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SHORT COMMUNICATION

Survey of intestinal helminths collected from pet rodents in México

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Abstract In this survey, intestinal helminths from pet rodents in Mérida, México, were analyzed. A total of 46 mice *Mus musculus*, 28 hamsters *Mesocricetus auratus*, 23 rats *Rattus norvegicus*, and 1 gerbil *Meriones unguiculatus* were purchased from six pet shops and one black market for wildlife in the city of Mérida. The overall prevalence of helminths in rodents was 61.2% (60/98). Six species of helminths were identified: the zoonotic cestode *Rodentolepis nana*, and the nematodes *Aspiculuris tetraptera*, *Dentostomella translucida*, *Syphacia obvelata*, *Syphacia mesocriceti*, and *Syphacia muris*. Of the 60 infected rodents, 25 (41.7%) harbored 2 or 3 species of helminths. *Rodentolepis nana* was found in 4.3% of mice and 17.9% of hamsters. This is the first report of infection with *S. muris* in pet rats. Considering the close physical contact between pet rodents and humans, the presence of *R. nana* in pets represents a potential risk of transmission, especially to children and immunocompromised individuals.

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Introduction

Breeding and rearing exotic pet animals have increased worldwide popularity in the last decades. Among these, small rodents such as mice *Mus musculus* Linnaeus, 1758, rats *Rattus norvegicus* (Berkenhout, 1769), and hamsters *Mesocricetus auratus* (Waterhouse, 1839) are the most popular pocket pets today (Grier 2006). They are essential companions in many households, providing psychological, social, and emotional benefits for children and adults (Bryant 1990). In addition, some authors have reported that pet owners go to the doctor less often and take fewer medications than people that did not own a pet, which saves money on health expenditures (Headey et al. 2002).

Although pet rodents provide benefits to owners, they are also recognized as carriers of zoonotic agents, such as viruses, bacteria, and helminths (Stone and Manwell 1966; Amman et al. 2007; Gaudie et al. 2008). Among zoonotic helminths, the cestodes *Hymenolepis diminuta* (Rudolphi, 1819) and *Rodentolepis nana* (von Siebold, 1852) have been found as common parasites in pet rodents (Stone and Manwell 1966; Hasegawa et al. 2008; Roble et al. 2012; d'Ovidio et al. 2015). In Italy, d'Ovidio et al. (2015) reported the infection by *R. nana* in rats *R. norvegicus*, mice *Mus minutoides* Smith, 1834, chinchillas *Chinchilla lanigera* Bennett, 1829, and hamsters *Phodopus campbelli* (Thomas, 1905), and the infection by *H. diminuta* in squirrels *Callosciurus prevosti* (Desmarest, 1822) from pet shops and private owners. In Japan, *R. nana* was found in imported pet hamsters *M. auratus* and *Phodopus sungorus* (Pallas, 1773) from the Czech Republic and the Netherlands (Hasegawa et al. 2008).

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Pet rodents, as with other companion animals, require care and veterinary attention because they also suffer from diseases. Nematodes of the genera *Syphacia* Seurat, 1916, and *Aspiculuris* Schultz, 1924, are common parasites of pet and laboratory rodents (Pinto et al. 1994; Hasegawa et al. 2008; Roble et al. 2012). Although they are relatively non-pathogenic, heavy infections can cause poor host condition and diarrhea (Klement et al. 1996; Baker 2007). In addition, reinfection with these nematodes represents an important health problem (Baker 2007).

In México, there are no previous reports of the parasites of pet rodents. In the present study, we report the prevalence and intensity of intestinal helminths in pet rodents in the city of Mérida, Yucatán, México.

Material and methods

Between September 2016 and January 2017, 46 mice *M. musculus*, 28 hamsters *M. auratus*, 23 rats *R. norvegicus*, and 1 gerbil *Meriones unguiculatus* (Milne-Edwards, 1867) were purchased from six pet shops and one black market for wildlife, which are the most important sources of pocket pets in the city of Mérida. Rodents were transported in plastic boxes from the shop/market to the Laboratorio de Arbovirología, Centro de Investigaciones Regionales 'Dr. Hideyo Noguchi', Universidad Autónoma de Yucatán (UADY). Specimens were anesthetized with isofluorane and euthanized by cervical dislocation or overdose of sodium pentobarbital. After euthanasia, the intestinal tracts were collected and examined for parasites. Helminths were preserved in 70% ethanol and identified at the Centro de Estudios Parasitológicos y de Vectores (CEPAVE), CCT-CONICET-UNLP. For identification, nematodes were cleared in lactophenol and cestodes were stained with acetic carmine and mounted in Canada balsam. Vouchers of specimens were deposited in the helminthological collection of the Museo de La Plata, Argentina (MLP-He 7401–06).

Prevalence and mean intensity of helminth infection were calculated (Bush et al. 1997).

The ethics committee for the use of animals from the Campus de Ciencias Biológicas y Agropecuarias, UADY, approved the protocols used in this study (CB-CCBA-L-2017-001), and the guidelines of the American Veterinary Medical Association for the euthanasia of animals (Leary et al. 2013) were adhered to.

Results and discussion

The overall prevalence of helminths in pet rodents was 61.2% (60/98). Six species of helminths were identified: the cestode *R. nana*, and the nematodes *Aspiculuris tetraptera* (Nitzsch, 1821), *Dentostomella translucida* Schulz & Krepkorgorskaja, 1932, *Syphacia obvelata* (Rudolphi, 1802), *Syphacia mesocriceti* Quentin, 1971, and *Syphacia muris* (Yamaguti, 1935) (Table 1). Mice were infected with three helminth species, hamsters with two species, and rats and the gerbil with one species. Of the 60 infected rodents, 25 (42.4%) harbored 2 or 3 species of helminths. *Rodentolepis nana* was found in mice and hamsters.

Rodentolepis nana is the most human-prevalent cestode worldwide (Thompson 2015). In the present study, this species was found in mice and hamsters from four dealers (three pet shops and the black market). This cestode has been reported in the same pet rodents in Brazil (Pinto et al. 2001), Japan (Hasegawa et al. 2008; Hayashimoto et al. 2015), USA (Stone and Manwell 1966; Roble et al. 2012), and Turkey (Sürsal et al. 2014) (Table 2). Infections with *R. nana* in rodents are usually non-pathogenic, but heavy infections can cause acute catarrhal enteritis or chronic enterocolitis (Baker 2007). Humans can acquire the infection by accidental ingestion of intermediate hosts (e.g., beetles or fleas) or embrionated eggs, usually from contaminated food. Human hymenolepiasis is often asymptomatic, but it can cause chronic diarrhea, abdominal pain, irritability, and itching (Chero et al. 2007). In addition, the poor hygiene practices and the close physical proximity between pet rodents and breeders, vendors, and pet owners, especially children and immunocompromised persons, help to promote the direct transmission of pathogens (Amman et al. 2007).

Table 1. Prevalence (%) and intensity of helminth species of mice *Mus musculus*, hamsters *Mesocricetus auratus*, rats *Rattus norvegicus*, and a gerbil *Meriones unguiculatus* from México

Rodent host	No. hosts examined	No. hosts infected	Helminth species	Prevalence and intensity (mean [range])
Mice	46	2	*Rodentolepis nana*	4.3 (3 [2–3])
		36	*Syphacia obvelata*	78.3 (37.2 [1–148])
		28	*Aspiculuris tetraptera*	60.9 (29.4 [1–226])
Hamsters	28	5	*Rodentolepis nana*	17.9 (50.6 [3–175])
		8	*Syphacia mesocriceti*	28.6 (48.5 [6–95])
Rats	23	4	*Syphacia muris*	17.4 (21.2 [2–34])
Gerbil	1	1	*Dentostomella translucida*	100.0 (6)

Table 2 Published reports of helminth species in mice *Mus musculus*, hamsters *Mesocricetus auratus*, rats *Rattus norvegicus*, and gerbils *Meriones unguiculatus* collected from pet shops

Rodent host	Helminth species	Country	Reference
Mice	*Rodentolepis nana* (von Siebold, 1852)	Japan	Hayashimoto et al. 2015[a]
		USA	Stone and Manwell 1966
		USA	Duclos and Richardson 2000
		USA	Roble et al. 2012[a]
		México	Present study
	Aspiculuris tetraptera (Nitzsch, 1821)	Japan	Hayashimoto et al. 2015[a]
		USA	Stone and Manwell 1966
		USA	Roble et al. 2012[a]
		México	Present study
	Syphacia obvelata (Rudolphi, 1802)	Japan	Hayashimoto et al. 2015[a]
		USA	Stone and Manwell 1966
		USA	Roble et al. 2012[a]
		México	Present study
	Syphacia sp.	Germany	Dammann et al. 2011[a]
Hamsters	*Rodentolepis nana*	Brazil	Pinto et al. 2001
		Japan	Hasegawa et al. 2008
		USA	Stone and Manwell 1966
		USA	Duclos and Richardson 2000
		Turkey	Sürsal et al. 2014[a]
		México	Present study
	Aspiculuris sp.	Turkey	Sürsal et al. 2014[a]
	Dentostomella translucida Schulz & Krepkorgorskaja, 1932	Perú	Tantaleán et al. 2011
	Syphacia mesocriceti Quentin, 1971	Japan	Hasegawa et al. 2008
		México	Present study
	Syphacia obvelata	USA	Stone and Manwell 1966
	Syphacia peromysci Harkema, 1936	Japan	Hasegawa et al. 2008
	Syphacia stroma (Linstow, 1884)	Japan	Hasegawa et al. 2008
	Syphacia sp.	Turkey	Sürsal et al. 2014[a]
	Trichuris sp.	Turkey	Sürsal et al. 2014[a]
Rats	*Rodentolepis nana*	Italy	d'Ovidio et al. 2015[a]
		USA	Duclos and Richardson 2000
	Hymenolepis diminuta (Rudolphi, 1819)	USA	Duclos and Richardson 2000
	Syphacia muris (Yamaguti, 1935)	México	Present study
Gerbils	*R. nana*	Canada	Lussier and Loew 1970
	D. translucida	USA	Wightman et al. 1978
		Brazil	Pinto et al. 2003
		Poland	Zaleśny et al. 2008
		México	Present study

[a] Detection of helminth eggs

In this survey, five oxyurids (*A. tetraptera*, *D. translucida*, *S. obvelata*, *S. mesocriceti*, and *S. muris*) were identified from six out of seven dealers. *Aspiculuris tetraptera*, *D. translucida*, and *S. obvelata* have been previously reported in pet rodents (Table 2). Despite *S. muris* having been reported in laboratory rodents, there are no previous records in pet rats. Although oxyurids are considered relatively non-pathogenic in rodents, reduced growth rate, diarrhea, rectal prolapse, intestinal impaction, and mucoid enteritis have been associated with heavy parasite burdens (Taffs 1976; Mahesh Kumar et al. 2004). Human infections with *S. obvelata* and *S. muris* have been reported (Riley 1919; Stone and Manwell 1966); however, these infections appear to be spurious. Our results show that these nematodes are common in pet rodents in Mérida.

This survey shows that helminths of pet rodents in Mérida should be of veterinary and public health concern. Pet shops should implement adequate biosecurity measures in rodent colonies to prevent the transmission of parasites and improve animal welfare. Moreover, pet owners should be advised of the possibility of acquiring zoonotic pathogens from pets and of precautions that should be taken to prevent infections (Amman et al. 2007).

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

References

Amman BR, Pavlin BI, Albariño CG et al (2007) Pet rodents and fatal lymphocytic choriomeningitis in transplant patients. Emerg Infect Dis 13:719–725. https://doi.org/10.3201/eid1305.061269

Baker DG (2007) Parasites of rats and mice. In: Baker DG (ed) Flynn's parasites of laboratory animals, 2nd edn. Blackwell Publishing, Iowa, pp 303–397

Bryant B (1990) The richness of child-pet relationship: a consideration of both benefits and costs of pets to children. Anthrozoös 3:253–261. https://doi.org/10.2752/089279390787057469

Bush AO, Lafferty KD, Lotz JM, Shostak AW (1997) Parasitology meets ecology on its own terms: Margolis et al. revisited. J Parasitol 83: 575–583. https://doi.org/10.2307/3284227

Chero JC, Saito M, Bustos JA et al (2007) *Hymenolepis nana* infection: symptoms and response to nitazoxanide in field conditions. Trans R Soc Trop Med Hyg 101:203–205. https://doi.org/10.1016/j.trstmh.2006.04.004

d'Ovidio D, Noviello E, Pepe P et al (2015) Survey of *Hymenolepis* spp. in pet rodents in Italy. Parasitol Res 114:4381–4384. https://doi.org/10.1007/s00436-015-4675-9

Dammann P, Hilken G, Hueber B et al (2011) Infectious microorganisms in mice (*Mus musculus*) purchased from commercial pet shops in Germany. Lab Anim 45:271–275. https://doi.org/10.1258/la.2011.010183

Duclos LM, Richardson DJ (2000) *Hymenolepis nana* in pet store rodents. Comp Parasitol 67:197–201

Gaudie CM, Featherstone CA, Phillips WS, et al (2008) Human *Leptospira interrogans* serogroup icterohaemorrhagiae infection (Weil's disease) acquired from pet rats. Vet Rec 163:599–601. doi: 163/20/599 [pii]

Grier KC (2006) Pets in America: a history. The University of North Carolina Press, North Carolina

Hasegawa H, Sato H, Iwakiri E et al (2008) Helminths collected from imported pet murids, with special reference to concomitant infection of the golden hamsters with three pinworm species of the genus *Syphacia* (Nematoda: Oxyuridae). J Parasitol 94:752–754. https://doi.org/10.1645/ge-13471.1

Hayashimoto N, Morita H, Ishida T et al (2015) Microbiological survey of mice (*Mus musculus*) purchased from commercial pet shops in Kanagawa and Tokyo, Japan. Exp Anim 64:155–160. https://doi.org/10.1538/expanim.14-0087

Headey B, Grabka M, Kelley J et al (2002) Pet ownership is good for your health and saves public expenditure too: Australian and German longitudinal evidence. Aust Soc Monit 5:93–99

Klement P, Augustine JM, Delaney KH et al (1996) An oral ivermectin regimen that eradicates pinworms (*Syphacia* spp.) in laboratory rats and mice. Lab Anim Sci 46:286–290

Leary S, Underwood W, Lilly E, et al (2013) AVMA guidelines for the euthanasia of animals: 2013 Edition. American Veterinary Medical Association, Schaumburg, Illinois

Lussier G, Loew FM (1970) Natural *Hymenolepis nana* infection in Mongolian gerbils (*Meriones unguiculatus*). Can Vet J 11:105–107. https://doi.org/10.1016/j.sleep.2013.11.108

Mahesh Kumar MJ, Nagarajan P, Venkatesan R, Juyal RC (2004) Rectal prolapse associated with an unusual combination of pinworms and citrobacter species infection in FVB mice colony. Scand J Lab Anim Sci 31:221–223

Pinto RM, Gomes DC, Menezes RC et al (2003) First natural helminth infection in the mongolian gerbil *Meriones unguiculatus* (Rodentia, Muridae), parasitized with *Dentostomella translucida* (Nematoda, Heteroxynematidae) in the neotropical region. Brazilian J Biol 63: 173–175. https://doi.org/10.1590/S1519-69842003000100022

Pinto RM, Gonçalves L, Gomes DC, Noronha D (2001) Helminth fauna of the golden hamster *Mesocricetus auratus* in Brazil. Contemp Top Lab Anim Sci 40:21–26

Pinto RM, Vicente JJ, Noronha D, et al (1994) Helminth parasites of conventionally maintained laboratory mice. Mem. Inst. Oswaldo Cruz 89:33–40

Riley WA (1919) A mouse oxyurid, *Syphacia obvelata*, as a parasite of man. J Parasitol 6:89. https://doi.org/10.2307/3270899

Roble GS, Gillespie V, Lipman NS (2012) Infectious disease survey of *Mus musculus* from pet stores in New York City. J Am Assoc Lab Anim Sci 51:37–41

Stone WB, Manwell RD (1966) Potential helminth infections in humans from pet or laboratory mice and hamsters. Public Health Rep 81:647–653

Sürsal N, Gökpinar S, Yildiz K (2014) Prevalence of intestinal parasites in hamsters and rabbits in some pet shops of Turkey. Turkish J Parasitol 38:102–105. https://doi.org/10.5152/tpd.2014.3338

Taffs LF (1976) Pinworm infections in laboratory rodents: a review. Lab Anim 10:1–13. https://doi.org/10.1258/002367776780948862

Tantaleán VM, Quispe HM, Angulo TJ, Serrano ME (2011) *Dentostomella translucida* (Nematoda, Oxyuroidea, Heteroxynematidae) en *Mesocricetus autatus* en el Perú. Peruvian J Parasitol 19:73–76

Thompson RCA (2015) Neglected zoonotic helminths: *Hymenolepis nana*, *Echinococcus canadensis* and *Ancylostoma ceylanicum*. Clin Microbiol Infect 21:426–432. https://doi.org/10.1016/j.cmi.2015.01.004

Wightman SR, Pilitt PA, Wagner JE (1978) *Dentostomella translucida* in the Mongolian gerbil (*Meriones unguiculatus*). Lab Anim Sci 28:290–296

Zaleśny G, Hildebrand J, Popiołek M, Okulewicz A (2008) *Dentostomella translucida* Schulz et Krepkorgorskaya, 1932 (Nematoda, Heteroxynematidae), a new species for the European nematofauna. Acta Parasitol 53:219–221. https://doi.org/10.2478/s11686-008-0032-9