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Nota

HELMINTH INFECTION LEVELS ON *Rattus rattus* (RODENTIA: MURIDAE) FROM CORRIENTES CITY, ARGENTINA

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ABSTRACT. The aim of this study was to describe the infection levels of helminths of *Rattus rattus* in Corrientes city, Corrientes Province, Argentina. In order to determine the role of rodents as potential reservoirs for zoonotic parasites, different indices of helminth infection were assessed with respect to sex, age, season and urban landscapes. A total of 107 individuals of *R. rattus* were examined. Seven species of helminths were found. The values of total prevalence, mean intensity and mean abundance were 68%, 20 and 13, respectively. *Nippostrongylus brasiliensis* was the species more prevalent and abundant. The results showed that the age of the rodents and the season of capture had effects on the helminth infection.

RESUMEN. Niveles de infección de helmintos de *Rattus rattus* (Rodentia: Muridae) en la ciudad de Corrientes, Argentina. El objetivo del trabajo fue describir los niveles de infección de *Rattus rattus* en la ciudad de Corrientes, provincia de Corrientes, Argentina. Con el objetivo de determinar el rol de los roedores como reservorios potenciales de parásitos zoonóticos, se analizó la distribución de helmintos respecto al sexo, edad, estación del año y ambientes urbanos. Un total de 107 individuos de *R. rattus* fueron examinados. Se identificaron siete especies de helmintos. Los valores de prevalencia total, intensidad media y abundancia media fueron 68%, 20 y 13, respectivamente. *Nippostrongylus brasiliensis* fue la especie más prevalente y abundante. Los resultados demostraron que la edad de los roedores y la estación del año tuvieron efectos en la infección con helmintos.

Key words: Commensal rodents. Helminths. Northeast Argentina. Parasitological indices.

Palabras clave: Helmintos. Índices parasitológicos. Nordeste Argentino. Roedores sinantrópicos.

In urban and suburban environments rodents find numerous shelters, which increase the contact between rats and humans. Consequently, this may result in an increase of zoonotic diseases (Stojcevic et al. 2004). Murid rodents have been recognized as reservoirs of different protozoa and helminth parasites of zoonotic importance in Argentina (Hancke et al. 2011; Hancke & Suárez 2015), America (Waugh et al. 2006; Panti-May et al. 2013; Simões et al. 2014;

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De Sotomayor et al. 2015), and other parts of the world (Milazzo & Goüy de Bellocq 2003; Stojcevick et al. 2004; Milazzo et al. 2010a; Feliú et al. 2012; Mohd Zain et al. 2012; Sharma et al. 2012; Tung et al. 2013).

In Argentina, the levels of poverty and inequality have grown noticeably in the last decades, originating multiple shantytowns consolidated mostly in the periphery of the bigger cities (Zonta et al. 2007). In the northeast of the country, Corrientes city is an example of this situation, as it is one of the fastest growing urban districts. In spite of this, the few studies on parasites of commensal rodents were carried out in Buenos Aires Province (Gómez Villafañe et al. 2008; Hancke et al. 2011; Hancke & Suárez, 2015; Fitte et al. 2017). The aim of this study was to describe the infection levels of helminths parasitizing *Rattus rattus* (Linnaeus, 1758) in Corrientes city (27°28'00" S, 58°50'00" W), capital of the Province of Corrientes, Argentina. Different ecological parameters of the distribution of helminths were analyzed with respect to sex and age of hosts, seasons and levels of urbanization in order to determine the role of these rodents as potential reservoirs of zoonotic parasites.

Two sampling efforts were conducted in 2013: one in May, representing the cold season, with minimum night temperatures below zero and low rainfall, and one in September, representing the warm and rainy season, with maximum day temperatures between 20° and 40° C (Brown et al. 2006). Different neighborhoods with two types of urbanization landscapes were involved in this study: urban areas (UA) and suburban areas (SA). Buildings and pavement were the dominant elements in UA, and unpaved streets, sparsely distributed houses, precarious housing conditions and the presence of patches of spontaneous vegetation were the dominant elements in SA (Cavia et al. 2009). The rats sampling were conducted in both types of urbanization for each season (cold and warm).

Official collecting permits were granted by Dirección de Flora y Fauna, Ministerio de Turismo de Corrientes. The specimens were obtained following the procedures and protocols approved by national laws. Traps were set inside and in the backyards of houses of each type of urbanization. The total trapping effort was 1900 traps/night (Jones et al. 1996). The rodents were sexed, measured and weighed. Individuals were classified as either sub-adults (≤70g female, ≤80g males) or adults (≥70g females, ≥80g males) (Panti-May et al. 2012). The digestive track and annexed glands were fixed in 10% formalin and examined. Helminths were preserved in 70% ethanol. Prevalence (P), Mean Abundance (MA), Mean Intensity (MI) and Specific Richness (S) were calculated following Bush et al. (1997). The dominance (D) level of each species in the component community was estimated following Morales & Pino (1987). Chi-square and Fisher's exact test were used to evaluate the statistical differences of proportions (p) respect to the host (sex and age) and environmental variables (season and urbanization landscapes). In addition, a Bootstrap test was applied to compare the differences of infection (MA and MI) with respect to the same variables (Quantitative Parasitology 3.0 software, Rozsa et al. 2000).

A total of 107 individuals of *R. rattus* were captured and analyzed. Seven species of helminths were found. The parasite species, localization in the host and infection parameters are shown in **Table 1**. All helminths were present in the adult stage, with the exception of the acanthocephala and the cysts of the cestode *Taenia taeniaeformis* (Batsch, 1786) frequently called *Strobilocercus fasciolaris*.

The total P was 68%. Thirty five percent of the rats were parasitized with one helminth species (monoparasitism), 38% with two species, and 27% with three or more. The most prevalent species was *Nippostrongylus brasiliensis* (Travassos, 1914), followed by the cysts of *T. taeniaeformis* and *Heterakis spumosa* (Schneider, 1866). *Nippostrongylus brasiliensis* presented the highest values of MA, MI and D.

Helminths were significantly more prevalent and abundant in adult (n = 43, P = 95%; MA = 19) than in subadult rodents (n = 44, P = 29%, MA = 2.7) (x^2 = 39 df = 1, p≤ 0.001 and Bootstrap p-value = 0.02, respectively). Also, helminths were significantly more prevalent in warm season (n = 46, P = 71%) than in cold season (n = 41, P = 51%) (x^2 = 3.8 df = 1, p = 0.04). There were no significant differences in MA

Table 1

Helminth species, localization, parasitological indices and dominance in *Rattus rattus* (n = 107) from Corrientes city, Argentina.

	Helminths	Infection site	P % (CI)	MA (CI)	MI (CI)	Dominance
Nematoda	*Nippostrongylus brasiliensis* (Travassos, 1914)	SI	37.4 (28.4-47.1)	10.9 (6.5-19.6)	29.2 (18.8-53.3)	79
	Heterakis spumosa (Schneider, 1866)	LI. Cecum	25.2 (17.6-34.5)	1.05 (0.5-2.2)	4.15 (2.4-7.7)	7.5
	Trichuris muris (Schrank,1788)	Cecum	15 (9.2-23.2)	0.46 (0.2-0.7)	3.06 (2.1-4.4)	3.3
	Syphacia muris (Yamaguti, 1941)	Cecum	0.9 (0.05-4.9)	0.07 (0-0.2)	8[a]	0.5
Cestoda	*Taenia taeniaeiformis* (Batsch, 1786)	Liver	26.2 (18.6-35.4)	0.33 (0.2-0.4)	1.25 (1-1.6)	2.3
	Hymenolepis sp. (Weinland, 1858)	SI	24.3 (16.6-33.5)	0.62 (0.4-0.9)	2.54 (2-3)	4.4
Acantocephala	*Moniliformis* sp. (Travassos, 1915)	SI	5.6 (02.4-11.9)	0.13 (0.04-0.2)	2.33 (1.3-3.3)	0.9

CI 95% Confidence Intervals. SI: Small Intestine. LI: Large Intestine. [a]Helminth present in one host individual.

and MI in the rest of variables (sex, season and urban landscapes). Among helminth species, *N. brasiliensis*, *H. spumosa*, *T. muris* (Schrank, 1788), *Hymenolepis* sp. and cysts of *T. taeniaeformis* were significantly more prevalent in adult than in subadult rodents ($x^2 = 14$ df = 1, p< 0.01; $x^2 = 15$ df = 1, p< 0.01; $x^2 = 11$ df = 1, p< 0.01; $x^2 = 10$ df = 1, p< 0.01; $x^2 = 13$ df = 1, p< 0.01; respectively). Also, *T. muris* was more frequently found in UA than in SA ($x^2 = 6.3$ df = 1, p< 0.01). The rest of the helminths species did not show significant differences with respect to prevalence. Regarding MA, *N. brasiliensis*, *T. muris*, *Hymenolepis* sp. and cysts of *T. taeniaeiformis* were significantly more abundant in adults than in subadult rodents (Bootstrap p-values = 0.02; 0.03; 0.01; and <0.001; respectively) and only *T. muris* was more abundant in UA than in SA (Bootstrap p-value = 0.02). Respect to MI, *T. muris* showed higher intensity in males (Bootstrap p-value = 0.03) and in UA (Bootstrap p-value = 0.02). The rest of the helminth species did not show significant differences in MA and MI.

In Argentina, the helminth communities of commensal rodents are better known in *R. norvergicus* (Gómez Villafañe et al. 2008; Hancke et al. 2011) than in *R. rattus* (Hancke & Suárez 2015). The total prevalence of helminths in *R. rattus* reported in this paper was higher than those recorded in other countries of the Americas (52.2% in Mexico, Panti-May et al. 2013; 35% in Jamaica, Waugh et al. 2006) and lower than in Peru (90.8% and 77.4%, Iannacone Oliver & Alvariño Flores 2002, and De Sotomayor et al. 2015, respectively).

The percentages of poly- and monoparasitism from commensal rodents in the present study differ from those given by other authors, such as Waught et al. (2006) and Panti-May et al. (2013), who found only up to 20% of polyparasitism and between 80% and 81% of monoparasitism, respectively.

We observed that the age of the rodents has effects on helminth infection (P and MA). Similar results of P and MI in adult rodents were previously reported in *Mus musculus* and *R. norvergicus* (Stojcevic et al. 2004; Gómez Villafañe et al. 2008; Milazzo et al. 2010b; Panti-May et al. 2013). The size of adult rodents increases in relation to age, and consequently these are more parasitized than juveniles due to their longer exposure time to infectious stages (Cattadori et al. 2006). The prevalence of infection was significantly higher during the warm season, which coincides predominantly with host reproduction period (Morand et al. 2006). Certain surveys recorded a significantly higher prevalence in autumn (Feliú et al. 2012), while others observed no significant differences (Hancke et al. 2011). Notably, the different conditions of the neighborhoods sampled (except the case of *T. muris*) do not seem to influence the indices of the helminth species neither the species richness. Further studies are needed to corroborate whether the increase of urbanization levels and rodent density have effects on sanitary risks in the city of Corrientes. In this sense, *Hymenolepis* sp., cysts of *T. taeniaeformis* and immature stages of *Moniliformis* sp. are recognized as zoonotic parasites.

Cysts of *T. taeniaeformis* and *Hymenolepis* sp. showed prevalences of 26.2% and 24.3%, respectively. Both species are of health importance, and it is notable that the results in Corrientes are higher than those recorded in other sites in South America. Additionally, different Argentinian surveys indicated the presence of eggs of *Hymenolepis* sp. in humans (Costamagna et al. 2002; Gamboa et al. 2014). *Nippostrongylus brasiliensis* had the highest prevalence and dominance among collected helminths (37.4% and 79, respectively). *Heterakis spumosa* was the second nematode found in order of prevalence. *Trichuris muris* is reported for first time in Argentina associated with *R. rattus* and no data on levels of infection are known in other countries of the American continent. *Syphacia muris* was only found in one individual (P = 0.9%), and constitutes the first report in *R. rattus* from Argentina. *Moniliformis* sp. was not identified at the species level because they were found in immature stages and showed a low prevalence (5.6%). Prevalence of the helminths parasites in the present study differs from those reported by other authors (**Table 2**).

Notably, in this study the P, MA and MI did not coincide with previous records from Argentina and other countries of South America. However, in general, the results on the species

Table 2
Prevalence of species parasite in different hosts from different countries of the continent.

Parasite specie	P (%)	MA	MI	Country	Hosts	References
Nippostrongylus brasiliensis	11	-	-	Argentina	*R. norvergicus*	Gómez Villafañe et al. 2008
	75	135.3	180.4		*R. norvergicus*	Hancke et al. 2011
	100	9.5	-	Mexico	*R. rattus*	Pulido Flores et al. 2005
	43.5	-	8.0		*R. rattus*	Panti-May et al. 2013
	14.2	-	22.6	Jamaica	*R. rattus*	Waugh et al. 2006
Heterakis spumosa	66	-	-	Argentina	*R. norvegicus*	Gómez Villafañe et al. 2008
	77.5	25.4	32.8		*R. norvegicus*	Hancke et al. 2011
	3.1	0.03	1	Peru	*R. rattus*	Iannacone Oliver & Alvariño Flores 2002
	13.2	-	-		*R. rattus*	De Sotomayor et al. 2015
Taenia taeniaeformis	35	0.5	1.4	Argentina	*R. norvegicus*	Hancke et al. 2011, Fitte et al. 2017
	19	0.52	2.75		*R. rattus*	Fitte et al. 2017
	14	0.18	1.33		*M. musculus*	Fitte et al. 2017
	8.33	0.17	2.09		*A. azarae*	Miño et al. 2012
	4.3	-	1.5	Mexico	*R. rattus*	Panti-May et al. 2013
Hymenolepis sp.	5	0.2	4.5	Argentina	*R. norvegicus*	Hancke et al. 2011
	21	2.04	9.56		*Rattus* spp.	Hancke & Suárez 2015
Moniliformis sp.	3.5	0.035	1	Brazil	*R. norvegicus*	Simões et al. 2014

found are similar to previous studies (Waugh et al. 2006; Hancke et al. 2011; Panti-May et al. 2013; Simões et al. 2014). In this sense, the urban environment is particularly problematic with regard to rat-associated health risks since zoonotic disease transmissions are frequent. In Argentina, poverty results in numerous shantytowns with similar conditions to those described in this paper (Zonta et al. 2007). It is important to continue studying the factors that could induce changes in the levels of infection of helminths in commensal rodents, especially considering the zoonotic importance of some species.

A total of 4 new parasite associations with *R. rattus* are reported for Argentina in this note (*Nippostrongylus brasiliensis*, *Heterakis spumosa*, *Trichuris muris* and *Syphacia muris*). Although commensal rodents are well known in many ecological and epidemiological aspects, the studies in Argentina are still preliminary.

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