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### Original Article

## Helminth Infections of *Meriones persicus* (Persian Jird), *Mus musculus* (House Mice) and *Cricetulus migratorius* (Grey Hamster): A Cross-Sectional Study in Meshkin-Shahr District, Northwest Iran

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### **Abstract**

**Background:** Rodents have important role as reservoirs of different parasites. The aim of this study was to determine helminth parasites of abundant rodents in Meshkin-Shahr, Ardabil Province northwest Iran.

**Methods:** From April 2014 to March 2015; 205 rodents including 118 *Meriones persicus*, 63 *Mus musculus* and 24 *Cricetulus migratorius* were collected, using live traps. All rodents were dissected and their different tissues examined for infectivity with helminth parasites.

**Results:** Overall, 74.2% of rodents were infected with helminth parasites. The rate of infectivity in *M. persicus*, *M. musculus* and *C. migratorius* was 82.2%, 61.9%, 66.7%, respectively. In general, among all 205 rodents, the species and infection rates of helminthes were as follows: Nematoda: *Trichuris* sp. (46.8%), *Capillaria hepatica* (18.1%), *Syphacia frederici* (14.2%), *Aspicularis tetraoptera* (3.4%), *Trichuris rhombomidis* (2%), *Heligmosomom* sp. (2%), *Streptopharagus kuntzi* (0.5%), Spiruridae gen. sp. (0.5%); Cestoda: *Hymenolepis nana fraterna* (16.6%) *Hymenolepis diminuta* (7.3%) tetra-tiridium of *Mesocestoides* sp. (1%), *Paranoplocephala* sp. (0.5%), *Cysticercus fasciolaris* (0.5%), *Taenia endotheoracicus* larva (0.5%), and Acanthocephala: *Moniliformis moniliformis* (18.5%).

**Conclusions:** Variable species of helminthes circulate in the rodents of the study area. Presence of several zoonotic species highlights the potential risk of infections for public health.

## Introduction

Rodents are one of the most diverse mammalian animals constituting wide range of genus and species. They have widespread distribution in the world and have important roles as agricultural pests and spread of infectious diseases. There are many parasites in rodents, which can be transmitted to human and domestic animals (1).

Investigation on the role of rodents as reservoirs of parasitic agents is a subject of interest for parasitologists. Studies on helminthes of rodents in different parts of the world indicate the high variety of species occurring in such mammals. However, the parasitic fauna may be variable in different geographical areas. In a study on 315 small mammals (insectivores and rodents) in the Serra Calderona Mountains (Valencian Community, Spain) 38 helminth species (4 trematodes, 10 cestodes and 24 nematodes) were detected, reflecting a relatively very rich qualitative diversity in that study area (2). In a checklist of epidemiology of nematode parasites of genus *Apodemus* (Murina: Rodentia) throughout the world excluding Japan, 176 published data of the parasite-host distribution were derived and a wide range of species were listed (3). Coincidentally, in Iran, the importance of rodent borne parasites has also been reported in relevant studies (4-8).

*Leishmania* species were isolated from rodents of various parts of Iran and character-

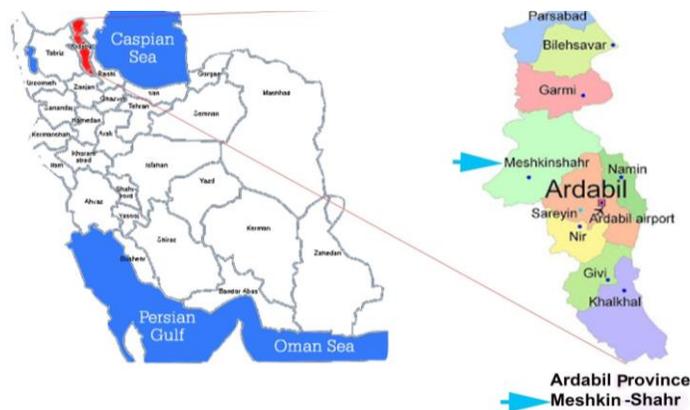
ized by isoenzyme and molecular analysis (9). Accordingly, rodents harbor *Leishmania* spp. and may have a role in transmission of leishmaniasis to humans. Additionally, *Leishmania donovani* was isolated from *Meriones persicus* (Persian jird) captured in Meshkin-Shahr, Ardabil Province, northwest Iran (9). In Gergi, the adjacent city of Meshkin-Shahr in Mogan Plain, *M. persicus* was infected with 13 different species of helminth parasites (5). During a preliminary study on parasites of rodents in Meshkin-Shahr, this rodent was introduced as a prevalent species and infected with some helminthes (10).

Due to medical importance of this issue and lack of adequate information, the current study was undertaken in Meshkin-Shahr to identify variety of helminth infections and to determine their potential zoonotic importance in *M. persicus* and two more abundant rodents in this area, including *Mus musculus* (house mouse) and *Cricetulus migratorius* (grey hamster).

## Material and Methods

### Study area

Rodents were collected from Meshkin-Shahr County (38° 23' N and 47° 40' E) in the central part of Ardabil Province, northwest Iran (Fig.1).



**Fig. 1:** Map of the study area; Left: Map of Iran, Right: Location of Meshkin-Shahr in Ardabil Province, Iran

It is the nearest city to one of the highest and famous mountains of Iran named Sabalan. Meshkin-Shahr enjoys a mountainous area with moderate climate. The capital city is Meshkin-Shahr at 839 kilometers from Tehran, with the population of 63655 by the 2006 census (11).

### **Sampling**

In this cross-sectional study, samplings of rodents were carried out from April 2014 to March 2015. The Ethics Committee of the Tehran University of Medical Sciences (TUMS) approved the study.

First, different sites including deserts, valleys, hills and rough pastures were searched for finding alive rodents or any sign of their active colonies such as newly turned soil, droppings, tracks and storage of food in nests. Then, Havahart and Sherman live traps were set at early evening until next day sunrise, with every hour interval inspection and removal of entrapped rodents to avoid death of the rodents or interfere of humans or animals, especially foxes. For house mouse and hamsters, traps were set in indoor places such as homes and around parks, and outdoor sites of human residential places in rural areas including agricultural farms and near dry riverbeds. For attraction of rodents, local mini aromatic cucumber, cheese and walnut were used to bait the traps.

### **Dissection and tissue examination**

All the trapped rodents were transferred to the Meshkin-Shahr Health Research Center where they were anesthetized with chloroform and after blood taking, thin and thick smears were prepared for further Giemsa staining and microscopic examinations for microfilaria. Gender and the results of physical examination of rodents were registered for species identification, using valid references (12). All the rodents were transferred to the Helminthological Laboratory of School of Public Health (SPH), TUMS, Tehran, Iran. There, every rodent was carefully dissected and dif-

ferent organs including liver, diaphragm, urinary bladder; muscles, esophagus, stomach, small intestine; large intestine and cecum were separately placed in petri dishes to be examined for helminthes. Some smears of livers were prepared for each rodent and examined microscopically for detection of *Capillaria hepatica* eggs. Peritoneal cavity and skin were also searched macroscopically. Some parts of intestinal contents were preserved in 10% formaldehyde solution to detect parasites ova, using formalin-ether concentration technique.

### **Helminthic detection and identification**

Every tissue in separate Petri dish was examined under stereomicroscope and in case of observation of helminth larva or adult; they were removed by fine blunt needle and after washing in lukewarm saline, gradually transferred to 70° ethanol. Nematodes and Acanthocephalas were cleared in lactophenol solution or temporary stained by azocarmine. Respect to the cestode parasites, they placed between two pieces of glasses, prior to immersion in 70° ethanol. Morphological descriptions were carried out after staining in carmine alum, dehydrating in graded ethanol and xylene, and mounting in canada balsam mounting medium. Characteristics features of every helminth (13-15) were measured by a calibrated microscope. Using valid systematic keys of helminthes identifications were fulfilled at the level of species, as far as possible. In case of presence of only female *Trichuris*, it was registered as *Trichuris* sp.

Data analysis was performed using SPSS software version 16 (Chicago, IL, USA). *P*-values of less than 0.05 considered as significant difference.

## **Results**

Overall, 205 rodents were collected of which 118 (57.6%), 63 (30.7%) and 24 (11.7%) samples were *M. persicus* (male = 69, female = 49),

*M. musculus* (male = 41, female = 22) and *C. migratorius* (male = 16, female = 8), respectively.

Table 1 illustrates the 15 helminth species identified among all 205 rodents. Accordingly, 74.2 % of the rodents were infected with 8 species of nematodes, 6 cestodes and one Acanthocephala. Some of these parasites are considered as zoonoses. The most prevalent helminth was *Trichuris* sp. (46.8%). No trematode was found in any rodent.

The helminthes of each rodent species separately are presented in Tables 2-4. In *M. persicus* 82.2% were infected with 9 different helminth species and the most prevalent one was *Trichuris* sp. (61.9%) (Table 2). In *M. musculus*, 13 species of helminthes were detected, giving 39% infectivity rate; among those *Syphacia frederici* (22%) was the most prevalent species (Table 3).

**Table 1:** Helminth parasites in 205 rodents from Meshkin-Shahr, Ardabil Province, Iran

| Nematodes                       | No. | %    | Cestodes                           | No. | %    |
|---------------------------------|-----|------|------------------------------------|-----|------|
| <i>Trichuris</i> sp.            | 96  | 46.8 | <i>Hymenolepis nana fraterna</i> * | 34  | 16.6 |
| <i>Capillaria hepatica</i> *    | 37  | 18.1 | <i>Hymenolepis diminuta</i> *      | 15  | 7.3  |
| <i>Syphacia frederici</i>       | 29  | 14.2 | <i>Tetrathyridium</i> *            | 2   | 1    |
| <i>Aspicularis tetraptera</i> * | 7   | 3.4  | <i>Paranoplocephala</i> sp.        | 1   | 0.5  |
| <i>Trichuris rbombomidis</i>    | 4   | 2    | <i>Cysticercus fasciolaris</i> *   | 1   | 0.5  |
| <i>Heligmosomum</i> sp.         | 4   | 2    | <i>Taenia endothoracicus</i> larva | 1   | 0.5  |
| <i>Streptopharagus kuntzi</i>   | 1   | 0.5  | <b>Acanthocephala</b>              |     |      |
| Spiruridae gen. sp.             | 1   | 0.5  | <i>Moniliformis moniliformis</i> * | 38  | 18.5 |

\*Potentially zoonotic species

**Table 2:** Frequency and prevalence of helminthes in *Meriones persicus* according to sex of rodents and infected organs

| Organ                     | Helminth species                   | Rodent sex     |      |                  |      | Total (No.= 118) |      |
|---------------------------|------------------------------------|----------------|------|------------------|------|------------------|------|
|                           |                                    | Male (No.= 69) |      | Female (No.= 49) |      | No.              | %    |
|                           |                                    | No.            | %    | No.              | %    |                  |      |
| Small intestine           | <i>Moniliformis moniliformis</i>   | 18             | 26.1 | 14               | 28.6 | 32               | 27.1 |
|                           | <i>Hymenolepis nana fraterna</i>   | 9              | 13   | 16               | 32.7 | 25               | 21.2 |
|                           | <i>Hymenolepis diminuta</i>        | 9              | 13   | 5                | 10.2 | 14               | 11.9 |
| Large intestine and cecum | <i>Trichuris</i> sp.               | 44             | 63.8 | 29               | 59.2 | 73               | 61.9 |
|                           | <i>Trichuris rbombomidis</i>       | 0              | 0    | 1                | 2    | 1                | 0.9  |
|                           | <i>Syphacia frederici</i>          | 2              | 2.9  | 1                | 2    | 3                | 2.5  |
| Liver                     | <i>Capillaria hepatica</i>         | 18             | 26.1 | 13               | 26.5 | 31               | 26.3 |
| Omentum                   | <i>Taenia endothoracicus</i> larva | 1              | 1.5  | 0                | 0    | 1                | 0.9  |
| Abdominal cavity          | <i>Tetrathyridium</i>              | 0              | 0    | 1                | 2    | 1                | 0.9  |
| *Total infection          |                                    | 55             | 79.7 | 42               | 85.7 | 97               | 82.2 |

\*In some cases co-infection with two or more parasites were found.

As indicated in Table 4, 16 *C. migratorius* (66.7%) were infected with 7 helminthes and *Trichuris* sp. (37.5%) constituted the most prevalent one. Statistical analysis among infectivity with different helminthes and rodent

species indicated that *Trichuris* sp. ( $P = 0.00$ ), *Capillaria hepatica* ( $P = 0.00$ ) and *Moniliformis moniliformis* ( $P = 0.004$ ) were more prevalent in *M. persicus*; while *S. frederici* ( $P = 0.00$ ) and *Aspicularis tetraptera* ( $P = 0.001$ ); and *Heligmosomum*

sp. ( $P=0.002$ ) were more prevalent in *M. musculus*, and *C. migratorius*, respectively.

In each rodent species, the relationships between rate of infectivity with every helminthes and sex of the host were analyzed. According-

ly, *Hymenolepis nana fraterna* in *M. persicus* and *S. frederici* in *M. musculus* were significantly more abundant in females than males ( $P = 0.002$ ). However, for other helminthes no sex tendency was found.

**Table 3:** Frequency and prevalence of helminthes in *Mus musculus* according to sex of rodents and infected organs

| Organ                     | Helminth species                 | Gender    |      |           |      | Total     |      |
|---------------------------|----------------------------------|-----------|------|-----------|------|-----------|------|
|                           |                                  | Male      |      | Female    |      | (No.= 63) |      |
|                           |                                  | (No.= 41) |      | (No.= 22) |      | No.       | %    |
|                           |                                  | No.       | %    | No.       | %    | No.       | %    |
| Small intestine           | <i>Moniliformis moniliformis</i> | 3         | 7.3  | 3         | 13.6 | 6         | 9.5  |
|                           | <i>Streptopharagus kuntzi</i>    | 0         | 0    | 1         | 4.5  | 1         | 1.6  |
|                           | <i>Hymenolepis nana fraterna</i> | 3         | 7.3  | 4         | 18.2 | 7         | 11.1 |
|                           | <i>Hymenolepis diminuta</i>      | 0         | 0    | 1         | 4.5  | 1         | 1.6  |
|                           | <i>Heligmosomum</i> sp.          | 0         | 0    | 1         | 4.5  | 1         | 1.6  |
|                           | <i>Paranoplocephala</i> sp.      | 0         | 0    | 1         | 4.5  | 1         | 1.6  |
| Large intestine and cecum | <i>Trichuris</i> sp.             | 9         | 22   | 5         | 22.7 | 14        | 22.2 |
|                           | <i>Trichuris rhomboidis</i>      | 1         | 2.4  | 0         | 0    | 1         | 1.6  |
|                           | <i>Syphacia frederici</i>        | 10        | 24.4 | 12        | 54.5 | 22        | 34.9 |
|                           | <i>Aspicularis tetraptera</i>    | 2         | 4.9  | 5         | 22.7 | 7         | 11.1 |
|                           | <i>Capillaria hepatica</i>       | 0         | 0    | 1         | 4.5  | 1         | 1.6  |
| Liver                     | <i>Cysticercus fasciolaris</i>   | 0         | 0    | 1         | 4.5  | 1         | 1.6  |
| Stomach                   | Spiruridae gen. sp.              | 0         | 0    | 1         | 4.5  | 1         | 1.6  |
| *Total Infection          |                                  | 21        | 51.2 | 18        | 81.8 | 39        | 61.9 |

\*In some cases co-infection with two or more parasites were found.

**Table 4:** Frequency and prevalence of helminthes in *Cricetulus migratorius* in Meshkin-Shahr according to the sex of the rodents and infected organs

| Organ                     | Helminth species                 | Rodent sex |      |          |      | Total     |      |
|---------------------------|----------------------------------|------------|------|----------|------|-----------|------|
|                           |                                  | Male       |      | Female   |      | (No.= 24) |      |
|                           |                                  | (No.= 16)  |      | (No.= 8) |      | No.       | %    |
|                           |                                  | No.        | %    | No.      | %    | No.       | %    |
| Small intestine           | <i>Hymenolepis nana fraterna</i> | 0          | 0    | 2        | 25   | 2         | 8.3  |
|                           | <i>Heligmosomum</i> sp.          | 3          | 18.8 | 0        | 0    | 3         | 12.5 |
| Large intestine and cecum | <i>Trichuris</i> sp.             | 6          | 37.5 | 3        | 37.5 | 9         | 37.5 |
|                           | <i>Trichuris rhomboidis</i>      | 1          | 6.3  | 1        | 12.5 | 2         | 8.3  |
|                           | <i>Syphacia frederici</i>        | 3          | 18.8 | 1        | 12.5 | 4         | 16.7 |
| Liver                     | <i>Capillaria hepatica</i>       | 2          | 12.5 | 3        | 37.5 | 5         | 20.8 |
| Abdominal cavity          | Tetrathyridium                   | 1          | 6.3  | 0        | 0    | 1         | 4.2  |
| *Total Infection          |                                  | 9          | 56.3 | 7        | 87.5 | 16        | 66.7 |

\*In some cases co-infection with two or more parasites were found.

## Discussion

The dominant rodent species in this study was *M. persicus* comprising 57.6 % of all captured rodents. This is concordant with the previous studies in rodents of Meshkin-Shahr

(10) and Germy (5) in Ardabil Province that reporting *M. persicus* as the most prevalent rodent captured.

In the current study, 205 rodents including 118 *M. persicus*, 63 *M. musculus* and 24 *C. migratorius* were examined for helminth parasites.

The overall rate of infectivity among these rodents was 74.2%, and for each species separately were 82.2%, 61.9% and 66.7%, respectively. Variety of helminthes comprised 15 different species including 8 nematodes, 6 cestodes and one Acanthocephalan. No trematode was found which is coincident with several other similar studies on rodents (4-7, 16).

Five species including *Trichuris* sp., *C. hepatica*, *S. frederici*, *H. nana fraterna* and *T. rhombomidis* were common among all three rodent species. Considering the public health concerns of these parasites, 7 species including *C. hepatica*, *M. moniliformis*, *H. nana fraterna*, *H. diminuta*, *A. tetraoptera*, *Mesocestoides* sp. (tetrathyridium) and larva of *Taenia taeniaeformis* (cysticercus fasciolaris) are known zoonotic species (1).

The most prevalent parasite in this study was *Trichuris* sp. with the rate of 61.9%, 22.2% and 37.5% in *M. persicus*, *M. musculus* and *C. migratorius*, respectively. In a similar study in Germy, Ardabil Province, Iran *Trichuris* sp. constituted the first rank of helminth parasites in *M. persicus* (5). In addition, in Golestan Province, Iran *Trichuris* sp. was one of the prevalent helminthes in great gerbil *Rhombomys opimus* (7).

The second most prevalent parasite was *M. moniliformis* with the rate of 27.1% and 9.5% in *M. persicus* and *M. musculus*, respectively. This parasite was not found in *C. migratorius* in this study. Infectivity of *M. persicus* with this parasite has also been recorded from Germy County in Ardabil Province (5). There are reports of human cases of infectivity with this pathogen in Iran (reviewed in 17).

The third most prevalent parasite was *C. hepatica* with the rate of 26.3%, 1.9% and 20.8% in *M. persicus*, *M. musculus* and *C. migratorius*, respectively. This nematode has previously been reported from *M. persicus* in Germy, the adjacent city to Meshkin-Shahr in Ardabil Province, Iran (5), as well as in *M. musculus*, brown rat *Rattus norvegicus* and black rat *Rattus rattus* in Kermanshah, Iran (6). *Capillaria hepatica* is a zoonotic parasite with worldwide distribution and has high affinity to the liver of the

hosts. However, no human report of hepatic capillariasis is documented in Iran, so far. This might be due to misdiagnosis, because diagnosis is by necropsy or biopsy, and eggs are not shed into the environment with the feces (18). The host specificity of this parasite is low and more than 180 mammalian species including human are known as suitable hosts (19). It has been found in more than 90 Muroidean rodent species in more than 60 countries through the world; and *R. norvegicus* seems to be the most important host species (18). The occurrence of *C. hepatica* in *C. migratorius* in the current study constitutes new host record in Iran.

Statistical analysis between infectivity with different helminthes and rodent species indicated that *Trichuris* sp ( $P = 0.00$ ), *M. moniliformis* ( $P = 0.004$ ), and *C. hepatica* ( $P = 0.00$ ) were more prevalent in *M. persicus*. However, in *M. musculus*, *S. frederici* ( $P = 0.00$ ) and *A. tetraoptera* ( $P = 0.001$ ) and in *C. migratorius*, *Heligmosomum* sp. ( $P = 0.002$ ) were more prevalent. Coincidentally, *Trichuris* sp, *M. moniliformis*, and *C. hepatica* constituted the most prevalent species of *M. persicus* in Germy County (5). This is more probably due to similarity of the host as well as geographical conditions. In a study in suburban areas of Hamadan City in western Iran, *S. frederici* was recorded as the most abundant species in wood mouse *Apodemus sylvaticus* (8). Considering the host specificity of helminthes in the present study, *H. nana fraterna* was low host specific species, being common among all three rodent species, without significant difference in its infection rates.

For all helminthes, the relationships between rate of infectivity and sex of the rodents were analyzed. Apart from *H. nana fraterna* in *M. persicus* and *S. frederici* in *M. musculus*, which had tendency in females, no significant sex difference was found in infectivity with other helminth species. In similar studies on *R. norvegicus* (20) and on *R. opimus* (7) females were found statistically more infected with *H. nana fraterna* than males. While, in the latter study and in a study in Belgrade, Serbia (16) *Trichuris*

*muris* showed tendency to male biased in *R. opimus* and *R. norvegicus*, respectively.

## Conclusion

Parasites abundances and species richness are both considerable in the rodents of the study area. *Trichuris* sp., *C. hepatica*, *S. frederici*, *H. nana* and *T. rhombomidis* are the less host specific species. *Trichuris* sp. and *C. hepatica* are two dominant species. Host species was a significant influence on abundances of some helminthes. Circulating of zoonotic species in the rodents, especially *M. moniliformis*, *C. hepatica*, and *H. nana fraterna* which are the most prevalent ones, highlights the potential risk of their infections for public health and implies utilizations of efficient diagnostic measures in population of the study area, notably children.

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