

A study of small mammals inhabiting pistachio gardens of Kerman Province, Southeast Iran

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Abstract. This study was performed in order to identify the rodent fauna inhabiting pistachio gardens in Kerman Province, Southeast Iran. In this order we used live trapping method for the sampling of rodents. In total, 105 rodent specimens were collected. The specimens were studied in respect to their morphological, cranial and external characteristics. The results showed that six species belonging to five genera of rodents and one species of lagomorpha occur in this region. The identified samples were as follow: *Cricetulus migratorius*, *Mus musculus*, *Nesokia indica*, *Meriones persicus*, *Meriones libycus*, *Tatera indica*, and *Ochotona rufescens*. *Mus musculus* and *Cricetulus migratorius* had maximum and minimum abundance respectively. Morphological and morphometric characteristics of the identified species were investigated.

Key words: Rodentia, Lagomorpha, Pistachio gardens, Kerman Province, Iran.

Introduction

Rodents constitute one of the largest orders of mammals, which composed of about 29 families, 443 genera and 2277 species in the world (Wilson & Reeder 2005). Some 42% of all mammal species are classified as rodents. This group has worldwide distribution and is found in all habitats on earth. Rodents are of great importance in our country since they are among the most important agricultural pests after insects. They also play a pivotal role in nutrient cycling and water flows in many ecosystems and so the non-pest species need to be protected. Rodents have three major impacts. The first is the substantial damage they can cause at any stage of the growing crop. The second is the losses they cause post-harvest to stored grain and vegetables. The third, and often overlooked, impact is on the health of smallholder farmers – rodents are carriers of at least 20 severely debilitating human diseases (Mills 1999, Meerburg et al. 2009). Lay (1967) published a list of 126 mammal species of Iran including distribution, habitat and their systematic status. Etemad (1978) provided descriptions and identification keys for Iranian rodents as well as their distribution map. A recent checklist of mammalian fauna of Iran was provided by Karami et al. (2008) who presented a list of 193 species from different parts of Iran from which rodents constitute 73 species. Ziaie (1996) published a field guide to the mammals of Iran. There is little English published information on the rodents of Southeastern Iran and there is no clear knowledge of the number of species and their systematic status in this region. However some morphological and molecular studies have been carried out in other parts of Iran (Gharkheloo & Kivanç 2003, Gharkheloo 2006, Yiğit et al. 2006, Darvish et al. 2006a,b,c, Darvish et al. 2008, Kryštufek & Hutterer 2006, Mirshamsi et al. 2007, Rajabi-maham et al. 2008, Siahsarvie et al. 2012, Ashrafzadeh et al. 2012), there are a few published information on morphological and morphometric characteristics of rodents in South and Southern areas of Iran especially in Kerman Province (Madjdzadeh 2012, Ashrafzadeh et al. 2007, Khajeh & Meshkani 2010, Ashrafzadeh et al. 2012). There are a few scattered reports on the occurrence of

some rodents in the agricultural areas of Southern parts of Kerman Province (Missone 1990). To date no such studies are carried out in agricultural areas such as pistachio gardens in Kerman Province. The purpose of this study was to introduce the small mammals that inhabit pistachio gardens of Kerman Province and to determine their morphological and morphometric characteristics.

Material and Methods

Fieldwork was carried out between September 2007 and February 2009 in pistachio gardens of Kerman Province located in Southeast Iran and a total of 105 specimens were collected from 9 localities (Fig.1). Specimens were collected using various live and snap traps. The traps were placed at animal's paths before sunset and then they were checked the next day. Different baits were used such as puffy snacks, dates, oil bread and cucumber (Deblase & Martin 1975, Russell, 2003). The following standard external measurements (in mm) were taken: tail length (T); Head and body length (HB); hind foot length (HF) and ear length (EL). Sixteen cranial and dental measurements (in mm) were used including: Condylbasal length (CBL) from the occipital condyles to the anterior edge of incisor; length of the nasals (LN); occipitonasal length (OL); width of tympanic bullae (WB); length of tympanic bullae (LB); auditory meatus diameter (AMD); length of mandible (LM); height of mandible (HM); width of mandible (WM); width of zygomatic arch (WZ); Width of palatine (WP); width of braincase (WBC); length of diastema (LD); length of anterior palatine foramina (LAPF); upper cheek teeth (UCT); lower cheek teeth (LCT); height of skull (HS); width of rostrum (WR); interorbital constriction (IC); diameter of orbit (DO). All measurements were made using digital Calipers accurate to 0.05 mm. The specimens were skinned, stuffed and prepared as conventional museum type. The samples are deposited in Biology Department, Faculty of Sciences, Shahid Bahonar University of Kerman, Iran.

Results

The result of identification of collected specimens based on external and cranial characteristics showed that six species belonging to five genera of rodents and one species belonging to Lagomorpha occur in pistachio gardens of this region. The identified species are as follow:

Table 1. Standard external and cranial measurements (in mm) of *Cricetulus migratorius* (see the text for abbreviations).

	N	Min	Max	Mean	SD
HBL	4	80.00	95.00	88.75	7.08
TL	4	34.00	47.00	40.00	5.35
HFL	4	15.00	17.00	15.75	0.95
EL	3	16.00	19.00	17.66	1.53
OL	4	25.25	29.98	27.33	2.42
CL	4	23.40	29.00	25.90	2.83
ZW	4	12.56	19.21	14.87	3.03
LW	4	4.26	4.48	4.37	0.09
CW	4	9.21	10.64	9.57	0.71
LN	4	8.94	11.30	10.00	1.20
LD	4	7.21	8.51	7.81	0.64
LPF	4	5.44	5.89	5.65	0.18
LTB	4	5.49	7.56	6.68	0.99
WTB	4	4.09	5.70	4.99	0.79
UCH	4	4.07	4.36	4.25	0.12
LCH	4	3.97	4.77	4.18	0.39
HS	4	7.76	9.56	8.48	0.77
WR	4	3.66	3.86	3.75	0.08
LM	4	14.20	16.50	15.23	1.14
AMD	4	2.25	2.78	2.54	0.22

Table 2. Standard external and cranial measurements (in mm) of *Mus musculus* (see the text for abbreviations).

	N	Min	Max	Mean	SD
HBL	51	48.00	99.00	77.4118	10.08598
TL	50	57.00	109.00	90.0400	10.91705
HFL	51	14.00	21.00	17.8137	1.15741
EL	51	11.00	18.00	14.1863	1.64912
OL	47	17.36	24.61	22.1077	1.56060
CL	55	17.08	24.26	21.4900	1.59091
ZW	50	8.88	12.54	11.3022	.76708
LW	55	3.18	4.01	3.5842	.15403
CW	55	5.54	9.93	7.3864	1.08530
LN	47	5.83	9.36	8.0864	.85174
LD	55	3.81	10.95	5.4776	.91430
LPF	55	3.51	5.84	4.8027	.49367
LTB	55	3.29	5.08	4.3295	.35918
WTB	55	3.21	4.16	3.7527	.23645
UCH	55	2.96	4.12	3.6484	.24323
LCH	55	2.72	3.71	3.1927	.20790
HS	55	6.50	8.56	7.7367	.42476
WR	55	2.86	3.78	3.3545	.22405
LM	54	7.52	13.61	11.1057	1.06312
AMD	55	1.26	2.08	1.7149	.19647

Table 3. Standard external and cranial measurements (in mm) of *Nesokia indica* (see the text for abbreviations).

	N	Min	Max	Mean	SD
HBL	17	96.00	195.00	152.8824	26.72284
TL	16	47.00	146.00	113.2500	28.97700
HFL	14	21.00	37.00	32.9643	4.30770
EL	17	10.00	20.00	15.8824	2.34207
OL	17	29.35	43.58	38.3324	4.24649
CL	18	29.14	44.92	39.0856	4.82403
ZW	14	20.19	29.29	23.9871	2.90624
LW	18	5.20	7.35	6.2411	.62737
CW	18	9.18	16.86	13.3017	1.80660
LN	16	7.86	14.01	11.6213	1.89310
LD	18	8.68	14.94	12.2144	2.07668
LPF	18	2.96	5.76	4.3100	.68426
LTB	18	6.81	9.73	8.3556	.97809
WTB	17	5.35	7.28	6.2465	.52341
UCH	17	6.56	10.04	8.4318	.73933
LCH	18	7.94	9.88	8.7694	.50328
HS	18	11.29	15.49	14.1361	1.07302
WR	18	5.60	8.49	6.9739	1.05071
LM	18	19.46	29.06	24.9033	3.04440
AMD	18	1.94	3.00	2.3022	.24328

Table 4. Standard external and cranial measurements (in mm) of *Meriones persicus* (see the text for abbreviations).

	N	Min	Max	Mean	SD
HBL	4	113.00	186.00	143.5000	32.80752
TL	4	135.00	186.00	158.7500	24.24012
HFL	4	35.00	40.00	37.6250	2.05649
EL	4	16.00	22.00	19.0000	2.94392
OL	8	37.92	46.56	42.1013	3.29188
CL	8	35.69	41.06	38.3375	1.95214
ZW	7	19.69	25.56	22.6686	2.05736
LW	7	6.65	7.52	7.1071	.32664
CW	8	17.32	19.36	18.1763	.63304
LN	8	14.24	20.04	16.9063	2.23297
LD	8	8.87	11.98	10.2687	1.32891
LPF	8	6.48	7.85	7.1125	.51402
LTB	8	11.93	16.70	13.8625	1.79473
WTB	8	8.46	11.39	9.8850	1.16782
UCH	7	5.86	7.18	6.6057	.51231
LCH	8	5.89	6.74	6.3550	.30896
HS	8	12.05	17.69	15.9275	1.71080
WR	8	4.90	6.66	5.5663	.58671
LM	8	18.70	22.88	20.8938	1.55234
AMD	8	2.80	4.31	3.5013	.66146

thirty per cent of occipito-nasal length. The skull is large and robust. Zygomata heavy. The rostrum is elongate. Anterior part of the nasal bones project beyond the incisors. The auditory ossicles are not visible. The suprimeatal triangle is small and closed posteriorly.

The descriptive statistics of external and cranial measurements are given in Table 4.

Meriones libycus Lichtenstein, 1823

Collection sites: Specimens of Libyan jird were trapped from Kerman county and environs (Zngi Abad), Mahan county and environs (Ghantghestan), Ravar county and environs

(Roupas) and Baghin County. Six specimens of *M. libycus* were collected in this study.

External characters: The dorsal colour is yellowish- grey or sandy colour with a sprinkling of black- tipped hairs. The ventral colour is pure white and the terminal tail tuft is blacker than that of *M. persicus*. The ventral part of the tail is ochraceous. The ears are covered with hairs. *Meriones libycus* is distinguishable from *M. persicus* by the hind feet position, so that in this species the hind feet are hairy except for small heel patch and the claws are black, the characters that separate this species from *M. persicus*. In the latter species the

Table 5. Standard external and cranial measurements (in mm) of *Meriones libycus* (see the text for abbreviations).

	N	Min	Max	Mean	SD
HBL	4	127.00	148.00	136.0000	9.48683
TL	3	120.00	150.00	134.0000	15.09967
HFL	4	34.00	37.00	35.7500	1.25831
EL	4	17.50	19.00	18.3750	.75000
OL	6	39.14	43.14	41.3400	1.57606
CL	6	35.42	39.76	38.0183	1.70352
ZW	6	21.17	23.06	21.9583	.76747
LW	6	6.69	7.87	7.0617	.43956
CW	6	16.78	19.36	18.4050	1.08546
LN	6	10.27	18.21	14.6933	2.93747
LD	6	9.25	10.19	9.7933	.35691
LPF	6	6.39	7.44	6.8183	.38572
LTB	6	11.21	16.32	14.7317	1.86396
WTB	6	8.36	11.63	10.6267	1.14826
UCH	6	6.08	7.12	6.4517	.37108
LCH	6	6.03	6.63	6.3483	.23034
HS	6	11.88	16.51	15.3517	1.72667
WR	6	4.88	5.44	5.1650	.21879
LM	6	13.96	22.10	19.4417	2.82073
AMD	5	2.97	4.96	4.0640	.80413

Table 6. Standard external and cranial measurements (in mm) of *Tatera indica* (see the text for abbreviations).

	N	Min	Max	Mean	SD
HBL	4	159.00	165.00	161.7500	2.75379
TL	4	180.00	225.00	198.7500	18.87459
HFL	4	36.00	41.00	39.0000	2.16025
EL	4	25.00	25.00	25.0000	.00000
OL	6	40.78	48.54	45.4650	2.81043
CL	6	38.64	44.75	41.9317	2.13182
ZW	5	21.72	25.73	23.9260	1.45373
LW	6	6.07	7.61	7.0750	.53542
CW	6	17.84	20.09	18.8033	.79167
LN	6	16.95	21.38	19.3817	1.54077
LD	6	10.14	12.71	11.5167	.87790
LPF	6	7.21	8.07	7.4767	.32910
LTB	6	11.60	13.24	12.4600	.55176
WTB	6	8.63	9.22	8.9617	.20615
UCH	6	6.64	7.16	6.9150	.17444
LCH	6	6.07	6.82	6.4117	.26799
HS	6	15.78	17.33	16.7467	.60212
WR	6	5.59	6.31	5.8933	.30813
LM	6	20.40	23.51	22.2767	1.15817
AMD	6	2.16	3.43	2.9433	.45820

hind feet are bare and have whitish claws. Tail is usually equal to or slightly longer than head and body length.

Cranial characters: Tympanic bulla is thirty- four percent of occipito-nasal length and has some small projections at posterior part. Zygomata are thicker than that of Persian jird. The auditory ossicles are visible.

The descriptive statistics of external and cranial measurements are given in Table 5.

Tatera indica Hardwicke, 1807

Collection sites: We collected Indian jerbil from Kerman county and environs (Zngi Abad) and Mahan county and environs (Langar). Six specimens of *T. indica* were collected in this study.

External characters: The colour of dorsal part of body is reddish-fawn and the belly is white. The ears are prominent and have sparse hairs. The tail length is about 120 percent of head and body length. The colour of tail is an important character which identifies this species from other Gerbillines. The dorsal and ventral parts of the tail are dark grayish-buff while sides of the tail have a paler creamy-buff. The distal part of tail has a dorsal part of long black hairs terminating in a tuft.

Cranial characters: Tympanic bullae are relatively small, less than twenty- five percent of occipito-nasal length. Upper incisors are longitudinally grooved. The nasal bones are very elongate.

The external and cranial measurements of the Indian gerbil are shown in Table 6.

Order Lagomorpha

Family Ochotonidae

Ochotona rufescens (Gray, 1842)

Collection sites: We collected Afghan Pika from Rayen and Mahan counties. Six specimens of *O. rufescens* were collected in this study.

External characters: This species is grey-brown dorsally, with the flanks and ventral surface grey to dirty grey-white, often with a tinge of yellow. It has a distinct creamy colour outlined with russet. They have rounded, relatively large ears, short legs, and a very short tail which is hardly visible.

Cranial characters: The skull is narrow. The relatively short rostrum possesses a large preorbital foramen of the triangular type. Nasal bones are wider anteriorly than posteriorly. The incisive-palatal foramen is not closed. The surface of interorbital space is concave with distinct lateral crests in adult specimens which continue on parietals.

The descriptive statistics of external and cranial measurements are given in Table 7.

Table 7. Standard external and cranial measurements (in mm) of *Ochotona rufescens* (see the text for abbreviations).

	N	Min	Max	Mean	SD
HBL	6	143.00	180.00	162.3333	16.60923
TL	1	8.00	8.00	8.0000	.
HFL	6	29.00	38.00	33.1667	3.31160
EL	5	11.00	25.00	17.8000	6.30079
OL	8	38.21	47.39	42.3662	3.18537
CL	8	38.34	48.09	42.6738	3.55201
ZW	8	21.15	27.47	23.5887	2.54951
LW	8	3.06	7.00	4.8925	1.36477
CW	8	11.73	21.82	18.5288	3.13039
LN	8	11.56	16.01	13.8187	1.42630
LD	8	7.22	14.91	10.0250	3.08779
LPF	8	5.43	13.33	9.6813	2.72717
LTB	8	8.64	12.99	11.1625	1.57108
WTB	8	6.25	11.21	9.2213	1.94846
UCH	8	7.98	10.32	8.8713	.82691
LCH	8	7.98	9.10	8.5663	.40595
HS	8	12.28	17.45	15.5213	1.59783
WR	8	6.71	8.24	7.1638	.48797
LM	8	20.26	32.19	27.2350	3.40599
AMD	8	2.59	4.21	3.2588	.60167

Discussion

To date around 73 species of rodents have been identified in Iran which distributed among 30 genera (38.2% all mammalian species of Iran) (Karami et al. 2008). Our study revealed six species belonging to five genera of rodents and one species of lagomorpha in pistachio gardens of Kerman Province.

Cricetulus migratorius (Pallas, 1773)

Cricetulus migratorius is the only species of the genus *Cricetulus* Milne-Edward, 1867 (Etemad 1978). It occurs in the Palaearctic region including Iran (Corbet 1978). This species was already recorded from Kerman (Lay 1961). A karyological study on population of this species was carried out in Torbat-e-Jam area located in Khorasan Razavi Province (northeastern Iran) (Madjdzadeh, unpublished data) which revealed that the diploid number of chromosomes was $2n=22$, the fundamental number of chromosomes was $NF=44$ while Gharkheloo (2006) found a different result of fundamental number of chromosomes ($NF=38$) in population of this species from Zanjan Province in northwestern Iran. Gharkheloo (2006) mentioned the following measurements from Zanjan Province (northwestern Iran) as follows: head and body length average 116.80 mm; tail length averaging 22.70 mm; hind foot length averaging 15.95 mm; ear length averaging 16.50 mm. So based on above measurements it is concluded that the tail length is about 19.4% of the head and body length. Darvish et al. (2006) stated that in this species the average tail length is 23.9% of the head and body length in Khorasan Razavi (northeastern Iran) which is bigger than Zanjan specimens. The result of the present study showed that in Kerman specimens, the tail length is 45% of the head and body length. So it seems that the Kerman specimens have a longer tail in comparison to specimens from other two regions. The hind foot length of Zanjan, Khorasan Razavi and Kerman specimens is 15.95 mm, 16.11 mm and 15.75 mm respectively.

Mus musculus L. 1786

Lay (1967) and Etemad (1978) reported *M. musculus* to be widespread throughout Iran except in the great eastern desert basin or in the highest mountains. It seems that this species lives in the buildings adjacent to the pistachio gardens. Darvish (1995) recognized two subspecies in Khorasan: *M. m. bactrianus* Blyth, 1846 (South Khorasan Province), and *M. m. musculus* (North Khorasan Province). Darvish et al. (2006a) believe that specimens of *M. m. bactrianus* from South Khorasan Province and Southeastern Iran are very close genetically to *M. m. castaneus* from India and Pakistan. However a few studies have been carried out on populations of this species at subspecific level (Rajabi-maham et al. 2008, Sihsarvie et al. 2012), there is no agreement on subspecies classification of this species between various authorities. There is no detailed taxonomic study of this species in Kerman Province while it is also believed that specimens of this region (Southeastern Iran) belong to *M. m. castaneus* (Rajabi-Maham, Personal Communication 2012).

Nesokia indica (Gray, 1830)

Nesokia indica is recorded from different parts of Iran which water sources are available except central desert and North-

west of Iran (Misonne 1959, Lay 1967, Madjdzadeh 1992). Based on Darvish et al. (2006) in this species the average tail length is 60.7% of the head and body length in northeastern Iran. The result of the present study showed that in Kerman specimens, the tail length is 74% of the head and body length. So the Kerman specimens have a longer tail in comparison to specimens from northeastern Iran. However the specimens from northeastern Iran have bigger hind foot and ear in comparison to Kerman specimens.

Merinos persicus Blanford, 1875

The Persian Jird, *M. persicus* is found at rocky areas of semi-arid regions (Wilson & Reader 2005, Shirani Bidabadi et al. 2009). The original sample was captured by Blanford (1875) from Kohrud, North of Isfahan Province. According to Eken et al. (2008), Persian Jird is native to Afghanistan, Armenia, Azerbaijan, Iran, Iraq, Pakistan, Turkey and Turkmenistan. Based on Lay (1967) and Etemad (1978) this species is widespread in Iran, with the exception of the Caspian forests border of Persian Gulf (Misonne 1959). Darvish et al. (2006) stated that in this species tail length is longer than head and body length and so the average tail length is 113.4% of the head and body length in northeastern Iran. The result of the present study showed that in Kerman specimens, the tail length is 110.6% of the head and body length. The tail length is nearly the same in the Kerman and northeastern specimens but Kerman specimens have a bigger head and body length in comparison to northeastern specimens. However the specimens from northeastern Iran have longer hind foot and ear in comparison to Kerman specimens.

Meriones libycus Lichtenstein, 1823

The Libyan jird is widespread in Iran, except for the forests of Caspian region and also Persian Gulf region as stated by Misonne (1959), Petter et al. (1957) and Etemad (1978). Based on Darvish et al. (2006) in this species tail length is longer than head and body length and so the average tail length is 103.9% of the head and body length in northeastern Iran. The result of the present study showed that in Kerman specimens, the tail length is shorter than head and body length which is 98.5% of the head and body length. Kerman specimens have a smaller head and body length in comparison to northeastern specimens. The specimens from northeastern Iran have bigger hind foot and smaller ear length in comparison to Kerman specimens.

Tatera indica Hardwicke, 1807

Lay (1967) and Etemad (1978) reported the Indian gerbil from southeastern Iran and also Madjdzadeh (1992) reported this species in Northwest Iran (Torbat-e-Jam) in Khorasan Razavi Province. *Tatera indica* distributed throughout south of Iran from sea level to 1370 m height (Lay 1967, Misonne 1959). Mirshamsi et al. (2007) carried out a study on karyotype and cranial variation in this species in Iran. Khajeh & Meshkani (2010) reported intraspecific variation in this species in three different localities of eastern border of Iran. Ashrafzadeh et al. (2007) studied the Gerbilinae fauna of Geno Biosphere reserve in southern Iran. Ashrafzadeh et al. (2012) investigated intraspecific variation of this species gerbil in Minab and Geno Biosphere reserve located in southern part of Iran. Darvish et al. (2006) stated that in this

species tail length is shorter than head and body length and so the average tail length is 96.4% of the head and body length in northeastern Iran. Based on Khajeh & Meshkani (2010), in this species tail length is longer than head and body length in three populations in Torbat-e-Jam, Sistan and Chabahar located in eastern border of Iran and the average tail length is 107.3% of the head and body length in three mentioned populations. The result of the present study showed that in Kerman specimens, the tail length is 122.8% of the head and body length which is longer than head and body length. The result shows that Kerman specimens have longer tail in comparison to other mentioned localities while Torbat-e-Jam specimens (Darvish et al. 2006) have shorter tail. In comparison with the results of above mentioned studies and the present study, these results show that Chabahar specimens (southern Iran) (Khajeh & Meshkani 2010) have longer head and body length in comparison to other localities while northeastern specimens of Torbat-e-Jam (Darvish et al. 2006) have smaller head and body length in comparison to other localities. Kerman specimens also have longer hind foot length in comparison to other localities while Torbat-e-Jam specimens have shorter hind foot length. Chabahar specimens have longer ear length while Minab specimens in southern Iran have smaller ear length in comparison to other localities.

Ochotona rufescens (Gray, 1842)

Afghan Pika was recorded from all of the mountainous regions of Iran by Lay (1967). To date no published systematic study on this species in other parts of Iran is available.

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