1: 0.62	1: 0.31–1:0.47	2: 3–3: 4	—

TABLE I. Extended.

T. neotomae Chandler, 1945	*T. peromysci* Chandler, 1946	*T. madisonensis* Tiner, 1950	*T. dolichotis* Morini, Boero, and Rodriguez, 1955	*T. dipodomys* (Read, 1956)	*T. bradleyi* Babero, Cattan, and Cabello, 1975	*T. chilensis* Babero, Cattan and Cabello, 1976
Chandler, 1945	Chandler, 1946	Tiner, 1950	Morini et al., 1955	Read, 1956	Babero et al., 1975	Babero et al., 1976
Neotoma fuscipes	*Peromyscus californicus*	*Tamias striatus*	*Dolichotis patagonum*	*Dipodomys ordii*	*Octodon degus*	*Abrothrix longipilis*§
—	—	—	—	—	—	—
Cricetidae	Cricetidae	Sciuridae	Caviidae	Heteromyidae	Octodontidae	Cricetidae Santiago (Chile)
—	—	—	—	3	18	6
22–23	14.7–31.8	21.5	—	19.7–25.1	27–33	14.5–18.0
14–17	9.2–20.8	14.3	—	8.7–14.1	15–20	7.5–11.0
7.5–8	5.5–11.5	6.9–7.2	—	10.3–11.6	12–18	7.00–7.50
0.125	0.1–0.11	0.012–0.073	—	0.043	0.02	0.021–0.025
0.14	—	0.2	—	0.28–0.29	0.32	0.13–0.19
0.47–0.5	0.4–0.48	0.286–0.305	—	0.33–0.46	0.45–0.47	0.37–0.41
Present	Present	Present	—	Present	Absent	Absent
1.15–1.23	0.86–1.4	0.83–0.95	—	1.21–1.33	7.13–7.56	2.3–2.5
With distal spherical bulge spiny	Cylindrical and with spines uniformly distributed, and better develop distally	Cylindrical and spiny	—	Campanuliform and spiny	Cylindrical and spiny	Cylindrical and spiny
1.22–1.25	1.2–2.0	1.14–1.22	—	1.70–1.74		—
—	—	—	—	—	6.09–7.1	2.06–2.15
0.57–0.6	0.37–0.52	—	—	0.43–0.58	7.2–8.5	2.10–2.78
1: 2–3: 5	1: 2–3: 5	—	—	—	—	—
—	—	—	—	3	26	6
28–34	23–41	25.7–28.5	30	39.5–47.9	52.3–56.2	21.0–22.0
16–21	14.3–24.4	17.2–18.5	17	15.9–25.7	24.–39.10	10.5–11.7
13–16	9–17	8.5–10.0	13	22.2–23.6	24–34.3	11.0–11.7
—	—	—	0.1	—	—	—
015–0.18	0.1–0.12	—	0.2	0.16	0.36–0.44	0.33
0.7–0.8	0.55–0.625	—	0.5	0.51–0.58	0.79–0.85	0.51–0.55
0	0	—	—	0	0.15–0.27	0.11–0.15
Slightly protruding	Not protrusive	Not protrusive	Not protrusive	Anterior vulvar labium slightly projecting	Not protrusive	Slightly protruding
0.09	0.087–0.092	0.072	0.075	0.058–0.065	0.057–0.065	0.06–0.067
0.04	0.04	0.075	0.045	0.028–0.029	0.029–0.034	0.032–0.034
1: 1.25–1:1.6	2: 3	—	2: 1.5	—	—	—

TABLE I. Extended.

Species:	*T. fulvi* Babero and Murua, 1987	*T. elatoris* Pfaffnberger and Best, 1989	*T. robusti* Babero and Murua, 1990	*T. travassosi* Correa Gomes, Lanfredi, Pinto, and Souza, 1992	*T. laevitestis* Suriano and Navone, 1994	*T. bursacaudata* Suriano and Navone, 1994
Reference:	Babero and Murua, 1987	Pfaffnberger and Bests, 1989	Babero and Murua, 1990	Correa Gomes et al., 1992	Suriano and Navone, 1994; Robles and Navone, 2006	Suriano and Navone, 1994
Type host:	*Ctenomys fulvus phillipiensis*	*Dipodomys elator*	*Ctenomys robustus*	*Oligoryzomys nigripes*‖	*Scapteromys aquaticus*	*Ctenomys talarum*
Other hosts:	—	—	—	—	*Akodon azarae*	—
Host family:	Ctenomyidae	Heteromyidae	Ctenomyidae	Cricetidae	Cricetidae	Ctenomyidae
Localities:	San Pedro de Atacama (Chile)	Texas (Mexico)	La Hauyca (Chile)	Arvorezinha (Brazil)	Buenos Aires (Argentina)	Buenos Aires (Argentina)
Male (N) (mm)	2	8	3	—	37	16
Body length	23.5–26.48	15.0–21.0	20.1–26.65	32.0–40.0	13–25.2	18.5–23.0
Anterior portion of body	12.5–13.72	8.00–11.0	10.26–14.70	11.9–16.0	7.9–14.88	13.97–21.7
Posterior portion of body	10.0–12.76	8.00–11.0	9.44–14.20	20.1–24.0	4–11.31	—
Anterior width	0.04	—	0.02–0.03	0.028–0.043	0.04–0.19	—
Esoph.-intes. junction width	0.2–0.28	—	0.09–0.12	0.072–0.086	0.1–0.25	0.12–0.16
Maximum posterior width	0.49–0.52	—	0.41–0.57	0.34	0.17–0.39	0.48–0.53
Spicular tube	Present	Absent	Absent	Absent	Present	Absent
Spicule length	3.47–3.71	0.92–1.03	2.30–3.90	2–2.56	2.73–6.8	4.8–5.6
Spicular sheath	Cylindrical and spiny	Cylindrical and spiny	Cylindrical and spiny	Cylindrical and with spines dense proximately	Cylindrical and with distal spines of rounded tip	Pseudobursa spiny
Cloacal tube#	1.7–2.3	0.85–1.07	—	—	—	—
Proximal clocal tube	—	—	1.65–2.6	0.42–0.71	0.84–1.8	1.73–1.95
Distal cloacal tube	0.43–0.56	—	2.31	1.2–1.4	0.52–2.25	3.9–4.5
Ratio post.–ant. of body	—	—	—	—	1:1.48	1:1– 1:1.3
Female (N) (mm)	2	8	3	—	30	16
Body length	34.8–40.07	25.0–31.0	37.35–46.10	38.89–48.52	13.45–27.56	32.65–43.35
Anterior portion of body	14.0–20.02	9.0–12.0	14.00–24.36	14.07–20.01	8.19–16.77	15.88–21.7
Posterior portion of body	16.2–22.8	16.0–19.0	18.35–27.00	24.82–28.51	6.24–13.06	—
Anterior width	—	—	0.03–0.04	0.043–0.052	0.039–0.14	—
Esoph.-intes. junction width	0.24–031	0.14–0.19	0.28–0.35	0.086–0.12	0.1–0.26	0.22–0.30
Maximum posterior width	0.64–0.72	0.33–0.5	0.63–0.8	0.5–0.63	0.25–0.4	0.32–0.56
Distance between esoph.-intes. and vulva	0.19–0.26	0.15–0.33	0	0	0–0.18	0.1–0.25
Vulva	Not protrusive	Not protrusive	Not protrusive	Not protrusive	Protrusive	Not protrusive
Eggs length	0.065–0.072	0.061–0.066	0.057–0.065	0.054–0.061	0.066–0.08	0.06–0.07
Eggs width	0.028–0.031	0.027–0.029	0.029–0.036	0.025–0.028	0.027–0.04	0.02–0.03
Ratio post.–ant. of body	—	—	—	—	1:1.3	1:1.1–1:1.9

TABLE I. Extended.

T. pampeana Suriano and Navone, 1994	*T. pardinasi* Robles, Navone, and Notarnicola, 2006	*Trichuris* n. sp. Present study
Suriano and Navone, 1994; Rossin and Malizia, 2005	Robles et al., 2006	
Ctenomys azarae	*Phyllotis xanthopygus*	*Akodon montensis*
Ctenomys talarum	—	
Ctenomyidae	Cricetidae	Cricetidae
La Pampa, Buenos Aires (Argentina)	Buenos Aires, Córdoba (Argentina)	Misiones (Argentina)
52	12	25
23.26–43.6	18.81–22.55	9,46–16.24
22.38–29.1	9.26–12.41	5.47–9
10.2–14.48	10.07–12.85	3.9–7.24
0.09–0.12	0.12–0.16	0.027–0.075
0.20–0.32	0.15–0.25	0.087–0.2
0.3–0.52	0.35–0.78	0.2–0.34
Absent	Absent	Absent
3.7–4.4	4.30–5.2	1.3–2.1
Cylindrical and with spines dense proximately	Cylindrical and spiny	Cylindrical and with distal spines of sharp tip
—	—	—
1.77–2.89	2.14–3.47	0.75–1.5
2.18–4.5	3–4.81	1–1.9
1: 1.21	–	1:1.2–1:1.4
47	8	27
32.7–73.1	37.54–42.9	10.6–24.8
19.4–39.95	15.64–16.85	5.6–14.5
13.3–33.15	19.47–21.97	4–10.7
0.10–0.15	0.0.78–0.15	0.031–0.093
0.17–0.26	0.22–0.32	0.09–0.25
0.49–0.66	0.58–0.71	0.2–0.36
0.020.38	—	—
Not protrusive	Not protrusive	Not protrusive
0.058–0.06	0.06	0.05–0.06
0.02–0.03	0.03	0.02–0.03
1: 1.14	—	1:1.2–1:1.4

0.14 (2.12–2.57). Ratio between total body length and spicule length 7.63, 7.14 ± 0.69 (6.32–8.44). Ratio between posterior portion length and spicule length 2.88, 2.99 ± 0.41 (2.56–3.97). Ratio beween proximal cloacal tube length and distal cloacal tube length 0.59, 0.77 ± 0.09 (0.60–0.95). Ratio between maximum posterior body width and posterior portion length 0.06, 0.056 ± 0.01 (0.04–0.07).

Female (27 specimens): Body length 22.31, 18.46 ± 2.5 (13.39–22.7). Anterior portion of body 12.5, 10.31 ± 1.5 (6.89–12.23) long, and thick portion of body 9.81, 7.8 ± 1.56 (4–10.7) long. Anterior body width 0.09, 0.052 ± 0.016 (0.031–0.093), maximum posterior body width 0.36, 0.28 ± 0.033 (0.25–0.36), width at esophagus-intestinal junction 0.156, 0.15 ± 0.034 (0.09–0.25) (Fig. 3). Total length of esophagus 12.5, 10.29 ± 1.5 (6.89–12.23), muscular portion 0.62, 0.51 ± 0.074 (0.38–0.62) long, stichosome portion 11.88, 9.78 ± 1.53 (6.3–11.85) long. Distance between esophagus-intestinal junction and vulva 0.05, 0.08 ± 0.05 (0.02–0.014) (Fig. 3). Eggs oval, flat, with bipolar plugs (n = 10) 0.03 × 0.06 (Fig. 5). Ratio between total body length and posterior portion length 2.27, 2.27 ± 0.15 (2.06–2.5). Ratio between maximum posterior body width and posterior portion length 0.03, 0.04 ± 0.009 (0.028–0.06).

Taxonomic summary

Type host: Akodon montensis Thomas, 1913 (Sigmodontinae: Akodontini).

Symbiotype: Female CNP 1833 (BC). Other hosts housed at the CNP 1811, 1825, 1831, 1850, 1852 (BC); CNP 1922, 1924 (CP); CNP 1923, 1934 (AP); CNP 1925 (SP); CNP 1937 (AO); CNP 1939, 1940 (CC); CNP 1936 (PM); MLP 24.VIII.00.17 (PP).

Type locality: Balneario Municipal de Aristóbulo del Valle (BC), (27°05′S, 54°56′W), Aristóbulo del Valle, Departamento Cainguás, Misiones, Argentina.

Other localities: CP (26°40′S, 54°48′W), AP (26°40′S, 54°50′W), AS (26°36′S, 54°46′W), SP (27°13′S, 54°02′W), AO (27°08′S, 53°55′W), CC (26°31′S, 53°59′W), PM (27°08′S, 53°53′W), PP (25°40′S, 54°38′W).

Site of infection: Caecum.

Type specimens: Holotype male, allotype female, 4 paratypes and 14 voucher specimens deposited at the Helminthological Collection of MLP, MLP numbers: 6261, 6262, 6263 and 6264, 6265, 6266, 6267, 6268, 6269, 6270, 6271, respectively.

Etymology: Dedicated to my mentor, Graciela T. Navone, a world-recognized parasitologist from Argentina.

Remarks

Trichuris navonae n. sp. can be separated from 8 of the species parasitic in American rodents, i.e., *T. citelli, T. perognathi, T. neotomae, T. peromysci, T. madisonensis, T. dipodomys, T. fulvi,* and *T. laevitestis,* by the absence of a spicular tube (the spicule lies entirely within the distal cloacal tube).

The new species differs from *T. opaca, T. fossor, T. citelli, T. neotomae, T. dipodomys,* and *T. bursacaudata* by lacking a spicular sheath with a spiny distal spherical bulge or a spiny campanuliform shape. Among those species with a cylindric spicular sheath, the new species can be separated from *T. travassosi, T. laevitestis,* and *T. pampeana* by the distribution of spines.

The new species has a shorter spicule than *T. myocastoris, T. bradleyi, T. chilensis, T. fulvi, T. robusti, T. travassosi, T. laevitestis, T. bursacaudata, T. pampeana,* and *T. pardinasi* and longer than *T. opaca, T. fossor, T. perognathi, T. neotomae, T peromysci, T. madisonensis, T. dipodomys,* and *T. elatoris.* Moreover, *T. navonae* n. sp. has a shorter distal cloacal tube than *T. bradleyi, T. chilensis, T. robusti, T. bursacaudata, T. pampeana,* and *T. pardinasi* and longer than *T. perognathi, T. neotomae, T peromysci, T. dipodomys,* and *T. fulvi.*

←

* Cited as *Cavia agouti* by Rudolphi, 1819.
† Cited as *Thomomys fossor* by Hall, 1916.
‡ Cited as *Citellus beecheyi* by Chandler, 1945
§ Cited as *Akodon longipilis* by Babero, Cattan, and Cabello, 1976.
‖ Cited as *Oryzomys nigripes* by Correa Gomes et al., 1992.
\# Referred by author.

Since the males of *T. gracilis* and *T. dolichotis* have not been described, these species were not included in the preceding comparison. However, the females of these species can be separated from *T. navonae* by the dimensions of the body length, and the lengths of the anterior and posterior portions of the body.

Also, the new species has smaller distance to vulva from the anterior end than *T. gracilis, T. myocastoris, T. citelli, T. perognathi, T. neotomae, T. madisonensis, T. dolichotis, T. dipodomys, T. bradleyi, T. bursacaudata, T. pampeana,* and *T. pardinasi.*

A comparison between the lengths of the bacillary bands, and the size, shape, and distribution of the bacillary glands, as well as their number, with respect to the tranversal cuticular striations showed differences with other previously studied species with SEM such as *T. myocastoris, T. travassosi, T. pampeana, T. padinasi,* and *T. laevitestis.* The bacillary band of *T. navonae* begins anteriorly to that reported for *T. laevitestis* but is similar to the rest of the species. The cuticular inflations of the new species form low rings with thick walls and a very reduced interior cavity, differing from the species mentioned above (Gomes et al., 1992; Lanfredi et al., 1995; Rossin and Malizia, 2005; Robles and Navone, 2006; Robles et al., 2006).

Table I lists the measurements (generally ranges of paratypes) of all the *Trichuris* species from North and South American rodents (Lent and Teixeira de Freitas, 1936; Chandler, 1945; Tiner, 1950; Cameron and Reesal, 1951; Morini et al., 1955; Read, 1956; Kenneth and Leep, 1972; Babero et al., 1975, 1976; Barus et al., 1975; Babero and Murua, 1987; Pfaffnberger and Best, 1989; Babero and Murua, 1990; Gomes et al., 1992; Suriano and Navone, 1994; Rossin and Malizia, 2005; Robles and Navone, 2006; Robles et al., 2006). This table presents updated names of all hosts (Wilson and Reeder, 2005); the host names identified in the original papers are placed in the footnotes.

DISCUSSION

Twenty-two species of *Trichuris* parasites from 9 host families of American rodents have been compared in this paper. Although the ranges of some morphometric features overlap among different species (Spakulová, 1994), and some share morphologic characteristics, the combination of these characters permit separation of the different species. The unique features of *T. navonae* n.sp., such as the absence of a spicular tube, a cylindrical spicular sheath with very sharp and joined together spines, a non-protrusive vulva, and different morphometric characters and ratios, combine to validate a new species.

Morphological details of *T. navonae* and diagnostic structures were also examined using SEM. Although the bacillary band can be differentiated from the remaining transversal striated cuticle using light microscopy, only a few studies include an SEM description of this structure. Although fixation can alter the structure of the bacillary band (Wright, 1975), in the new species the bands appear to be very well conserved, showing some differences in the distribution of the glands, and different sizes and shapes of cuticular inflations compared with those observed in 5 other studied species (Gomes et al., 1992; Lanfredi et al., 1995; Rossin and Malizia, 2005; Robles and Navone, 2006; Robles et al., 2006). Since the bacillary bands are not known for all *Trichuris* species, it is possible that the real importance of this structure will be assessed only when new studies with detailed descriptions, illustrations, and photographs are provided.

The description of *T. navonae* was based on *A. montensis* specimens from 9 localities. These localities are distributed in the north, middle, and margins of 2 bordering rivers, the Paraná and Uruguay, from the Misiones Province. This species is evidently associated with the host and the Paranaense Forest since other species of sigmodontine rodents distributed in several environment of Argentina were parasitized with other different species of *Trichuris.* Further studies are necessary to verify if the new species follows the distribution of *A. montensis* in the rest of the Atlantic forest in Paraguay and Brazil.

Although the Paranaense Forest has a high species diversity, very few species of mammal parasites have been described in the area (e.g., Notarnicola and Navone, 2002; Robles and Navone, 2007, 2010; Lareschi, 2010). *Trichuris navonae* n. sp. constitutes the third record of this genus in rodents of the Sigmodontinae from Argentina and the fifth from South American rodents. Sigmodontine rodents are distributed predominantly in South American, reaching a Central and North American distribution; this subfamily includes approximately 400 species (D'Elía et al., 2007). Despite the large number of potential host species, only about 1.9% of sigmodontine rodent species have been recorded as hosts for *Trichuris* spp. (Babero et al., 1976; Gomes et al., 1992; Suriano and Navone, 1994; Wilson and Reader, 2005; Robles et al., 2006). It is suggested that this number represents but a small fraction of *Trichuris* spp. that occur in sigmodontine rodents, and that additional survey of this group should yield additional species.

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