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Journal of Lab Animal Research. 2022; 1(1): 8-13.

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Research Article

An Investigation of Potentially Zoonotic Helminth Parasites of *Allactaga elater* in Sarakhs, Iran

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ARTICLE INFO

Article History:
Received: 13/09/2022
Accepted: 17/10/2022

Keywords:
Allactaga elater
Sarakhs
Zoonotic helminth parasites

ABSTRACT

Introduction: Rodents are the reservoir of many endoparasites and act as their intermediate or final hosts. This study aimed to assess parasitic helminths of *Allactaga elater* in Sarakhs, Khorasan Razavi Province, northeastern Iran.
Materials and methods: From August 2017 to February 2018, 33 *Allactaga elater* were collected using live traps. All *Allactaga elater*s were euthanized, and their gastrointestinal tracts were removed and examined to identify parasitic helminths. Finally, parasites were identified using key morphological characteristics.
Results: Overall, 91% of *Allactaga elater*s were infected with helminths, including *Syphacia obvelata* (86.6%), *Aspicularis tetraptera* (36.6%), *Trichuris* spp (13.3%), *Heligmosomoides polygyrus* (3.3%), *Hymenolepis nana* (16.6%), *Hymenolepis* diminuta (16.6%), and *Cysticercus fasciolaris* (13.3%).
Conclusion: Various species of helminths were found in *Allactaga elater* from the studied area. These findings highlight the importance of this rodent species as a reservoir for zoonotic helminths.

1. Introduction

Allactaga elater is a rat-sized five-toed jerboa belonging to the family Dipodidae[1]. The coat of *Allactaga elater* is velvety, with sandy color upperparts and whitish underparts. The tail tuft is black but white at the point[2]. The five-toed jerboas are decent excavators and joggers. They can run at a speed of 40 kilometers per hour. They use their burrows for various purposes, such as resting, evading hunters and high temperatures, caring for progenies, and winter hibernation[2]. The diet of *Allactaga elater* includes invertebrates, like insects, seeds, leaves, stems, and roots of plants[3]. They are specialized herbivores[4,5], and the mode of locomotion in the *Allactaga elater* is jumping. They can be found in desert areas of Asia and some parts of Europe, such as Afghanistan, Azerbaijan, China, Armenia, Iran, Russia, Turkey, Georgia, and Turkmenistan[6,7]. Rodents, including *Allactaga elater*, have an important role as a host of many parasitic agents, either zoonotic or those threatening rodents' health, such as o*xyuriasis*[8]. One of the most life-threatening parasitic diseases with a high fatality rate is echinococcosis. Echinococcosis is a disease caused by *Echinococcus* species, including different types, such as cystic and alveolar echinococcosis[9]. Alveolar echinococcosis, caused by the metacestode of *Echinococcus multilocularis*, is a fatal zoonotic disease[10]. Regarding geographical distribution, it could be found mostly in the northern hemisphere, including the Middle East[11-14]. The life cycle of *Echinococcus multilocularis* includes adult worms that are found in wild carnivores, and metacestodes developed in small mammals, especially rodents such as *Allactaga elater*[15]. Certainly, rodents have a main role in the transmission and storage of some transmissible diseases[16]. So, they are considered a risk factor for both human and animal health. *Allactaga elater* is one of the most widespread rodents in Iran[8], and also, little attempt has been made to demonstrate the role of *Allactaga elater* in transmitting rodent-borne diseases nearby the region of our study[17,18]. The current study aimed to investigate cysts and

► *Cite this paper as*: Shahrokhi A, Moradpour N, Siahsarvie R, Borji H. An Investigation of Potentially Zoonotic Helminth Parasites of *Allactaga elater* in Sarakhs, Iran. Journal of Lab Animal Research. 2022; 1(1): 8-13.

helminths in *Allactaga elater* in Sarakhs, Razavi Khorasan, Iran, as a threatening factor for both residents and animals of that region.

2. Materials and Methods

2.1. Ethical approval

All procedures were approved by the Animal Care Committee of Veterinary Medicine, Ferdowsi University, Mashhad, Iran. The principles of laboratory animal care were followed, and specific international laws were observed.

2.2. Sampling

*Allactaga elater*s were captured (Figure 1) using live traps from the countryside of Sarakhs (36°31' N and 61°12' E), a city located in the Razavi Khorasan Province, Iran (Figure 2), with a hot, semi-arid climate, from Aug 2017 to Feb 2018. Rodents were transferred to the Rodentology

Figure 1. Euthanized *Allactaga elater* (Original)

Research Department, Institute of Applied Zoology, Ferdowsi University of Mashhad, Iran, and anesthetized under chloroform inhalation. After measuring morphological features, species of rodents were detected based on identification keys (Figure 3)[19, 20].

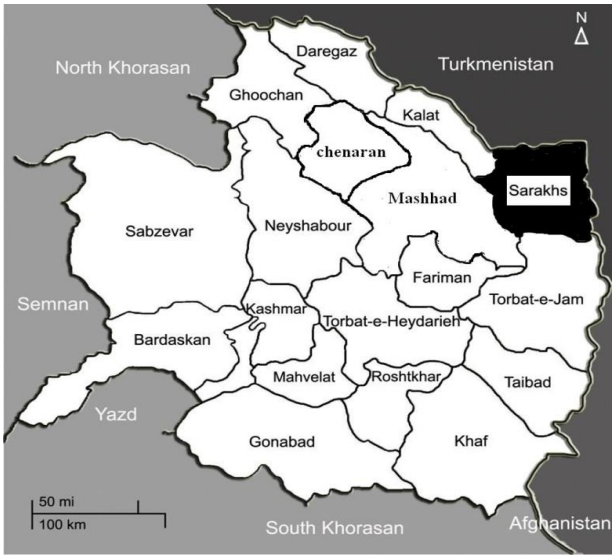

Figure 2. Map of Razavi Khorasan Province showing Sarakhs County, where the present study was carried out

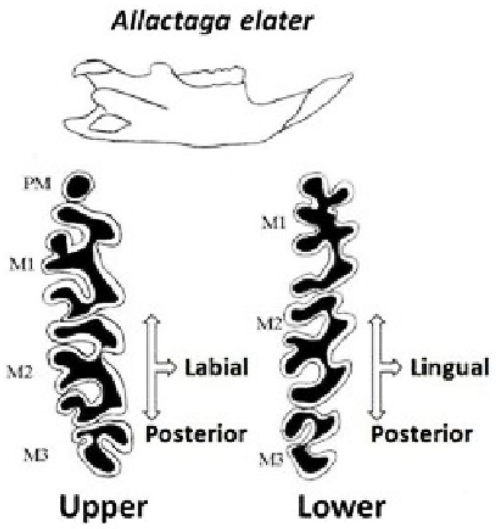

Figure 3. Mandible, upper and lower teeth of *Allactaga elater* [20]

2.3. Dissection and tissue examination

After dissection, the skin was removed, and the body was opened from the ventral surface. Abdominal cavities and livers were observed macroscopically for the presence of alveolar hydatid cysts and metacestodes, respectively. The internal organs (esophagus, stomach, intestine, and liver) of each rodent carcass were cut longitudinally and put in 0.95% mammalian saline solution (MSS). The contents were examined under a stereomicroscope (Olympus, Japan) to find adult or larval stages of helminths. Also, to separate *Trichinella spp* larvae, a sample of striated muscles was taken from arms and tongues.

2.4. Helminthic detection and identification

Regarding cysts, they were examined under a stereomicroscope to determine their base on their *protoscolex* formations. About cestode parasites, they were placed between two glasses for a week. After immersion in 70° ethanol, they were stained with carmine alum stain. Dehydrated in ethanol and mounted in Canada balsam, the species and genus of cestodes were described. Concerning nematodes, they were fixed in 70 ° ethanol before clearing in lactophenol. Species and genera of nematodes were detected using the morphology of their spicules and mouths[21].

2.5. Trichinella and Capillaria spp findings

About *Trichinella* spp, cut muscles were digested in acid-pepsin. After that, the settled sediment was washed several times and the sediment of the last washing was examined under a microscope to find any probable larva. Livers, similar to muscles, were digested by acid-pepsin to remove *Capillaria* spp larva. Species and genera of isolated parasites identified with valid systematic keys[21].

3. Results

During the study, 33 rodents belonging to the species and genus *Allactaga elater* were captured. It was measured that 91% of *Allactaga elater*s were infected at least with one species of parasites. According to Table 1, while no *Allactaga elater* was infected with an alveolar hydatid cyst, the infectivity rate with *Cysticercus fasciolaris* was 13.3%. Furthermore, contamination with cestodes and nematodes had a high prevalence, some of which are considered a zoonosis. Table 1 and Table 2 show the number, infection frequency, and range of examined *Allactaga elater*s with cestodes and nematodes, respectively.

Table 1. Number, prevalence, and range of cestodes species collected from 30 *Allactaga elater*s from Aug 2017 to Feb 2018

Genus	Number of cestodes	Infection frequency (%)	Range
Echinococcus multilocularis	-	-	-
Hymenolepis nana	5	16.6	1
Hymenolepis diminuta	5	16.6	1
Cysticercus fasciolaris	4	13.3	1

Table 2. Number, prevalence, and range of Nematodes species collected from 30 *Allactaga elater*s from Aug 2017 to Feb 2018

Genus	Number of nematodes	Infection frequency (%)	Number of males	Number of females	Range
Syphacia obvelata	549	86.6	20	529	1-120
Aspicularis tetraptera	19	36.6	1	18	1-4
Trichuris spp	5	13.3	-	5	1-2
Heligmosomoides polygyrus	3	3.3	-	3	3

4. Discussion

In the year 1971, *Echinococcus multilocularis* was reported for the first time in the carnivores of northwestern Iran[22-23]. Despite the high-frequency reports of *infection* with *Echinococcus multilocularis* throughout Iran, in this study, no alveolar cyst was found. However, the presence of other parasites in different areas of Iran has been proven [22-25]. In 2008, it was reported an Alveolar Echinococcosis infection in a Monkey (*Ateles geoffroyi*) in Mashhad, northeast of Iran[15]. In 2011, alveolar echinococcosis was reported in carnivores in the northeast of Iran, *Chenaran, Razavi Khorasan Province*[26].

Concerning *Cysticercus fasciolaris*, in the present study, similar to previous ones, it was one of the uncommon cestodes[17,18,27,28]. Metacestodes of *Cysticercus fasciolaris* (larvae of *Taenia taeniaeformis*) were found in the livers of *Allactaga elater*s in North Khorasan Province, northeast of Iran[18]. While in a study in the southwest of *Iran,* the rate of infectivity with *C. fasciolaris* in rodents was almost high[16].

Syphacia obvelata was the most frequent helminth in our study, with a rate of 86.6%, which is kind of in agreement with the study had been done by Moradpour et al. in a different region of Iran[17]. In their study, 16.6% of *Allactaga elater*s were infected with *S. obvelata*[17]. This nematode has been reported from north[29], central[30], and northwestern Iran[31]. *S.obvelata* is a zoonotic parasite, and its high frequency could be because of its direct life cycle.

In the present study, 36.6% of the *Allactaga elater*s were infected with at least one *Aspicularis tetraptera. A. tetraptera* was widely reported from wild rodents in Iran and other countries[16,27,28]. Through the study of Moradpour et al., it was separated excessively from *Allactaga elater* in Razavi Khorasan and Zanjan Provinces, Iran[17]. In a study in Shiraz, Fars Province, Iran, 90% of rodents were infected with A. *tetraptera*[32]. Its high prevalence may be due to the direct life cycle and also the climate condition of the region, which provided appropriate temperatures for completing the life cycle.

Trichuris spp was another frequent nematode that had been reported in *Allactaga elater* and mouse in eastern Iran[17-18]. Since all of *Trichuris* spp in the present study were female, we could not determine their genus of them.

Regarding *Heligmosomoides polygyrus*, similar to other reports from Iran, it was the lowest nematode throughout our study[17, 33]. While it was commonly reported in different countries[34, 35].

Hymenolepis nana and *Hymenolepis diminuta* were the most removed cestodes. Similar to other studies on rodent helminth parasites in different parts of the country[16, 30, 36, 37,] the results of the present study emphasized that *H. diminuta* is the most common cestode in rodents. The cause of such high prevalence might be based on a specific life cycle that includes intermediate hosts, such as cockroaches. If rodents or humans eat an infected cockroach, cestodes will develop in their intestines[17]. The prevalence of this parasite was distinguished a long time ago in Iran, Turkey, Italy, and Spain[35,39-41]. *H. nana* was recorded as another common zoonotic helminth in both rodents and humans in Iran and other countries[42- 44]. *H. nana* is another common zoonotic helminth parasite that plays a crucial role in the prevalence of some of the significant human parasitic diseases[45]. Though no study has reported the presence of *Trichinella* spp in rodents of Khorasan Province, in the study performed on wildlife in the northeast of Iran, *Trichinella britovi* larvae were found for the first time in three stray dogs[46]. The presence of *T. britovi* was formerly reported in two previous studies in a leopard (*Panthera pardus saxicolous*) and a wild boar in the north and west of Iran, respectively[47-49]. Additionally, in Isfahan Province and some areas in the northeast of Iran, *Trichinella* spp. was found in rodents and carnivores[49]. Generally, due to the consumption of pork meat is not common among Iranian people, the prevalence of *Trichinella* spp. is low.

Capillaria hepatica is a zoonotic nematode. The

distribution of the parasite is not limited to a specific geographical area; its prevalence has been reported from all continents[50]. However, due to being an accidental host, the number of human infections is rare. Infectious rodents with this nematode have been reported by Kia et al. [31] and Zarei et al.[51] from the northwest, Moradpour et al.[17] from the east and west, and Pakdel et al.[27] and Kazemi et al.[52] from western regions of Iran. Regarding the hosts, almost 80 species of rodents in the family Muridae, as well as about 24 species of mammals, including humans, could be infected with this parasite[53-54].

The life cycle of *Capillaria hepatica* begins with eating embryonated eggs that exist in the carcass or feces of contaminated animals. Hatching the eggs, larvae migrate from the intestine to the liver of the host, mature, and lay eggs there. Exposing to the environment through the decomposition of the carcass or in the feces of predators, eggs are embryonic and become infected. Rodents, as the final host, ingest eggs, and the life cycle of the parasite starts in their bodies[55-57]. Infection with *Capillaria hepatica* in humans (Capillariasis) causes inflammation and necrosis, and biopsy or autopsy of the liver is the only diagnostic method.

5. Conclusion

According to the present study, the role of *Allactaga elater* in transmitting zoonotic parasitic diseases to humans in Sarakhs should be taken into account; it could play a role as a final host of some nematodes, such as *Hymenolepis nana*, *Hymenolepis diminuta*, *Cysticercus fasciolaris*, *Syphacia obvelata*, and *Trichuris spp.* Further studies are required to improve the knowledge about the importance of *Allactaga elater* in spreading parasitic diseases in this region.

Declarations

Competing interests

The authors have declared no conflicts of interest.

Authors' contributions

Nona Moradpour and Hassan Borji were responsible for the conceptualization of the study, while Nona Moradpour and Roohollah Siahsarvie developed the methodology. Formal analysis and investigation were also carried out by Nona Moradpour and Roohollah Siahsarvie. Nona Moradpour and Hassan Borji provided supervision throughout the project. All authors participated in the writing of the original draft and subsequent review and editing of the manuscript. Finally, all authors have reviewed and approved the final version of the manuscript for publication in the present journal.

Funding

This research was financially supported by Grant No 47274 from Ferdowsi University of Mashhad.

Ethical considerations

The authors declare that this manuscript is original and has not been submitted elsewhere for possible publication. The authors also declare that the data used/presented in this manuscript has not been fabricated.

Availability of data and materials

The data presented in this study are available on request from the corresponding author.

Acknowledgments

The authors are grateful to the Rodentology Research Department, Institute of Applied Zoology, Ferdowsi University of Mashhad, Iran. Thanks to Mr. Eshrati H for his technical assistance during data collection.

References

1. Wilson DE and Reeder DM. Mammal species of the world: A taxonomic and geographic reference. J. Mammal. 2007; 88(3): 824-830. DOI: 10.1644/06-MAMM-R-422.1
2. Fokin IM. Jerboas. Obituary Igor Mikhailovich Fokin. Russian J Theriol. 2018; 17(2): 108-112. Available at: https://www.kmkjournals.com/upload/PDF/RJT/17/ther17_2_108_112.pdf
3. Miljutin A. Trends of specialization in rodents: The five-toed jerboas, subfamily *Allactaginae* (Dipodoidea, Rodentia). Acta Zool Litu. 2008; 18(4): 228-239. DOI: 10.2478/V10043-008-0033-9
4. Dianat M, Aliabadian M, Darvish J, and Akbarirad S. Molecular phylogeny of the Iranian Plateau five-toed jerboa, Allactaga (Dipodidea: Rodentia), inferred from mtDNA. Mammalia. 2013; 77(1): 95-103. DOI: 10.1515/mammalia-2012-0011
5. Shenbrot GI, Sokolov VE, Heptner VG, and Kovalskaya YM. Dipodoidea. Mammals of Russia and Adjacent Regions. Moscow: Nauka Publishing House; 1995. Available at: https://www.routledge.com/Jerboas-Mammals-of-Russia-and-Adjacent-Regions/Shenbrot-Sokolov-Heptner/p/book/9781578085316#
6. Shenbrot G, Tsytsulina K, Batsaikhan N, Avirmed D, Tinnin D, Sukhchuluun G, et al. International Union for Conservation of Nature. 2008. Available at: IUCN Red List of Threatened Species.
7. Lagassé P. The Columbia encyclopedia. 6th ed. New York: Columbia UP; 2000.
8. Rabiee MH, Mahmoudi A, Siahsarvie R, Kryštufek B, and Mostafavi E. Rodent-borne diseases and their public health importance in Iran. PLoS Negl Trop Dis. 2018; 12(4): e0006256. DOI: 10.1371/journal.pntd.0006256
9. Sadr S, Charbgoo A, Borji H and Hajjafari A. Interactions between innate immunity system and *Echinococcus granulosus*: Permission for vaccine development. Series Med Sci. 2022; 3(1): 1-18. Available at: https://seriesscience.com/echinococcus-granulosus/
10. Lotfalizadeh N, Sadr S, Moghaddam S, Najjar MS, Khakshoor A, Simab PA, et al. The innate immunity defense against gastrointestinal nematodes: Vaccine development. Farm Anim Health Nutr. 2022; 1(2): 31-38. Available at: https://fahn.rovedar.com/article_164201_04a5451bd9cbb5bc803e8d08b64032e3.pdf
11. Carmena D, Benito A, and Eraso E. The immunodiagnosis of *Echinococcus multilocularis* infection. Clin Microbiol Infect. 2007; 13(5): 460-475. DOI: 10.1111/j.1469-0691.2007.01665.x
12. Bartholomot G, Vuitton DA, Harraga S, Giraudoux P, Barnish G, Wang YH, et al. Combined ultrasound and serologic screening for hepatic alveolar echinococcosis in central China. Am J Trop Med Hyg. 2002; 66(1): 23-29. DOI: 10.4269/AJTMH.2002.66.23
13. Eckert J. Predictive values and quality control of techniques for the diagnosis of *Echinococcus multilocularis* in definitive hosts. Acta Trop. 2003; 85(2): 157-163. DOI: 10.1016/S0001-706X(02)00216-4
14. Ito A, Romig T, and Takahashi K. Perspective on control options for *Echinococcus multilocularis* with particular reference to

Japan. Parasitol. 2003; 127(1): S159-S172. Available at: https://pubmed.ncbi.nlm.nih.gov/15027612/
15. Deplazes P, Hegglin D, Gloor S, and Romig T. Wilderness in the city: The urbanization of *Echinococcus multilocularis*. Trends parasitol. 2004; 20(2): 77-84. DOI: 10.1016/j.pt.2003.11.011
16. Kia EB, Homayouni MM, Farahnak A, Mohebali M, and Shojai S. Study of endoparasites of rodents and their zoonotic importance in Ahvaz, south west Iran. Iran J Public Health. 2001; 30(1-2): 49-52. Available at: https://www.sid.ir/EN/VEWSSID/J_pdf/86320011209.pdf
17. Moradpour N, Borji H, Darvish J, Moshaverinia A, and Mahmoudi A. Rodents helminth parasites in different region of Iran. Iran J Parasitol. 2018; 13(2): 275-284. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6068363/
18. Arzamani K, Salehi M, Mobedi I, Adinezade A, Hasanpour H, Alavinia M, et al. Intestinal helminths in different species of rodents in North Khorasan Province, northeast of Iran. Iran J Parasitol. 2017; 12(2): 267-273. Available at: https://europepmc.org/article/pmc/5527038
19. Darvish J, Hajjar T, Moghaddam Matin M, Haddad F, and Akbary rad S. New species of five-toed jerboa (Rodentia: Dipodidae, Allactaginae) from north-east Iran. J Sci I R Iran. 2008; 19(2): 103-109. Available at: https://jsciences.ut.ac.ir/article_31883_52906f2460011db0bce41cc94f2167e3.pdf
20. Darvish J, Mohammadi Z, Mahmoudi A, and Siahsarvie R. Faunistic and taxonomic study of Rodents from northwestern Iran. Iran J Anim Biosystem. 2014; 10(2): 119-136. DOI: 10.22067/IJAB.V10I2.44285
21. El-Hamed A, Abd-Rabou A, and Faramawy A. Therapeutic efficacy of curcuma and pomelo loaded chitosan nanoparticles in intestinal murine trichinellosis. Egypt J Chem. 2022; 65(2): 551-564. DOI: 10.21608/EJCHEM.2021.102400.4750
22. Yanagida T, Mohammadzadeh T, Kamhawi S, Nakao M, Sadjjadi SM, Hijjawi N, et al. Genetic polymorphisms of *Echinococcus* granulosus sensu stricto in the Middle East. Parasitol. Internat. 2012 1;61(4):599-603. DOI: 10.1016/j.parint.2012.05.014
23. Sazmand A, Joachim A. Parasitic diseases of camels in Iran (1931–2017)–a literature review. Parasite. 2017; 24: 21. DOI: 10.1051/parasite/2017024
24. Borhani M, Fathi S, Darabi E, Jalousian F, Simsek S, Ahmed H, et al. Echinococcoses in Iran, Turkey, and Pakistan: Old diseases in the new millennium. Clin Microbiol Rev. 2021; 34(3): e00290-20. DOI: 10.1128/CMR.00290-20
25. Zare-Bidaki M, Mobedi I, Naddaf SR, Kia EB, Mahmoudi M, Piazak N, et al. Prevalence of *Echinococcus* spp. infection using coproantigen ELISA among canids of Moghan Plain, Iran. Iran J Pub Health. 2009; 38(1): 112-118. Available at: https://eprints.arums.ac.ir/1047/1/Coproantigen.pdf
26. Borji H, Emami MR, Maleki MO, Razmi GH, Mehrjerdi HK, and Moghaddas E. Alveolar echinococcosis infection in a monkey (*Ateles geoffroyi*) in Mashhad, Iran. Iran J Pub Health. 2012; 41(2): 111-116. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3481672/
27. Pakdel N, Naem S, Rezaei F, and Chalehchaleh AA. A survey on helminthic infection in mice (Mus musculus) and rats (Rattus norvegicus and Rattus rattus) in Kermanshah, Iran. Vet Res Forum. 2013; 4(2): 105-109. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4313010/
28. Rasti S, Moubedi I, Dehghani R, Doroodgar A, and Arbabi M. Epidemiological evaluation of intestinal parasites of wild and domestic mice in Kashan Province in 1997. J Kashan Univ Med Sci. 2002; 5(4): 102-108. Available at: http://feyz.kaums.ac.ir/article-1-357-en.html
29. Gholami SH, Motavali Haghgi F, Mobedi I, and Shahabi S. Study on intestinal helminth parasites of rodents in urban and central area of Mazandaran Province. J Mazandaran Univ Med Sci. 2002; 12(35): 67-73. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6068363/
30. Moradpour N, Borji H, Darvish J, Moshaverinia A, Mahmoudi A. Rodents Helminth Parasites in Different Region of Iran. Iran J Parasitol. 2018; 13(2): 275-284. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6068363/
31. Kia EB, Shahryary-Rad E, Mohebali M, Mahmoudi M, Mobedi I, Zahabiun F, et al. Endoparasites of rodents and their zoonotic importance in Germi, Dashte–Mogan, Ardabil Province, Iran. Iran J Parasitol. 2010; 5(4): 15-20. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3279854/
32. Tanideh N, Sadjjadi SM, Mohammadzadeh T, and Mehrabani D. Helminthic infections of laboratory animals in animal house of Shiraz University of Medical Sciences and the potential risks of zoonotic infections for researchers. Iran Red Crescent Med J. 2010; 12(2): 151-157. Available at: https://pesquisa.bvsalud.org/portal/resource/pt/emr-93184
33. Eslami A. Veterinary helminthology. 2nd ed. Nematoda and Acanthocephala. Tehran University Publication; 1997.
34. Forrester DJ. *Heligmosomoides polygyrus* (= *Nematospiroides dubius*) from wild rodents of northern California: Natural infections, host specificity, and strain characteristics. J Parasitol. 1971; 57(3): 498-503. Available at: https://pubmed.ncbi.nlm.nih.gov/5090957/
35. GÜRLER AT, Beyhan YE, BÖLÜKBAŞ CS, Acici M, and Şinasi UM. Gastrointestinal helminths of wild rats (brown rat-*Rattus norvegicus*, Berkenhout 1769) in Samsun, Turkey. Ank Univ Vet Fak Derg. 2011; 58(4): 289-290. DOI: 10.1501/Vetfak_0000002490
36. Sadjjadi SM, and Massoud J. Helminth parasites of wild rodents in Khuzestan Province, south west of Iran. J Vet Parasitol. 1999; 13(1): 55-56. Available at: https://www.scienceopen.com/document?vid=dd1ca058-b2f6-48cf-82dd-8f2d0258fc57
37. Mowlavi GH, Mobedi I, and Mamishi S. *Hymenolepis diminuta* (Rudolphi, 1819) infection in a child from Iran. Iran J Public Health. 2008; 37(2): 120-121. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7145915
38. Mohebali M, Rezaei H, Farahnak A, and Kanani Nootash A. A survey on parasitic fauna (helminths and ectoparasites) of the rodents in Meshkin Shahr district, North West Iran. J Fac Vet Med Univ Tehran. 1997; 52(3): 23-25. Available at: https://www.sid.ir/en/Journal/ViewPaper.aspx?ID=58936
39. Ghadirian E, and Arfaa F. Human infection with *Hymenolepis diminutain* villages of Minab, Southern Iran. Int J Parasitol. 1972; 2(4): 481-482. DOI: 10.1016/0020-7519(72)90093-8
40. Tena D, Simón MP, Gimeno C, Pomata MT, Illescas S, Amondarain I, et al. Human infection with *Hymenolepis diminuta*: Case report from Spain. J Clin Microbiol. 1998; 36(8): 2375-2376. DOI: 10.1128/JCM.36.8.2375-2376.1998
41. Marangi M, Zechini B, Fileti A, Quaranta G, and Aceti A. Hymenolepis diminuta infection in a child living in the urban area of Rome, Italy. J Clin Microbiol. 2003; 41(8): 3994-3995. DOI: 10.1128/JCM.41.8.3994-3995.2003
42. Rokni MB. The present status of human helminthic diseases in Iran. Ann Trop Med Parasitol. 2008; 102(4): 283-295. DOI: 10.1179/136485908X300805
43. Rafique A, Rana SA, Khan HA, and Sohail A. Prevalence of some helminths in rodents captured from different city structures including poultry farms and human population of Faisalabad, Pakistan. Pak Vet J. 2009; 29(3): 141-144. Available at: http://www.pvj.com.pk/pdf-files/29_3/141-144.pdf
44. Medeiros VB. Endo and ectoparasites in conventionally maintained rodents laboratory animals. J Surg Clin Res. 2012; 3(1): 27-40. DOI: 10.20398/jscr.v3i1.3144
45. Goudarzi F, Mohtasebi S, Teimouri A, Yimam Y, Heydarian P, Sangani GS, et al. A systematic review and meta-analysis of Hymenolepis nana in human and rodent hosts in Iran: A remaining public health concern. Comp Immunol Microbiol Infect Dis. 2021; 74: 101580. DOI: 10.1016/j.cimid.2020.101580
46. Borji H, Sadeghi H, Razmi G, Pozio E, and La Rosa G. Trichinella infection in wildlife of northeast of Iran. Iran J Parasitol. 2012; 7(4): 57-61. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3537469/
47. Mowlavi G, Marucci G, Mobedi I, Zahabiioon F, Mirjalali H, and Pozio E. Trichinella britovi in a leopard (*Panthera pardus saxicolor*) in Iran. Vet Parasitol. 2009; 164(2-4): 350-352. DOI: 10.1016/j.vetpar.2009.05.001
48. Marucci G, La Rosa G, and Pozio E. Incorrect sequencing and taxon misidentification: An example in the *Trichinella* genus. J Helminthol. 2010; 84(3): 336-339. DOI: 10.1017/S0022149X10000131
49. Sadighian A, Arfaa F, and Movafagh K. *Trichinella spiralis* in carnivores and rodents in Isfahan, Iran. J Parasitol. 1973; 59(6): 986. https://pubmed.ncbi.nlm.nih.gov/4760650/
50. Fuehrer HP, Igel P, and Auer H. *Capillaria hepatica* in man—an overview of hepatic capillariosis and spurious infections. Parasitol Res. 2011; 109(4): 969-979. DOI: 10.1007/s00436-011-2494-1
51. Zarei Z, Mohebali M, Heidari Z, Davoodi J, Shabestari A, Haghi AM, et al. 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. Iran J Parasitol. 2016; 11(2): 213-220. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5236098/
52. Kazemi Aghdam M, Karimi A, Amanati A, Ghoroubi J, Khoddami M,

Shamsian S, et al. *Capillaria hepatica*, A case report and review of the literatures. Arch Pediatr Infect Dis. 2015; 3(2): e19398. DOI: 10.5812/pedinfect.19398.

53. Dubey A, Bagchi A, Sharma D, Dey A, Nandy K, and Sharma R. Hepatic Capillariasis- Drug Targets. Infect disord – drug Targ. 2018; 18: 3-10. DOI: 10.2174/1871526517666170427124254
54. da Rocha EJG, Basano Sde A, Souza MM, Honda ER, Castro MB, Colodel EM, et al. Study of the prevalence of *Capillaria hepatica* in humans and rodents in an urban area of the city of Porto Velho, Rondônia, Brazil. Rev Inst Med Trop Sao Paulo, 2015; 57(1): 39-46. DOI: 10.1590/S0036-46652015000100006
55. Miller MA, Duignan PJ, Dodd E, Batac F, Staedler M, Tomoleoni JA, et al. Emergence of a zoonotic pathogen in a coastal marine sentinel: Capillaria hepatica (syn. Calodium hepaticum)-associated hepatitis in southern sea otters (Enhydra lutris nereis). Front Marine Sci. 2020; 7: 335. DOI: 10.3389/fmars.2020.00335
56. Misra S, Nanda P, Nandan D, and Sakhuja P. Capillaria hepatica: Report from North India. Trop Gastroenterol. 2020; 40(3): 118-121. DOI: 10.7869/tg.551
57. Singla N, Singla LD, Gupta K, and Sood NK. Pathological alterations in natural cases of Capillaria hepatica infection alone and in concurrence with Cysticercus fasciolaris in Bandicota bengalensis. J Parasit Dis. 2013; 37: 16-20. DOI: 10.1007/s12639-012-0121-4