Original Article

Faunistic Study of the Rodents of North Khorasan Province, North East of Iran, 2011–2013

Kourosh Arzamani 1, *Zeinolabedin Mohammadi 2, Mohammad Reza Shirzadi 3, Seyed Mohammad Alavinia 1, Behruz Jafari 4, Jamshid Darvish 2,5

1Vector-borne Diseases Research Center, North Khorasan University of Medical Sciences, Bojnurd, Iran
2Department of Biology, Faculty of Sciences, Ferdowsi University of Mashhad, Mashhad, Iran
3Zoonoses Control Department, Ministry of Health, Tehran, Iran
4Environmental Office of North Khorasan Province, Bojnurd, Iran
5Rodentology Research Department, Applied Animal Institute, Ferdowsi University of Mashhad, Mashhad, Iran

(Received 25 Nov 2015; accepted 8 May 2018)

Abstract

Background: Rodents are one of the most important hosts for some zoonotic diseases and also act as a reservoir of some ectoparasites and endoparasites. They cause damage to the farms and inflict public health. The aim of this study was to investigate the faunal composition of rodent in North Khorasan Province, Northeast of Iran.

Methods: The sampling was carried out between 2011 to 2013. The specimens were collected using different methods including rodent death and live traps, digging of their burrow, and hand net from 75 different sample sites.

Results: The total number of 396 specimens belonging to 22 species and six families were identified. The results illustrated the high numbers and densities of Meriones persicus (17.68%), Meriones libycus (15.15%), Nesokia indica (7.32%) and Rhombomys opimus (6.82%), as the most important reservoirs for different zoonotic diseases. Moreover, significant number of other rodent species including Mus musculus (15.66%), Apodemus witherbyi (13.89%), A. hyrcanicus (0.25%), Rattus norvegicus (1.01%), Meriones crassus (0.25%), Gerbillus nanus (0.51%), Microtus paradoxus (2.27%), M. transescapicus (0.76%), Elllobius fuscocapillus (0.25%), Cricetulus migratorius (4.29%), Calomyscus elburzensis (4.29%), C. mystax (1.26%), Spermophilus fulvus (0.25%), Dryomys nitedula (3.54%), Allactaga elater (3.54%), Jaculus blanfordi (0.25%), Meriones zarudnyi (0.25%), M. meridianus (0.51%), and Hystrix indica as hosts for parasites and zoonotic diseases were identified.

Conclusion: The high biodiversity including at least 22 species and six families of rodents were found in North Khorasan Province, some of them were medically important species.

Keywords: Fauna, Rodents, Biodiversity, Iran

Introduction

Rodents are the most widely distributed and the largest group of small mammals’ worldwide (1) which cause economic loss and inflict public health. Rodents play a significant role as reservoirs or vectors of sixty different diseases including leishmaniasis, leptospirosis, plague, Hantavirus Pulmonary Syndrome, salmonellosis, etc., with direct or indirect role in spread of these diseases (2).

The fauna of the rodent is medically important in Iran and in North Khorasan Province (3–8). These are identified and reported 15 species of rodent from this Province, Spermophilus fulvus, Microtus transescapicus, M. paradoxus, Elllobius fuscocapillus, Cricetulus migratorius, Calomyscus sp., Mus musculus, Apodemus witherbyi, Nesokia indica, Gerbillus nanus, Meriones libycus, M. meridianus, M. persicus, Rhombomys opimus and Dryomys nitedula (7).

North Khorasan Province was formerly known as eastern range of human plague ep-
idemics in Iran (5) and also has been the objective for study of rodent-borne diseases, especially, as a purpose of investigation on Leishmaniasis and leptospirosis (6, 9). The province is bordered by Golestan Province in the west which is one of the most important focus of zoonotic cutaneous leishmaniasis in Iran (3).

The province is located near the border of Turkmenistan and Afghanistan countries. Neighbour regions in Turkmenistan are mainly deserts and semi-desert areas and zoonotic cutaneous and visceral leishmaniasis are endemic in the country (10). Both of these low-income countries receive low health care and public services; therefore the province can be a trajectory for transportation of infectious disease from both countries via communications and transportation of nomads, refugees, and passengers. North Khorasan Province is one of the most important areas for agriculture and animal husbandry in Iran and the study area is potentially provide a suitable habitat for distribution of pests and favoring habitats for endemic and penetrating species such as Jirds and gerbils. This increases the risk of spreading vector-borne diseases and zoonosis, therefore, this province needs more consideration by Iranian health care service to control and preventing the spread of rodent-borne diseases.

We aimed to investigate the faunal composition of rodents in North Khorasan Province, Northeast of Iran.

Materials and Methods

Study area

This cross-sectional study was conducted from 36°37′–38°17′ N latitude and 55°53′–58°20′ E longitude in North Khorasan Province, Northeast of Iran with the total area of approximately 28434km². The sampling was carried out between 2011 to 2013 and includes 75 localities of eight counties from North Khorasan Province (Table 1, Fig. 1).

Rodent collection and Methods

The specimens were collected using different methods including live trap, rodent death trap, digging into their burrow, and hand net during all seasons. Geographical coordinates were recorded using GPS. Besides, 11 specimens of rodents deposited in the Zoology Museum of Ferdowsi University of Mashhad (ZMFUM), Mashhad, Iran from this region were considered (Table 2).

Specimen collection was performed in accordance with the procedures approved by the Ethical Committee of North Khorasan University of Medical Sciences.

The materials were identified using available identification keys (11-13). Taxonomic names and distribution of rodents followed Musser and Carleton (14). ArcGIS ver.9.3 software was applied for preparing of the map of sampling localities.

Results

Overall, 385 collected specimens were investigated. The specimens belong to 22 species, 16 genera, and six families. Of these, M. percicus, M. libycus, A. witherbyi and M. musculus, occur in the most localities studied and identified as widely distributed species. Abundance and different habitats of the rodents collected in the study area are shown in the Table. 2. All specimens of Apodemus captured from different localities of the province were identified as A. witherbyi based on morphology and morphometric approach. Only one A. hyrcanicus specimen from Shirvan has been identified. Specimens of R. opimus were diagnosed as R. opimus sargadensis based on the morphology and morphometric studies. Tracks, spines and some live specimens of Hystrix indica were observed in both arid regions and deciduous forests, but we avoided trapping of this species.
Table 1. Geographical coordinates and sampling locality of the rodents of North Khorasan Province, Iran, 2011–2013

<table>
<thead>
<tr>
<th>Town</th>
<th>Sampling Locality</th>
<th>Number of Locality on the map</th>
<th>Latitude</th>
<th>Longitude</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Esfarayen</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Safi Abad</td>
<td>1</td>
<td>36°39’ 01.93</td>
<td>58°00’ 19.05</td>
<td></td>
</tr>
<tr>
<td>Gerati</td>
<td>2</td>
<td>36°51’ 53.88</td>
<td>57°31’ 40.58</td>
<td></td>
</tr>
<tr>
<td>Kal Shor</td>
<td>3</td>
<td>36°53’ 51.22</td>
<td>57°07’ 52.74</td>
<td></td>
</tr>
<tr>
<td>Gorpan</td>
<td>4</td>
<td>36°56’ 46.82</td>
<td>57°12’ 16.15</td>
<td></td>
</tr>
<tr>
<td>Esfraien</td>
<td>5</td>
<td>37°08’ 43.87</td>
<td>57°24’ 13.20</td>
<td></td>
</tr>
<tr>
<td>Roein</td>
<td>6</td>
<td>37°12’ 38.02</td>
<td>57°28’ 21.97</td>
<td></td>
</tr>
<tr>
<td>Emam Vardi</td>
<td>7</td>
<td>37°15’ 04.35</td>
<td>57°22’ 30.77</td>
<td></td>
</tr>
<tr>
<td>Jafar Abad</td>
<td>8</td>
<td>37°06’ 17.54</td>
<td>57°06’ 24.94</td>
<td></td>
</tr>
</tbody>
</table>

| **Bojnurd**               |                            |                               |               |                |
| Saolook                   | 9                          | 37°16’ 32.15                  | 57°08’ 07.37  |
| Esfidan, Chenaran         | 16                         | 37°24’ 49.70                  | 57°33’ 00.02  |
| Mehan, Metranloo          | 17                         | 37°23’ 51.17                  | 57°17’ 23.46  |
| Baghcheh                  | 18                         | 37°29’ 27.74                  | 57°21’ 02.96  |
| Charkharvar, Peighoo      | 19                         | 37°28’ 58.48                  | 57°27’ 38.07  |
| Saolook 2                 | 20                         | 37°20’ 40.92                  | 57°03’ 58.60  |
| Bidak                     | 21                         | 37°29’ 27.74                  | 57°13’ 29.32  |
| Darsofian, Abchoor        | 22                         | 37°22’ 23.36                  | 57°26’ 10.27  |
| Tatar                     | 23                         | 37°33’ 51.16                  | 57°08’ 36.64  |
| Turkmenistan border       | 55                         | 37°59’ 42.33                  | 57°22’ 01.50  |
| Jodar                     | 56                         | 37°56’ 17.46                  | 57°18’ 07.36  |
| Gifan                     | 57                         | 37°54’ 35.02                  | 57°23’ 58.57  |
| Sisab                     | 63                         | 37°27’ 01.40                  | 57°39’ 05.86  |
| Asadli                    | 70                         | 37°19’ 42.39                  | 57°21’ 46.86  |

| **Jajarm**                |                            |                               |               |                |
| Miansasht                 | 10                         | 36°48’ 43.91                  | 56°29’ 05.97  |
| Kal Shor                  | 12                         | 36°54’ 20.48                  | 56°41’ 17.66  |
| Gamiteh                   | 14                         | 37°05’ 04.37                  | 56°46’ 24.97  |
| Esmaeilabad               | 15                         | 36°44’ 49.76                  | 57°48’ 07.31  |
| Kal Yazd, Daraq           | 11                         | 36°59’ 44.42                  | 56°13’ 29.42  |
| Sharleigh                 | 13                         | 37°18’ 58.49                  | 56°12’ 01.61  |
| Robat Gharahbil           | 34                         | 37°20’ 40.92                  | 56°18’ 51.36  |
| Golestan National Park    | 35                         | 37°20’ 11.66                  | 56°01’ 17.73  |

| **Garbeh**                |                            |                               |               |                |
| Tazeyab                   | 24                         | 37°51’ 54.08                  | 56°28’ 22.07  |
| Kikanloo                  | 25                         | 37°38’ 29.19                  | 57°03’ 58.60  |
| Pish Ghaleh               | 26                         | 37°41’ 54.06                  | 56°56’ 24.95  |
| Kohghale                  | 28                         | 37°56’ 32.08                  | 56°31’ 46.96  |
| Yomogh                    | 29                         | 38°00’ 40.86                  | 56°27’ 52.80  |
| Kohna Jolge               | 30                         | 38°04’ 49.63                  | 56°28’ 36.70  |
| Ashkhaneh                 | 32                         | 37°40’ 40.89                  | 56°38’ 51.32  |
| Behkade                   | 33                         | 37°33’ 51.15                  | 56°11’ 17.71  |
| Zard                      | 36                         | 37°30’ 11.64                  | 56°31’ 03.04  |
| Kastan                    | 37                         | 37°29’ 27.74                  | 56°24’ 27.93  |
| Ghale-khan                | 38                         | 37°29’ 57.01                  | 56°45’ 55.70  |
| Kohe Garimb               | 39                         | 37°43’ 21.87                  | 56°28’ 22.07  |
| Garmab                    | 40                         | 37°45’ 18.94                  | 56°19’ 49.89  |
| River Garimb              | 41                         | 37°41’ 24.30                  | 56°15’ 26.48  |
| Amand                     | 42                         | 37°49’ 13.08                  | 56°23’ 29.40  |
| Kheshti                   | 44                         | 38°03’ 21.88                  | 56°21’ 46.96  |

| **Raz and Jargalan**      |                            |                               |               |                |
| Raz                       | 27                         | 37°56’ 46.72                  | 57°06’ 10.30  |
| Ayri Qayeh                | 31                         | 38°10’ 55.48                  | 56°20’ 33.79  |
| Hesarcheh                 | 43                         | 38°10’ 55.47                  | 56°29’ 20.60  |
| Tangeh Turkeman           | 45                         | 37°55’ 48.18                  | 56°56’ 10.32  |
### Table 1. Continued …

<table>
<thead>
<tr>
<th>Location</th>
<th>Code</th>
<th>Latitude</th>
<th>Longitude</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goinik</td>
<td>46</td>
<td>37°59' 56.96</td>
<td>57°01' 17.63</td>
</tr>
<tr>
<td>Baghlegh. AshrafDare</td>
<td>47</td>
<td>38°05' 18.90</td>
<td>56°59' 05.93</td>
</tr>
<tr>
<td>Yekeh Suod</td>
<td>48</td>
<td>38°10' 55.48</td>
<td>56°38' 51.32</td>
</tr>
<tr>
<td>Bahar, Ghoridare</td>
<td>49</td>
<td>38°15' 18.88</td>
<td>56°47' 52.77</td>
</tr>
<tr>
<td>Kalatekariz</td>
<td>50</td>
<td>38°13' 07.18</td>
<td>56°54' 27.88</td>
</tr>
<tr>
<td>Sangsar</td>
<td>51</td>
<td>38°12' 08.65</td>
<td>57°00' 33.73</td>
</tr>
<tr>
<td>Gholaman</td>
<td>52</td>
<td>38°07' 45.24</td>
<td>57°06' 39.57</td>
</tr>
<tr>
<td>Sohso Enghelab</td>
<td>53</td>
<td>38°11' 54.01</td>
<td>57°09' 35.17</td>
</tr>
<tr>
<td>Takaleghoz</td>
<td>54</td>
<td>38°15' 33.52</td>
<td>57°12' 45.42</td>
</tr>
<tr>
<td>Ghool Sarani</td>
<td>58</td>
<td>37°45' 33.57</td>
<td>58°05' 55.57</td>
</tr>
<tr>
<td>Ghaltmano</td>
<td>59</td>
<td>37°41' 24.80</td>
<td>58°04' 27.77</td>
</tr>
<tr>
<td>Palkanlou</td>
<td>60</td>
<td>37°39' 56.99</td>
<td>57°53' 29.25</td>
</tr>
<tr>
<td>Gholanloo</td>
<td>61</td>
<td>37°35' 48.22</td>
<td>57°51' 17.55</td>
</tr>
<tr>
<td>Shirvan</td>
<td>62</td>
<td>37°25' 33.60</td>
<td>57°52' 58.98</td>
</tr>
<tr>
<td>Gelian</td>
<td>64</td>
<td>37°13' 51.18</td>
<td>57°52' 59.98</td>
</tr>
<tr>
<td>Hossein Abad</td>
<td>67</td>
<td>37°22' 52.63</td>
<td>57°47' 52.67</td>
</tr>
<tr>
<td>Devin</td>
<td>71</td>
<td>37°19' 13.12</td>
<td>58°01' 17.53</td>
</tr>
<tr>
<td>Topkanlou</td>
<td>72</td>
<td>37°36' 32.12</td>
<td>57°42' 01.46</td>
</tr>
<tr>
<td>Titkanlou</td>
<td>65</td>
<td>37°16' 02.88</td>
<td>58°22' 30.66</td>
</tr>
<tr>
<td>Mayvan</td>
<td>66</td>
<td>37°11' 10.21</td>
<td>58°02' 01.43</td>
</tr>
<tr>
<td>Khosrvieh</td>
<td>68</td>
<td>37°07' 01.44</td>
<td>58°00' 18.99</td>
</tr>
<tr>
<td>Cheri</td>
<td>69</td>
<td>37°10' 40.94</td>
<td>58°08' 36.54</td>
</tr>
<tr>
<td>Barzoo</td>
<td>73</td>
<td>37°35' 33.58</td>
<td>57°58' 36.59</td>
</tr>
<tr>
<td>Koran Kordieh</td>
<td>74</td>
<td>37°23' 36.52</td>
<td>58°15' 40.92</td>
</tr>
<tr>
<td>Sogtali, Zinkanlou</td>
<td>75</td>
<td>37°04' 05.84</td>
<td>58°05' 26.30</td>
</tr>
</tbody>
</table>

**Fig. 1.** Map of the study area. The samples were taken from 75 regions marked by a number from North Khorasan Province, Iran, 2011–2013
### Table 2. Abundance, percent and different habitats of the rodents of North Khorasan Province, Iran, 2011–2013

<table>
<thead>
<tr>
<th>Family</th>
<th>Species</th>
<th>Locality number</th>
<th>n</th>
<th>%</th>
<th>Collection habitats</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>A</td>
</tr>
<tr>
<td>Muridae</td>
<td>M. musculus</td>
<td>4, 5, 7, 13, 15, 16, 18, 19, 25, 49, 50, 51, 54, 57, 60, 69, 70</td>
<td>62</td>
<td>15.66</td>
<td>×</td>
</tr>
<tr>
<td></td>
<td>A. witherbyi</td>
<td>5, 6, 7, 11, 14, 15, 16, 17, 19, 22, 23, 25, 35, 36, 39, 38, 48, 49, 51, 3, 54, 58, 59, 60, 61, 63, 68, 70</td>
<td>55</td>
<td>13.89</td>
<td>×</td>
</tr>
<tr>
<td></td>
<td>A. hyrcanicus</td>
<td>59</td>
<td>1</td>
<td>0.25</td>
<td>×</td>
</tr>
<tr>
<td></td>
<td>N. indica</td>
<td>9, 20, 28, 29, 30, 38, 60, 51, 52</td>
<td>29</td>
<td>7.32</td>
<td>×</td>
</tr>
<tr>
<td></td>
<td>R. norvegicus</td>
<td>38</td>
<td>4</td>
<td>1.01</td>
<td>×</td>
</tr>
<tr>
<td></td>
<td>R. opimus</td>
<td>3, 4, 34</td>
<td>27</td>
<td>6.82</td>
<td>×</td>
</tr>
<tr>
<td></td>
<td>M. libycus</td>
<td>1, 2, 3, 4, 11, 14, 22, 26, 32, 33, 34, 39, 40, 41, 42, 46, 55, 60, 63, 65, 66, 71</td>
<td>60</td>
<td>15.15</td>
<td>×</td>
</tr>
<tr>
<td></td>
<td>M. persicus</td>
<td>2, 3, 14, 16, 19, 20, 22, 23, 24, 27, 28, 29, 30, 35, 36, 37, 38, 43, 45, 48, 47, 56, 57, 58, 59, 62</td>
<td>70</td>
<td>17.68</td>
<td>×</td>
</tr>
<tr>
<td></td>
<td>M. crassus</td>
<td>3</td>
<td>1</td>
<td>0.25</td>
<td>×</td>
</tr>
<tr>
<td></td>
<td>M. zarudnyi</td>
<td>72</td>
<td>1</td>
<td>0.25</td>
<td>×</td>
</tr>
<tr>
<td></td>
<td>M. meridianus</td>
<td>64</td>
<td>2</td>
<td>0.51</td>
<td>×</td>
</tr>
<tr>
<td></td>
<td>G. nanus</td>
<td>11</td>
<td>2</td>
<td>0.51</td>
<td>×</td>
</tr>
<tr>
<td>Cricetidae</td>
<td>M. paradoxus</td>
<td>9,20,61,67,71</td>
<td>9</td>
<td>2.27</td>
<td>×</td>
</tr>
<tr>
<td></td>
<td>M. transcaspicus</td>
<td>67</td>
<td>3</td>
<td>0.76</td>
<td>×</td>
</tr>
<tr>
<td></td>
<td>E. fuscocapillus</td>
<td>51</td>
<td>1</td>
<td>0.25</td>
<td>×</td>
</tr>
<tr>
<td></td>
<td>C. migratorius</td>
<td>16,21,28,29,60,69</td>
<td>17</td>
<td>4.29</td>
<td>×</td>
</tr>
<tr>
<td>Calomysidae</td>
<td>C. elburzensis</td>
<td>16,20,36,37,42,53, 58,61,64</td>
<td>17</td>
<td>4.29</td>
<td>×</td>
</tr>
<tr>
<td></td>
<td>C. mystax</td>
<td>50, 53, 57</td>
<td>5</td>
<td>1.26</td>
<td>×</td>
</tr>
<tr>
<td>Sciuridae</td>
<td>S. fulvus</td>
<td>4</td>
<td>1</td>
<td>0.25</td>
<td>×</td>
</tr>
<tr>
<td>Gliridae</td>
<td>D. nitedula</td>
<td>16,28,35,44,61</td>
<td>14</td>
<td>3.54</td>
<td>×</td>
</tr>
<tr>
<td>Dipodidae</td>
<td>A. elater</td>
<td>11,12</td>
<td>14</td>
<td>3.54</td>
<td>×</td>
</tr>
<tr>
<td></td>
<td>J. blanfordi</td>
<td>10</td>
<td>1</td>
<td>0.25</td>
<td>×</td>
</tr>
</tbody>
</table>

1. One specimen of *M. zarudnyi* belonged to museum samples.
2. Two specimens of *M. meridianus* belonged to museum samples.
3. One specimen of *G. nanus* belonged to museum samples.
4. Five specimens of *M. paradoxus* belonged to museum samples.
5. Two specimens of *M. transcaspicus* belonged to museum samples.

Discussion

This is the first study that reports *Rattus norvegicus*, *M. crassus*, *Allactaga elater*, *Jaculus blanfordi* and *H. indica* in North Khorasan.

Extensive distribution of fields and pasture in the study region provides suitable habitat for the existence of different kinds of rodents. In the present study, *J. blanfordi* captured from sand dunes and *M. crassus* trapped in semi-desert and salt lands were new records from the region. This species was previously reported from southern parts of Iran, and a new additional record was added from North Khorasan to its occurrence range. *Meriones crassus* is distributed in south-western Palaeartic (14) and in this study, we reported it from the North-Eastern part of its distributional range.

*Rattus norvegicus* had been reported only from Mashhad in Northeast of Iran (7) and this study is the first record of the species from North Khorasan Province. *Allactaga elater* reported previously from South Khorasan and Khorasan Razavi (7) and we reported this species from North Khorasan for the first time. *Meriones persicus*, *M. libycus*, *M. musculus*, *N. indica*, and *R. opimus* were the most abundant rodent species, especially in rural areas. These species are common both in Iran and Turkmenistan. Central parts of Iran demonstrated actually different fauna from Turkmenistan region, however, northeast of Iran (Khorasan) was affected by both cradles in species composition and also correlated to endemism (15).

In total, genus *Meriones* is known as a natural reservoir of *Yersinia pestis* in endemic foci of plague in Iran and genus *Microtus*, *Mesocricetus*, *Allactaga*, *Cricetulus* play a minor role (16). *Mus musculus* (reservoir of *Hymenolepis* and *Syphacia*) and *N. indica* (a secondary host for *Leishmania turanica*) are rodents with zoonotic importance (17, 18) and were captured in high numbers through the northern and central parts of the province in farms and rural areas near the streams. *Apodemus witherbyi* were also one of the most abundant rodents in most of the habitats except very dry sand dunes and urban areas. The wood mice of the genus *Apodemus* collected from most of North Khorasan with relatively high level of humidity were considered to be the vector for *Babesia*, *Hepatozoon*, *Trypanosoma*, and *Grahamella* (19). *Dryomys nitedula* are distributed in gardens and forests around villages in the North Khorasan Province. *Dryomys nitedula*, *Microtus*, *Mus*, and *Calomyscus* have recently demonstrated positive results for *Francisella tularensis* and can play a role to transmit tularemia in Iran (20).

In this study, some of the most important reservoirs of leishmaniasis, leptospirosis, tularemia, plague and other well-known reservoirs of zoonotic diseases were collected. The most records of cutaneous leishmaniasis in North Khorasan Province in the recent years were from rural areas of Garmeh, Jajarm, Bojnurd, and Esfarayen (21), which is consistent with our results of collecting the highest number of *M. libycus*, *M. persicus* and *R. opimus* as the most well-known hosts of the cutaneous leishmaniasis. Previously, *R. opimus* was reported as a host of *L. major* in Esfarayen (9) county and Golestan Province (adjacent province to the North Khorasan) (22).

North Khorasan Province is one of the most important foci of visceral leishmaniasis in Iran (23) and the disease agent was isolated from *M. persicus* and *C. migratorius* (24) while, *M. persicus* was one of the most abundant rodent species and significant numbers of *C. migratorius* were captured in the province.

*Rattus norvegicus* collected from North Khorasan Province, was previously reported as one of the reservoirs of *Giardia muris* (protozoan) and some other parasites in Ahvaz, Southwest of Iran (25) and leptospirosis (6, 26). Regarding to increasing population of Norwegian rats in the cities, their population should be controlled to prevent potential risk to public health.
Conclusion

Our results demonstrate the high biodiversity of rodents in North Khorasan Province of Iran. *Meriones percicus, M. libycus, A. witherbyi* and *M. musculus*, are present in most localities. Their massive presence in this region is important medically and agriculturally. The present study is a contribution to the ecological study of rodents in this region and an initiation to medically aspects of rodents as the reservoir of some important zoonotic diseases in the Northeast of Iran.

Acknowledgements

This study was supported by North Khorasan University of Medical Sciences, Iran (Research No: 296), Dr Darvish grants from University of Ferdowsi (Research No: 1.19727) and Ministry of Health, Iran. The authors would like to thank the staff of the department of biology of Ferdowsi University and Vector-Borne Diseases Research Center of North Khorasan University of Medical Sciences for their kind cooperation. Voucher specimens are stored at Ferdowsi University and Vector-Borne Diseases Research Center Museum of North Khorasan University of Medical Sciences, Bojnurd, Iran. The authors declare that there is no conflict of interests.

References


