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Original Article

Assessment of the Endoparasite Fauna amongst the Rodents in Kurdistan Province, West of Iran

Ali Mohammadi [1,3], Arezoo Bozorgomid [2], Mohammad Mehdi Sedaghat [1], GholamReza Mowlavi [2], Mohammad Reza Abai [1], *Ehsan Mostafavi [3,4]

1. *Department of Medical Entomology, School of Public Health, Tehran University of Medical Sciences, Tehran, Iran*
2. *Infectious Diseases Research Center, Health Institute, Kermanshah University of Medical Sciences, Kermanshah, Iran*
3. *National Reference Laboratory for Plague, Tularemia and Q Fever, Research Centre for Emerging and Reemerging Infection Diseases, Pasteur Institute of Iran, Hamadan, Iran*
4. *Department of Epidemiology and Biostatistics, Research Centre for Emerging and Reemerging Infectious Diseases, Pasteur Institute of Iran, Tehran, Iran*

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***Correspondence Email:**
mostafaviehsan@gmail.com

Abstract

Background: We aimed to evaluate the rate of infection by endoparasites amongst rodents in the western regions of Iran to enhance the level of knowledge amongst health authorities in this entity.

Methods: This study was conducted in the west and southwest of Kurdistan Province, including the cities of Sanandaj, Marivan, and Sarvabad. The field mission of this work was performed in three seasons' spring, summer, and autumn. The rodents were captured alive and their gastrointestinal tracts were evaluated for the worm endoparasites.

Results: Herein, 208 rodents from 15 types of seven species, including *Apodemus*, *Meriones*, *Mus*, *Sciurus*, *Cricetulus*, *Microtus*, and *Dryomys*, were captured. In addition, 67 (32.21%) rodents were infected with endoparasites and 10 types of worms endoparasites, including *Syphacia muris*, *Streptophagus* spp., *Mastophorus muris*, *Skrjabinema* spp., *Trichostrongylus* spp., *Trichuris muris*, *Hymenolepis nana, Hymenolepis dimimuta*, *Heligmosomoide* spp., and other oxiuros were isolated from their gastrointestinal tracts. Most of these parasites (60%) were isolated from their small intestine whereas they were least (10%) found in their stomach and cecum.

Conclusion: Having compared the results of this study with other studies in different regions of Iran, there is a higher variety of rodents and worm parasites in these regions of Iran.

Introduction

Rodents form more than 40% of all the mammals on the earth (1). One of the most important reasons behind the crucial role of these creatures in the transmission of zoonotic diseases is their living status. Rodents are present in form of most biotypes in all the continents except Antarctica. They can breed fast and feed on different types of food; in addition, they can adapt themselves to environmental changes (2, 3).

Rodents can easily breed in newly formed living complexes, deforested regions, or areas affected by the earthquake. Hence, proximity between humans and rodents can be a potential threat to humans' health due to pathogenic factors carried by rodents. Rodents would act as reservoirs and carriers of different diseases which can have different viral, bacterial, rickettsial, worm, and parasitic, fungal or protozoan causes (4-6). Such diseases are transferred via rodents' parasites, urine, feces, or bites (7). Moreover, rodents are also reservoirs of certain diseases transferred to humans, such as plague, leptospirosis, recurrent fever, Lassa and fever. Worm parasites stand amongst the endoparasites of rodents (8). The endoparasites of rodents are in the forms of nematodes, cestodes, and trematodes (9, 10). Reports of parasitic infections, such as *H. nana*, *H. diminuta*, *Moniliformis moniliformis*, *Richtolar iaratti,* and *Cysticercus fasciolaris* are result from the intake of vegetables, meat, and other nutrients in direct or indirect contact with the rodents. They are seen amongst humans and other domestic livestock around the world (11-13). In studies conducted in different areas of Iran, various species of rodents infected with these worm parasites have been identified and several human infections with these parasites have been documented so far (14-16).

Hence, this present work was conducted to evaluate the infection rate of worm parasites amongst the rodents in the southwest of Iran to enhance the knowledge level of the health authorities in this regard.

Methods

This study was performed in the west and southwest of Kurdistan Province, including the cities of Sanandaj, Marivan, and Sarvabad. The field mission of this study was conducted in the three seasons of spring, summer, and autumn in different biotypes and climatic conditions via sampling from 59 spots in six sections and 31 villages. The studied sections and villages were selected randomly among these three cities. The geographic coordinates were registered using a GPS.

Capturing rodents

The rodents were captured alive via simple wooden or wire live traps. For nocturnal rodents, trapping was completed from sunset to sunrise whereas, for those rodents active during the day, the traps were applied from early in the morning until sunset. The baits were chosen according to the season and the region. In spring, dates, walnuts, bread with animal oil or chocolate, or snacks were used while dates, cucumbers, tomatoes, and snacks were also utilized in summer. In addition, dates and bread with animal oil were also used in autumn.

Diagnosis and dissection of the rodents and isolation of the adult form of endoparasites

To respect the rights of animals in the study, the captured rodents were killed with Chloroform and body length, tail length, foot, ear, and skull sizes were then measured to check their gender and species. To isolate the endoparasites, the captured rodents were fixed on a stable surface and the body was dissected

from anus to mid-chest vertically; subsequently, the skin was retracted and the gastrointestinal tract was dissected in four different parts, including colon, small intestine, stomach, and esophagus. The beginning and the end of these tracts were tied firmly and they were kept in formalin 10%. All the samples were then sent to the parasitology laboratory of Tehran University of Medical Sciences. Afterward, the gastrointestinal samples were separately washed in separate plates. The small intestine, stomach, and cecum were placed in different plates and were then opened with a surgical knife. Following the evacuation of their internal ingredients, the internal surface was scratched to extract worm parasites living in the internal wall of the gastrointestinal tract. In the next step, the ingredients of each plate were separately studied under a loop (Stereo Microscope) and in case of finding any parasite, it was transferred to a smaller plate using forceps, a needle, or dropper; these parasites were then preserved in lactophenol to be clarified and kept temporarily. A code was dedicated to each plate indicating the rodent, out of which the parasite was isolated. The worm parasites were then placed on different glass slides separately to make the diagnosis. All the retrieved specimens were plotted through Camera lucida in a taxonomic way and they were identified using key features. The final diagnosis was made via Canada Balsam mounting.

Ethics approval

All the procedures performed in this study involving capturing and euthanizing the animals was following the national and international ethical standards. The institutional animal and human Ethical Committee of the Pasteur Institute of Iran approved the project (Ethical approval code: IR.PII.REC.1395.9). Gloves, masks, face shields, and gowns were worn by the personnel handling the animals in the field and by laboratory personnel handling the animal specimens. The personnel specifically trained in handling pathogenic agents performed the laboratory work. The procedures involving potentially infectious material were performed within a class II plus biological safety cabinet.

Results

Out of the 208 captured rodents, 124 (59.61%) were trapped in summer whereas 47 (22.59%) and 37 (17.78%) were respectively captured in autumn and spring. Herein, the most frequently captured rodents belonged to *A. witherbyi, M. qazvinensis,* and *M. socialis* with 34.13%, 17.30%, and 9.13% of all the captured rodents, respectively. With a frequency of 8.65%, *M. persicus* was the most frequently trapped Jird. The highest rate of variety in types of rodents was seen in Marivan city was out of all the 15 captured types, 12 belonged to this city (Table 1).

Moreover, out of all the rodents in this study, 32.21% were infected with worm endoparasites. Additionally, 25.80% of 124 rodents, 42.55% of the 47 rodents, and 40.54% of 37 rodents respectively captured in summer, autumn, and spring were infected with endoparasites. There were no significant relationships between the season and the rate of parasitic infection (P=0.055).

Most worm endoparasites amongst the infected rodents were found in small intestines (60%) whereas they were least found in the stomachs and cecum (10%) (Table 2). The organotropism of *S. muris* was detected to be in the colon of *A. witherbyi* captured in Marivan city. Furthermore, out of all 30 captured *A. witherbyis*, nine (30%) were infected with the parasite.

Table 1: Rodents captured during this study from three districts in northwest Iran

Species	***Sampling site (district)***			***Total No. (% of all collected rodents)***
	Sarvabad	Marivan	Sanandaj	
Apodemus witherbyi	24	30	17	71(34.13)
Microtus qazvinensis	9	6	21	36(17.3)
Microtus socialis	10	9	0	19(9.13)
Apodemus spp.	0	18	0	18(8.65)
Meriones persicus	1	6	11	18(8.65)
Mus macedonicus	6	8	1	15(7.21)
Dryomys nitedula	3	9	0	12(5.76)
Apodemus ponticus	4	4	0	8 (3.84)
Apodemus mystacinus	0	3	0	3(1.44)
Meriones vinogradovi	0	0	2	2(0.96)
Meriones libycus	0	0	2	2(0.96)
Cricetulus migratorius	0	1	0	1(0.48)
Mus musculus domesticus	0	1	0	1(0.48)
Meriones tristrami	0	0	1	1(0.48)
Sciurus anomalus	0	1	0	1(0.48)
Total	57	96	55	208 (100)

Table 2: The frequently of endoparasites and their habitat in different parts of gastrointestinal systems of trapped rodents

Habitat / ***Species***	***Stomach***	***Small intestine***	***Cecum***	***Colon***
Syphacia spp.				❋
Heligmosomoides spp.		❋		
Hymeolepis diminuata		❋		
Hymeolepis nana		❋		
Trichuris muris			❋	
Trichostrongylus spp.		❋		
Skryabina spp.		❋		
Mastophorus muris	❋			
Streptophagus spp.		❋		
Syphacia muris				❋
Frequently	1(10%)	6 (60%)	1(10%)	2(20%)

The main organotropism of *Syphacia* spp. is the colon of *A. witherbyi* captured in Marivan City. Out of all the 30 rodents of *A. witherbyi* trapped in this study, nine (30%) were infected with the parasite. *Streptophagus* spp. was found in the small intestine of *M. tristrami* and *Dryomys nitedula* in Sanandaj and Sarvabad. *M. muris* was found in the stomachs of two *M. libycus* captured in Sanandaj. The main organotropism of *Skrjabinema* spp. was the small intestine of *M. qazvinensis*, *A. witherbyi,* and *D. nitedula* captured in Sanandaj and Sarvabad.

The main organotropism of *Trichostrongylus* spp. was the small intestine of *M. socialis* and *A. mystacinus* captured in Sarvabad and Marivan. Moreover, the organotropism of *T muris* was in the cecum of six types of rodents, including *M.qazvinensis*, *A. witherbyi*, *M. macedonicus*, *D.nitedula*, *M.libycus,* and *M. persicus,* in all the three studied cities.

The presence of *H. nana* and *H. diminuata* was also documented in the small intestine of *M. qazvinensis* in Sanandaj. The organotropism of *Heligmosomoides* spp. was the small intestine of six types of rodents, including *D. nitedula*, *Apodemus* spp., *M. persicus*, *M. qazvinensis*, *A. witherbyi,* and *Sciurus anomalus* in Sanandaj, Marivan, and Sarvabad.

In addition, the main organotropism of *Syphacia* spp. also was the rectum of six types of rodents, including *D. nitedula*, *Apodemus* spp., *M. macedonicus*, *A. witherbyi,* and *M. qazvinensis* (Table 3).

Table 3: Infected rodent species and their endoparasites

Species	No. of captured rodents	No. (%) of Infected rodent	No. of endoparasites	*Syphacia muris* ♀	*Syphacia muris* ♂	*Streptophagus* spp. ♀	*Streptophagus muris* ♂	*Mastophorus* spp. ♀	*Mastophorus* spp. ♂	*Skrjabinema* spp. ♀	*Skrjabinema* spp. ♂	*Trichostrongylus* spp. ♀	*Trichostrongylus* spp. ♂	*Trichuris muris* ♀	*Trichuris muris* ♂	*Hymenolepis nana* ♀	*Hymenolepis nana* ♂	*Hymenolepis diminuata* ♀	*Hymenolepis diminuata* ♂	*Heligmosomoides* spp. ♀	*Heligmosomoides* spp. ♂	*Syphacia* spp. ♀	*Syphacia* spp. ♂
Microtus qazvinensis	36	14(38.88	6							❁	❁				❁	❁	❁	❁		❁	❁	❁	❁	❁
Apodemus witherbyi	71	24(33.8)	6		❁					❁	❁			❁						❁	❁	❁	❁	❁
Apodemus ponticus	8	2(25)	2																		❁		❁
Dryomys nitedula	12	1(8.33)	5				❁			❁	❁				❁						❁		❁
Apodemus spp.	18	9(50)	2																	❁	❁	❁	❁
Microtus socialis	19	4(21.05)	3									❁	❁							❁	❁		❁
Apodemus mystacinus	3	1(33.3)	1										❁										
Sciurus anomalus	1	1(100)	1																		❁		
Cricetulus migratorius	1	0 (0)	0																				
Meriones tristrami	1	1(100)	1				❁																
Meriones winogradovi	2	2 (100)	2					❁						❁									
Meriones libycus	2	2(100)	2					❁						❁									
Meriones persicus	18	3(16.66)	3											❁				❁		❁			
Mus macedonicus	15	2(13.33)	2											❁								❁	
Mus musculus domesticus	1	0 (0)	0																				
Total	208	67(32.2)	10	❁		❁		❁		❁	❁	❁	❁	❁	❁	❁	❁	❁	❁	❁	❁	❁	❁

Furthermore, there were no significant differences between the city of sampling and the rate of parasitic infection (P=0.14). 36.4% of all 55 captured rodents in Sanandaj, 27.1% and 28.1% of the rodents respectively captured in Marivan and Sarvabad were infected with worm parasites.

Discussion

S. muris was found in 30% of the colons of 30 *A. witherbyi* captured in Marivan and it was also reported in domestic mice in Meshkin Shahr (southeast of Iran) and report in *Tatera indica* Punjab State (India) (17, 18), the rats in Tehran (16), the *Rattus norvegicus* in Ahvaz (southeast of Iran) (19), and the black and brown rats and domestic mice in Kermanshah (west of Iran) (20).

Herein, *Streptophagus* spp. was also reported from the small intestine of *M. tristrami* and *D. nitedula*. Several other types of this parasite have also been reported in monkeys and other mammals in Africa (21).

M. muris, the parasite of the stomach, has also been reported in *M. musculus*, *R. norvegicus*, and *Cricetulus migratorius* in Tabriz (22, 23). In the current work, its organotropism was detected to be in the stomach of *M. libycus*.

In addition, this study revealed that the organotropism of *Skrjabinema* spp. has been the small intestine of *M. qazvinensis*, *A. witherbyi,* and *D. nitedula*. The same parasite has also been reported from *R. rattus* and *T. indica* in Khuzestan Province (13) and *M. persicus* from Dasht Moghan (24). According to valid references, some types of these species were regarded as the parasites of ruminating animals (17, 25-27).

In the present study, *Trichostrongylus* spp. was isolated from the small intestine of the rodents, such as *M. socialis* and *A. mystacinus*. Some types of this parasite were also found in *R. rattus* and *M. persicus* in Boyer-Ahmad District, (Southwestern Iran) (28) this parasite was also found in *T. indica* in Sistan Baluchistan in the southeast of Iran (12). They were also found in the gastrointestinal tract of *Hystrix indica* in the northern parts of Iran, the borders of the Caspian Sea (27, 29).

Furthermore, the organotropism of *T. muris* was proven to be in the cecum and its infection was documented in six types of rodents in this paper.

T. muris was reported from *Rhombomys opimus* in the northeast of Iran and reported from *M. musculus* in central region and North Khorasan of Iran (10, 30, 31), from *M. libycus* in the north of Isfahan (32) in the rodents, including *M. persicus*, *C. migratorius*, *M. musculus* and *Allactaga elater* in Meshkinshahr (northwest of Iran) (17), black and brown rats and domestic mice in Kermanshah (20), the rodents in the central urban areas of Mazandaran Province (33), *R. norvegicus* in Bandar Abbas (34, 35), and *M. persicus* and *M. socialis* in Dasht Moghan (36).

Moreover, in the current research, *H. nana* was isolated from the small intestine. The infection with this parasite has been reported in the rats in Tehran and *Rattus* spp. in Caspian Sea Littoral, Iran (16, 37), *R. opimus* and *M. libycus* in the north of Isfahan (central Iran) (19), and *R. norvegicus* in Dasht Moghan (38). *H. diminuta* was present in the small intestine of *M. qazvinensis* and the black and brown rats and domestic mice in Kermanshah (20).

H. nana is the most frequent cestode infecting humans with an estimate of about 50 to 75 million infected individuals worldwide. In Iran, human cases infected with this parasite are prevalent while infections with *H. diminuta* are rarely reported from the different parts of the country (38).

Herein, *Heligmosomoides* spp. was reported from the small intestine of six types of rodents; however, according to the scientific references, its organotropism includes the duodenum in addition to the small intestine (39-41).

Syphacia spp. has been identified from the rectum of certain rodents. Its presence has

been documented in six types of captured rodents. Furthermore, it has been isolated from *R. norvegicus*, *M. musculus*, and *R. rattus alexandrines* in Egypt (42, 43).

More taxonomic studies are needed to determine the identity of certain species of parasites represented in this work. One would conduct more studies to evaluate and determine the types of endoparasites in rodents in other spots of Kurdistan Province and neighboring provinces to find out the probable relationships between rodents and dissemination of endoparasites in the areas under study.

Conclusion

In this study, 208 rodents from 15 types of seven species were captured. The diversity of detected endoparasites, some of the zoonotic, were important result. Having compared the results of this study with other studies in different regions of Iran, there is a higher variety of rodents and worm parasites in studied areas.

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Conflict of interest

The authors declare that there is no conflict of interest.

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