

Faunistic and taxonomic study of Rodents from northwestern Iran

Darvish, J.^{a,b}, Mohammadi, Z.^{a*}, Mahmoudi, A.^a, Siahsarvie, R.^c

^a Department of Biology, Faculty of Sciences, Ferdowsi University of Mashhad, Mashhad, Iran

^b Institute of Applied Zoology (IAZ), Rodentology Research Department (RRD), Ferdowsi University of Mashhad, Mashhad, Iran.

^c CNRS UMR5554, Institut des Sciences de l'Evolution, Université Montpellier 2, Montpellier, France

(Received: 10 April 2014; Accepted: 5 October 2014)

The northwest Iran comprises parts of two major biodiversity hotspots; Irano-Anatoli and Caucasus. It is a mountainous transition realm between Caucasus forest in the north, Pontic forest of Turkey in the west and central deserts of Iranian Plateau. This study was designed to determine rodent diversity in northwest Iran. Moreover, corridor and barrier features of the region were investigated, as well. The samplings were done in different localities of northwestern Iran. In addition, all specimens of the Zoology Museum of Ferdowsi University of Mashhad (ZMFUM) attributed to the region were denoted. The study shows that the specimens belong to 18 nominal forms attributing to 5 families: Muridae (*Apodemus wütherbyi*, *Mus musculus domesticus*, *Mus macedonicus*, *Meriones persicus rossicus*, *M. libycus erythrorurus*, *M. vinogradovi* and *M. tristrami bogdanovi*), Gliridae (*Dryomys nitidula pictus*), Cricetidae (*Microtus socialis*, *M. obscurus*, *M. qazvinensis*, *Chionomys nivalis trialeticus*, *Arvicola amphibious persicus*, *Ellobius lutescens lutescens*, *Cricetulus migratorius pulcher* and *Mesocricetus brandti brandti*), Dipodidae (*Allactaga williamsi schmidtii*) and Calomyscidae (*Calomyscus urartensis*).

Key words: Fauna, Muridae, Cricetidae, Calomyscidae, Gliridae.

INTRODUCTION

Biogeographic studies increase our knowledge about distributional patterns of organisms and help us to explain how such patterns were formed (Lomolino, 2006). On the other hand, biogeographic investigations will aid to identify geographic barriers and filter features of different regions which play crucial role for speciation and endemism (Lomolino, 2006; Avise, 1987). In this study, the northwest of Iran was focused as a main corridor between the Republic of Azerbaijan, Armenia, Turkey and Iran. Indeed, northwest of Iran shares species between Irano-Anatolian and Caucasian hotspots (Noroozi et al., 2008). Irano-Anatolian and Caucasus hotspots are two of 35 regions proposed for conservation priorities (Myers et al., 2000; Mittermeier et al., 2012). Additionally, the northwest of Iran was a part of paleo-corridor between Iran and Anatolia where provided exchange of mammals between Europe and Asia (Wessel, 1955; De Bonis et al., 1993). Particularly, the region represents a high diversity of terrestrial mammals which may be attributed to its diverse ecological conditions. Such a pattern of transition along with high endemism was shown for flora of the region (Noroozi et al., 2008), however, few published studies regarding rodents of the northwestern Iran are available. Some limited attempts were done to report a checklist of rodents from northwest of Iran (Misonne, 1959; Lay, 1967; Etemad, 1978; Darvish, 1995; Ziaie, 1996; Firouz, 1999; Karami et al., 2008; Mohammadi et al., 2012; 2013) but some revisions were needed. In this study, we try to complete the checklist of rodent species of the northwest of Iran and make revision on previous reports in species and sub-specific levels. Besides, a number of museum specimens from northwest

of Iran were identified and morphometric and morphological characters of the specimens were compared.

MATERIAL AND METHODS

In total, 205 specimens were studied from which 61 specimens were related to the Zoological Museum of Ferdowsi University of Mashhad (ZMFUM) attributed to northwestern Iran. Besides, 144 specimens were captured using live traps from the same region (Table 1). For this purpose, the sampling was done using live traps in western and eastern Azarbaijan, Zanjan, Qazvin and Ardabil Provinces. In addition, all specimens of the ZMFUM which belong to these provinces were denoted. The materials were identified using diagnostic characters and available identification keys (Corbet 1978; Kryštufek and Vohralík, 2005; 2009). Morphometric and morphological characters of adult specimens were investigated (Appendix 1). Measurements of external and cranial characters were done using vernier caliper accurate to the nearest 0.05 mm (Table 2 and 3). Dental characters were measured with a Nikon measuring microscope MM-40 accurate to 0.001 mm (Table 4). ArcGIS ver.9.3 was applied for preparing of the maps of sampling area (Fig. 1). The type locality and distributions which were mentioned in the text related to species. Abbreviation of characters included BL: body length, TL: tail length, FL: foot length, EL: ear length, M1/L: length of first upper molar, M2/L: length of second upper molar, M3/L: length of third upper molar, M1/W: width of first upper molar, M2/W: width of second upper molar, M3/W: width of third upper molar, M/1L: length of first lower molar, M/2L: length of second lower molar, M/3L: length of third lower molar, M/1W: width of first lower molar, M/2W: width of second Lower molar, M/3W: width of third lower molar, UML: length of upper tooth row, LML: length of lower tooth row, BCH: braincase height, RH: rostral height, ZYGW: zygomatic breadth, RW: rostral width (maximum distance), IOW: interorbital constriction, BB: Breadth of braincase, CL: condylobasal length, BL: bulla length.

RESULTS

The specimens belong to 18 species and five families as described in details below.

Family Muridae Illiger, 1811

Subfamily Murinae Illiger, 1811

Apodemus witherbyi (Thomas, 1902)

Type locality: Iran, Fars Province, Shul (Musser and Carleton, 2005).

Distribution: Most of the Palearctic region and West Central Pakistan (Musser and Carleton, 2005).

Diagnosis: Pectoral spot is present in 100% of specimens but it is polymorphic in size; maxillary-tooth row at least 3.5 mm long; 1st upper molar clearly stephanodont (cusps t1 and t5 connected by a ridge); t7 normally cusp-like on 2nd upper molar; 3rd upper molar relatively large; fronto-parietal suture is U-shaped; posterior edge of the palatine is straight; cusp t7 on the first upper M1/ is large. Karyological study shows $2n=48$ and $FNa=46$.

Mus musculus domesticus Schwarz and Schwarz, 1943

Type locality: Sweden, Uppsala County, Uppsala (Musser and Carleton, 2005).

Distribution: Cosmopolitan (Musser and Carleton, 2005).

Diagnosis: The shape of molars is simpler than *M. musculus musculus*. The skull is angular in shape compared to other House mice. Suture between frontal and parietal bones demonstrates an extended projection. Upper M1 is without or with indistinct anterolabial cusp. Also, anterostyl of M2 is absent; zygomatic index is less than 0.5 (zygomatic index $(A/B) = \text{width of malar process} / \text{width of the antero-lateral part of the zygomatic arch}$).

TABLE 1. Sampling localities of previous reports and present study of rodents from the northwestern Iran.

Species	Locality of previous reports	This study
<i>Mus musculus</i>	Urumiyeh, Western Azarbaijan ¹	Marand, Zanjan, Qazvin
<i>Apodemus sylvaticus</i>	Maku, Western Azarbaijan ¹	-
<i>A. wütherbyi</i>	Makidi, Eastern Azarbaijan ²	Tabriz, Lighvan, Esprakhon, Kandovan, Kalyebar, Marand, Soufian, Makidi, Kordasht, Tatar, Zanjan, Urumiyeh
<i>A. uralensis</i>	Makidi, Eastern Azarbaijan ²	-
<i>Meriones persicus</i>	Maku and Urumiyeh, Western Azarbaijan; Jolfa, Eastern Azarbaijan ¹	Kordasht village, Soufian, Tabriz, Zanjan
<i>M. vinogradovi</i>	Naghadeh, Eastern Azarbaijan; Sultanieh, Zanjan ¹	Akinlo, Zanjan
<i>M. tristrami</i>	Urumiyeh, Western Azarbaijan ¹	Zanjan
<i>M. libycus</i>	Qazvin ¹	Zanjan
<i>M. zarudnyi</i>	Urumieh Lake region ³	-
<i>Cricetulus migratorius</i>	Maku and Urumiyeh, Western Azarbaijan; Sarab, Eastern Azarbaijan; Sultanieh, Zanjan ¹	Lighvan, Zanjan
<i>Mesocricetus auratus</i>	Sultanieh Zanjan; Kurdistan ^{1,4}	-
<i>M. brandti</i>	Zanjan ⁵	Zanjan, Ardabil
<i>Arvicola amphibius</i>	Maku, Western Azarbaijan; Sultanieh, Zanjan ¹	Sarab
<i>Microtus socialis</i>	Sarab, Eastern Azarbaijan; Sultanieh, Zanjan; Ardabil ¹	Zanjan
<i>M. arvalis</i>	Sahand, Eastern Azarbaijan; Urumiyeh, Western Azarbaijan ¹	-
<i>M. majori</i>	NW Iran ⁶	-
<i>M. obscurus</i>		Esprakhon village
<i>M. qazvinensis</i>	Qazvin ⁷	Qeydar, Qazvin
<i>M. schelkonnikovi</i>	Alborz Mountains, Southern of Caspian Sea ⁷	-
<i>Ellobius fuscocapillus</i>	Azerbaijan, Khorasan ¹	-
<i>E. lutescens</i>	Zanjan ⁸	Zanjan
<i>Allactaga elater</i>	Maku, Eastern Azarbaijan ^{1,13}	
<i>A. williamsi</i>	Urumiyeh, Western Azarbaijan; Sultanieh, Zanjan ¹	Ardabil, Zanjan
<i>Calomyscus bailwardi</i>	Maku and Urumiyeh, Western Azarbaijan ¹	-
<i>C. urartensis</i>	Julfa, Azerbaijan ⁹	Kordasht village
<i>Dryomys nitedula</i>	Maragheh, Eastern Azarbaijan ¹	Kandovan, Kalyebar and Makidi villages
<i>Spermophilus fulvus</i>	Sultanieh, Zanjan ^{1,13}	-
<i>S. xanthopygmnus</i>	Maku, Eastern Azarbaijan ¹⁰	-
<i>Myocastor coypus</i>	Aras River ^{6,11,12}	-
<i>Mus macedonicus</i>	Gazvin ¹⁴	Marand, Zanjan, Qazvin
<i>Chionomys nivalis</i>	-	Kordasht village

References: ¹Lay (1967); ²Kryštufek and Hutterer, 2006; ³Neronov et al., 1974; ⁴Misonne (1959); ⁵Yiğit et al., 2006; ⁶Gromov and Erbajeva, 1995; ⁷Musser and Carleton, 2005; ⁸Shenbrot and Krasnov, 2005; ⁹Gharkheloo and Kivanç, 2003; ¹⁰Özkurt et al., 2007; ¹¹Firouz, 1999; ¹²Ziaie, 1996; ¹³Etemad, 1978; ¹⁴Darvish, 1995 (repeated reports were not considered).

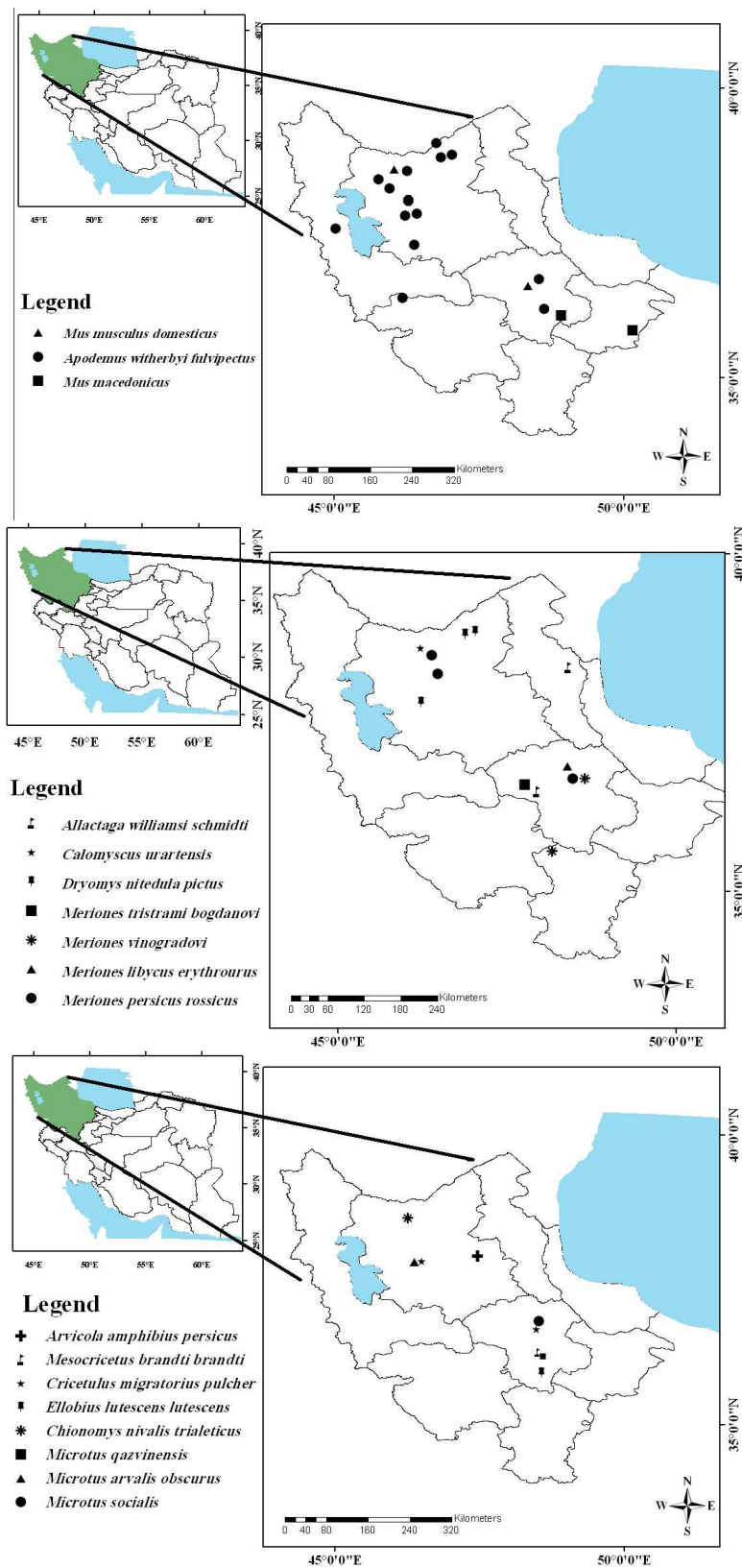


FIGURE 1. Maps of northwestern Iran with collecting sites for different specimens of rodents.

TABLE 2. Standard external measurements (Mean \pm SD, in mm) of different species of rodents in northwest of Iran. (See the text for abbreviations).

Taxa	N	BL	TL	FL	EL
Muridae					
<i>Apodemus wetherbyi</i>	49	85.41 \pm 11.38	89.83 \pm 15.21	20.83 \pm 1.29	12.90 \pm 2.40
<i>Mus musculus</i>	35	86.43 \pm 7.41	70.85 \pm 13.75	18.14 \pm 1.68	13.16 \pm 1
<i>M. macedonicus</i>		-	-	-	-
<i>Meriones vinogradovi</i>	5	148 \pm 11	145 \pm 2	35.7 \pm 0.58	20 \pm 0.58
<i>M. tristrami</i>	6	143.2 \pm 8.08	176.6 \pm 4.44	39.3 \pm 4.04	21 \pm 3.51
<i>M. persicus</i>	8	138 \pm 14.41	172.5 \pm 35.35	36 \pm 2.58	19.1 \pm 3.09
<i>M. libycus</i>	5	116.2 \pm 3.56	137.4 \pm 5.12	32.8 \pm 2.58	14.4 \pm 3.04
Gliridae					
<i>Dryomys nitedula</i>	6	84.71 \pm 9.91	88.57 \pm 12.62	21.28 \pm 0.75	11.71 \pm 1.38
Cricetidae					
<i>Microtus socialis</i>	20	107.2 \pm 9	33.25 \pm 2.75	16.5 \pm 1.3	12.22 \pm 2.01
<i>M. obscurus</i>	15	-	-	-	-
<i>M. gazvinensis</i>	23	109.1 \pm 11.4	26.05 \pm 3.58	16.84 \pm 2.59	10.73 \pm 0.8
<i>Chionomys nivalis</i>	1	82	58	20	14
<i>Arvicola amphibius</i>	2	-	-	-	-
<i>Ellobius lutescens</i>	3	-	-	-	-
<i>Cricetulus migratorius</i>	2	108 \pm 0.05	20 \pm 0.5	17 \pm 1-.07	15 \pm 1.01
<i>Mesocricetus brandti</i>	2	-	-	-	-
Dipodidae					
<i>Allactaga williamsi</i>	9	129.71 \pm 7.80	216 \pm 7.34	67.57 \pm 2.07	45.71 \pm 1.38
Calomyscidae					
<i>Calomyscus urartensis</i>	3	80 \pm 7.07	89 \pm 1.41	20 \pm 1.41	16.5 \pm 2.12

Mus macedonicus* Petrov and Ruzic, 1983*Type Locality:** Macedonia, near Valandovo (Musser and Carleton, 2005).**Distribution:** Mediterranean region, the Levant, Transcaucasia and Iran (Darvish, 1995; Musser and Carleton, 2005).**Diagnosis:** Tail length is normally shorter than head and body; soles are bare and brown. 3rd upper molar is large; Posterior bevel of upper incisor is rarely notched; anterolingual cusp of M/1 is tight; anterior root of 1st molar is more or less vertical; the sutura squamalis smooth or protruded anteriorly; zygomatic index at least 0.52.**Subfamily Gerbilinae Gray, 1825*****Meriones persicus rossicus* Heptner, 1931****Type locality:** Iran, Kohrud, north of Isfahan (Musser and Carleton, 2005).**Distribution:** Central Asia, Transcaucasia, Turkey and Pakistan (Musser and Carleton, 2005).**Diagnosis:** Tail is usually longer than head and body; soles of hind feet are entirely bare. The brain case is not smooth; it is rounded and slopes down posteriorly at the level of the parietal and interparietal bones; Squamosal root of the zygomatic arch has no contact with the anterior portion of the auditory bullae; the complete ossification of the upper part of the tympanic bullae blocks the view of meatus.

TABLE 3. Cranial measurements (Mean±SD, in mm) of different species of rodents in northwest of Iran. (See the text for abbreviations).

Taxa	N	BCH	RH	ZYGW	RW	IOW	BB	CL	BU
Muridae									
<i>Apodemus witherbyi</i>	49	8.33±0.36	3.97±0.30	12.71±0.63	4.71±1.7	4.18±0.13	11.6±0.33	22.5±2.38	4.76±0.1
<i>Mus musculus</i>	9	7.9	3.41±0.25	10.3	3.2±0.22	3.67±0.1	10±0.3	21±0.5	5.5
<i>M. macedonicus</i>	1	-	3.5	10.8	3.2	3.7	9.75	-	-
<i>Meriones vinogradovi</i>	5	14.36±0.25	9.94±0.31	21.51±1.03	6.09±0.09	7.38±0.88	19.69±0.44	36.85±0.66	12.52±0.79
<i>M. tristrami</i>	2	14.02±0.69	9.54±0.44	22.39±0.70	5.92±0.45	7.17±0.83	20.46±0.65	36.91±2.83	11.85±0.63
<i>M. persicus</i>	2	14.99±0.66	9.73±0.07	21±0.54	5.75±0.18	6.98±0.22	20.43±0.86	36.94±0.93	12.30±0.34
<i>M. libycus</i>	1	15.16	8.66	20.5	5.02	6.46	20.6	35.52	15.68
Gliridae									
<i>Dryomys nitedula</i>	6	10.3±0.7	4.9±0.54	16.2±0.21	4.9±0.4	4.03±0.08	12.8±0.6	24.28±1.9	8.4±0.1
Cricetidae									
<i>Microtus socialis</i>	19	8.65	4.1±3.17	14.67±0.63	4.02±0.15	3.76±0.09	10.53±0.37	24.72±0.84	9.06±0.26
<i>M. obscurus</i>	14	8.36	5.84	13.11±1.06	3.95±0.16	3.54±0.14	11.62	23.6±1.41	7.44±0.51
<i>M. qazvinensis</i>	18	-	-	15.9±0.94	4.28±0.20	4.1±0.17	-	27.06±1.18	9.85±0.34
<i>Chionomys nivalis</i>	1	10.36	7.48	15.50	4.52	4.18	13.16	27.36	9.18
<i>Arvicola amphibius</i>	2	11.73±0.16	10.01±0.18	19.53±0.52	6.05±0.07	5.06	15.13±0.18	30.20±6.96	8.75±0.15
<i>Ellobius lutescens</i>	1	12.12	74	24.4	6.36	5.82	16.04	34.12	8.84
<i>Cricetulus migratorius</i>	4	9.28±0.14	6.44±0.45	14.15±0.60	4.59±0.01	4.12±0.17	10.63±0.64	26.21±0.95	5.47±0.27
<i>Mesocricetus brandti</i>	1	12.32	9.12	19.74	7.02	4.06	12.2	35.82	7.02
Dipodidae									
<i>Allactaga williamsi</i>	9	13.57±0.46	6.55±0.55	23.3±0.52	5.5±0.2	9±0.5	16.9±0.25	32±0.92	8.7±0.34
Calomyscidae									
<i>Calomyscus urartensis</i>	2	-	-	12.99±0.01	-	4.23±0.03	-	21.88±0.60	3.91

***Meriones libycus erythrourus* Gray, 1842**

Type Locality: Egypt, near Alexandria (Musser and Carleton, 2005).

Distribution: Most of the Palearctic region and throughout Saudi Arabia (Musser and Carleton, 2005).

Diagnosis: Claws dark; mastoid portion does not extend much behind occipitals; supramental triangle smaller, normally closed posteriorly by a dorsally expanded hamular process.

***Meriones vinogradovi* Heptner, 1931**

Type locality: Iran, Persian Azarbaijan (Musser and Carleton, 2005).

Distribution: Turkey, Syria, Iran, and Armenia and Republic of Azerbaijan (Musser and Carleton, 2005).

Diagnosis: Tail with extensive black brush; center of sole is reddish brown. The skull is similar to *M. tristrami* but is broader; bullae are not much expanded, bony auditory meatus does not reach squamosal root of zygoma; the zygomatic arches are thicker than *M. tristrami*.

***Meriones tristrami bogdanovi* Heptner, 1931**

Type locality: Levant, Dead Sea region (Musser and Carleton, 2005).

Distribution: Levant, NW Iran and Transcaucasia (Musser and Carleton, 2005).

Diagnosis: Soles of hind feet have a distinct naked patch near the heels; throat and chest is plain white; black brush on tip of tail is normally less extensive, with white hairs in some populations, and there is an indistinct pale greyish-black line; the ventral color of the tail is pale light brown. It is distinguished from other jirds of similar size by its rather small bulla; the mastoid portion of the bulla never extends beyond the level of the occipital condyles; the zygomatic arches are narrow and bony auditory meatus does not reach squamosal root of zygoma.

Family Gliridae Muirhead, 1819

Subfamily Leithiinae Lydekker, 1895

***Dryomys nitedula pictus* (Blanford, 1875)**

Type locality: Russia, Lower Volga River (Musser and Carleton, 2005).

Distribution: Deciduous forests and gardens of the Palearctic region (Musser and Carleton, 2005).

Diagnosis: The black band surrounding the eyes and extending to just in front of the ears is a very distinctive characteristic; well defined black stripe extends from base of whiskers to ear; tail is approximately of the same length as head and body. The brain case is narrow and its depth across bullae more than 10.5 mm in majority of animals; condylobasal length less than 27 mm; the tympanic bulla is small; maxillary tooth-row less than 4.9 mm; outer margin of crowns of first and second upper molars with two large tubercles corresponding to the edge of the crests.

Family Cricetidae Fischer, 1817

Subfamily Arvicolinae Gray, 1821

***Microtus socialis* (Pallas, 1773)**

Type locality: Western Kazakhstan, the basin of Ural River (Musser and Carleton, 2005).

Distribution: Steppes of the Palearctic region (Musser and Carleton, 2005).

Diagnosis: Size is small; ears are short, hardly projecting from hair; tail is short (rarely more than 25 mm); with four pairs of mammary gland (two chests and two femoral); with five plantar pads in the sole of hind and fore limb. Auditory bullae is rather large, its length (without mastoid part) being greater than diastema; condylobasal length of skull is mainly less than 26.5 mm; M2/ may have a 3rd inner ridge, M3/ and M/1 moderately complex; M/1 with four labial and five lingual re-entrant folds; M3/ with three labial and four lingual folds. This species shows $2n=62$ and $FNa=60$ (Mahmoudi et al. 2014b).

***Microtus obscurus* (Eversmann, 1841)**

Type locality: Probably near Čujskij trakt (a road), Altai Mts, Siberia (Kryštufek and Vohralík, 2005).

Distribution: Yenisei River, north-western Mongolia, Chinese Xinjiang, the Altai Mts., northern Iran, Transcaucasia, and Anatolia (Kryštufek and Vohralík, 2005; Mahmoudi et al. 2014a).

Diagnosis: Tail length is longer in comparison with related groups; Hind foot is less than 18 mm in adults; with 6 plantar pads in hind foot; incisive foramens are mainly narrower than 1.0 mm; post-orbital tubercles distinctly detached; antero-lateral edge of interparietal are angular; incisive foramen is relatively long; upper posterior part of jugal is curved upward.

***Microtus qazvinensis* Golenishchev et al. 2003**

Type locality: N Iran, Qazvin, Buin-Zahra (Golenishchev et al. 2003).

Distribution: NW of Iran (Shenbrot and Krasnov, 2005; Mahmoudi et al., 2014c).

Diagnosis: Dorsal pelage is brown with basal part of hairs smoky; under part is grayish white; lateral parts of the body is light brown with an orange tint; tail length is more than one fifth of the

TABLE 4. Dental measurements (Mean \pm SD, in mm) of different species of rodents in northwest of Iran (Data were not prepared for *Meriones libycus*; see the text for abbreviations).

Taxa	N	M1/ L	M2/ L	M3/ L	M1/ W	M2/ W	M3/ W	M/1 L	M/2 L	M/3 L	M/1 W	M/2 W	M/3 W	LML	UML
Muridae															
<i>Apodemus wiberbyi</i>	49	1.80 ± 0.07	1.14 ± 0.05	0.85 ± 0.05	1.16 ± 0.4	1.15 ± 0.17	0.81 ± 0.48	1.68 ± 0.06	1.12 ± 0.05	0.91 ± 0.05	1.02 ± 0.53	1.04 ± 0.45	0.85 ± 0.54	3.73 ± 0.10	3.8 ± 0.12
<i>Mus musculus</i>	9	1.66 ± 0.05	0.96 ± 0.05	0.68 ± 0.05	1.09 ± 0.68	0.99 ± 0.04	0.74 ± 0.40	1.52 ± 0.82	0.99 ± 0.41	0.72 ± 0.06	0.95 ± 0.34	0.91 ± 0.04	0.66 ± 0.02	3.25 ± 0.12	3.20 ± 0.12
<i>M. macedonicus</i>	1	1.71	0.98	0.67	1.16	1.04	0.74	1.48	1.03	0.66	0.89	0.92	0.73	3.09	3.35
<i>Meriones vinogradovi</i>	5	3.35 ± 0.06	1.43	0.84 ± 0.08	1.71 ± 0.02	1.63 ± 0.17	1.21 ± 0.07	2.43 ± 0.03	1.14 ± 0.06	1.31 ± 0.24	1.56 ± 0.13	1.24 ± 0.44	1.45 ± 0.06	5.48 ± 0.32	6
<i>M. tristrami</i>	3	2.36 ± 0.03	1.38 ± 0.02	0.61 ± 0.01	1.51 ± 0.00	1.50 ± 0.12	0.79 ± 0.05	2.32 ± 0.02	1.30 ± 0.11	0.74 ± 0.15	1.46 ± 0.68	1.49 ± 0.06	0.92 ± 0.03	4.49 ± 0.24	5.28 ± 0.08
<i>M. persicus</i>	3	2.48 ± 0.08	1.49 ± 0.06	.90	1.56 ± 0.05	1.53 ± 0.13	1.09	2.40 ± 0.10	1.47 ± 0.05	.77 ± 0.01	1.55 ± 0.19	1.64 ± 0.12	1.20 ± 0.04	4.77 ± 0.05	4.95 ± 0.09
Gliridae															
<i>Dryomys nitedula</i>	6	1.13 ± 0.05	1.17 ± 0.04	1.06 ± 0.11	1.23 ± 0.02	1.31 ± 0.06	1.11 ± 0.08	1.16 ± 0.33	1.2 ± 0.07	1.12 ± 0.14	1.17 ± 0.05	1.28 ± 0.07	1.05 ± 0.10	4.05 ± 0.17	4 ± 0.13
Cricetidae															
<i>Microtus socialis</i>	19	-	1.57 ± 0.06	1.82 ± 0.10	-	.705 ± 0.11	.593 ± 0.09	2.68 ± 0.16	-	-	.84 ± 0.06	-	-	-	-
<i>M. obscurus</i>	14	-	1.48 ± 0.05	1.75 ± 0.10	-	.39 ± 0.02	.533 ± 0.05	2.52 ± 0.09	-	-	.764 ± 0.06	-	-	-	-
<i>M. qazvinensis</i>	25	-	1.68 ± 0.12	1.96 ± 0.16	-	.497 ± 0.05	.697 ± 0.16	2.93 ± 0.12	-	-	.88 ± 0.10	-	-	5.92 ± 0.3	6.01 ± 0.4
<i>Chionomys nivalis</i>	1	2.350	1.785	2.077	1.299	1.096	1.049	2.928	1.677	1.656	1.190	1.142	.821	6.212	6.243
<i>Arvicola amphibius</i>	2	3.41 ± 0.04	2.45 ± 0.05	2.48 ± 0.04	1.99	1.54 ± 0.19	1.27 ± 0.02	3.89	2.36 ± 0.01	2.17 ± 0.02	1.71 ± 0.04	1.56 ± 0.02	1.43 ± 0.32	8.57 ± 0.05	8.37 ± 0.14
<i>Ellobius lutescens</i>	1	2.853	2.223	1.847	1.618	1.514	1.338	3.256	2.080	1.860	1.427	1.345	1.134	7.171	6.951
<i>Cricetulus migratorius</i>	4	1.60 ± 0.14	1.21 ± 0.02	.99 ± 0.03	.91 ± 0.03	1 ± 0.03	.96 ± 0.01	1.50	1.23 ± 0.09	1.16 ± 0.01	.97 ± 0.04	1.02 ± 0.03	.94 ± 0.02	3.90 ± 0.13	3.79 ± 0.14
<i>Mesocricetus brandti</i>	1	2.12	1.665	1.513	1.239	1.201	1.128	1.919	1.775	1.941	0.955	1.168	1.098	5.549	5.488
Dipodidae															
<i>Allactaga williamsi</i>	9	2.41 ± 0.10	2.15 ± 0.07	1.3 ± 0.07	2.01 ± 0.14	1.90 ± 0.16	1.63 ± 0.12	2.77 ± 0.32	2.44 ± 0.2	1.73 ± 0.11	1.9 ± 0.71	1.94 ± 0.09 3	1.50 ± 0.73	6.89 ± 0.2	6.91 ± 0.23
Calomyscidae															
<i>Calomyscus urartensis</i>	2	1.42 ± 0.06	1.26 ± 0.02	0.74	0.95 ± 0.02	1.02 ± 0.02	0.71	1.56 ± 0.98	1.15 ± 0.03	0.79 ± 0.03	1.05 ± 0.00	1.08 ± 0.03	0.76	3.45 ± 0.99	3.52 ± 0.14

head and body; tail is bicolor; tip of the tail is dark. Incisive foramen do not reach to the line which connects left and right first upper molars; upper M2 with extra lingual loop; upper M3 mostly with 4 labial and 4 lingual loops; length of upper tooth row is more than 6.0 mm. The species revealed $2n=54$, $FNa=52$ (Golenishchev et al. 2003; Mahmoudi et al. 2014b, 2014c).

***Chionomys nivalis trialeticus* Shidlovsky, 1919**

Type locality: Berner Oberland, Switzerland (Musser and Carleton, 2005).

Distribution: Mountains of S Europe, east to Turkey, W Caucasus, Lebanon, W Syria, Zagros and W and N Iran, and Kopet Dag of S Turkmenistan (Musser and Carleton, 2005; Darvish et al., 2005).

Diagnosis: Tail is not dichromatic and it is less than 55% of head and body length; skull deeper; posterior margin of incisive foramen reaches line of anterior alveolar margins of upper M1. Upper M1 with pot-shaped anterior loop and two closed labial loops beside two closed lingual ones and a very small ridge like lingual loop. Upper M2 with two closed labial and one lingual loops. Upper M3 with one open and one closed labial beside one open lingual loop and posterior one with re-entrant fold. Lower M1 with pot-shaped anterior loop and two closed and one opened lingual triangle beside one closed and one opened labial triangle.

***Arvicola amphibius persicus* De Filippi, 1885**

Type locality: England (Musser and Carleton, 2005).

Distribution: Europe east through Siberia to Lena River Basin; from Arctic Sea south to Lake Baikal and N Tien Shan Mtns of NW China (Xinjiang) through NW Iran, Iraq, N Israel, Caucasus Turkey and Great Britain except Ireland (Musser and Carleton, 2005).

Diagnosis: Skull is widely arched; condylobasal length is more than 35 mm. Rostrum is short but deep; nasals expand anteriorly; Postorbital squamosal crest is well marked and the temporal ridges form a sagittal crest in full grown adults; Bullae shows moderate size; incisive foramina short; incisors are orthodont; molars are hypsodont; Triangles posterior to the anterior loop of the 1st and 2nd upper molars are alternating. Third upper molar consists of an anterior loop followed by two or three alternating triangles; the postero-labial triangle T4 is frequently fused with a much reduced posterior cup, but its dental fold is closed in some animals. There are never more than two deep re-entrant angles on either sides of the 3rd upper molar. First lower molar has three alternating triangles with closed dental folds (T1 to T3) (Appendix 1).

***Ellobius lutescens lutescens* Thomas, 1897**

Type Locality: Turkey, Kurdistan, Van (Musser and Carleton, 2005).

Distribution: S Caucasus south through E Turkey and NW Iran (Musser and Carleton, 2005).

Diagnosis: Front claws are of normal size; tail is shorter than hind foot; external pinnae absent; upper incisors are strongly proodont; skull is deep and slightly convex in profile; the zygomatic arches are widely curved (Appendix 1). Incisive foramina are distinctly short and have been shifted posteriorly. Bullae are small. Molars are rooted in adults and their grinding surfaces show a simple pattern with broadly confluent dental fields. Second upper molar is atypical in voles. First lower molar has three deep re-entrant angles on both sides. Third upper molar has three triangles, but the antero-labial one (T2) is integrated into the anterior lobe.

Subfamily Cricetinae Fischer, 1817

***Cricetulus migratorius pulcher* Ognev, 1924**

Type locality: West Kazakhstan, Lower Ural River (Musser and Carleton, 2005).

Distribution: Most of the Palearctic region (Musser and Carleton, 2005).

Diagnosis: Dorsal color is gray while hairs are black at base; ventral part is white; tail is shorter than head and body and longer than hind foot. Cheek pouches are rudimentary; skull is without crests and with large braincase and has narrowly separated zygomatic arches; pterygoid plates are broad and flat; condylobasal length less than 28.0 mm.

***Mesocricetus brandti brandti* (Nehring, 1898)**

Type Locality: Georgia, near Tbilisi (Musser and Carleton, 2005).

Distribution: Turkey, Caucasus, NW Iran and Levant (Musser and Carleton, 2005).

Diagnosis: Black and white transverse band across chest on the ventral side; tail is shorter than hind foot; oblique blackish or brownish subauricular stripe from cheeks to shoulders; 16 nipples in females; condylobasal length of skull more than 30.0 mm. Supraorbital crests are prominent; there is no external plate with infraorbital foramen; zygomatic plate narrowed. Incisive foramen does not reach the tooth rows, interparietal is small, deep pterygoid fossa, large coronoid process; lenticular foramen mandibulae; rectangular processus condylaris. The specimens characterized by $2n=42$, $FNa=78$.

Family Calomyscidae Vorontsov and Potapova, 1979

***Calomyscus urartensis* Vorontsov and Kartavseva, 1979**

Type Locality: Republic of Azerbaijan, Naxçivan, 7 km N of Julfa (Musser and Carleton, 2005).

Distribution: Republic of Azerbaijan and NW Iran (Norris et al., 2008)

Diagnosis: Tail is bicolored and well-haired, with a white tuft and longer than head and body. Soles are naked. Ears and eyes are relatively large. Under part is white with a yellowish tint. Dorsal pelage is light brown with some greyish hairs. Skull is very thin and *Mus*-like. Rostrum is narrow and long. Skull is without supraorbital ridges. Pterygoid processes diverge posteriorly (Appendix 1). Karyological study on this species demonstrated $2n=28$ and $FNa=44$.

Family Dipodidae Fischer de Waldheim, 1817

Subfamily Allactaginae Vinogradov, 1925

***Allactaga williamsi schmidti* Satunin, 1907**

Type locality: Turkey, near Van Golu (Musser and Carleton, 2005).

Distribution: Turkey, Caucasia, Afghanistan and Iran (Musser and Carleton, 2005).

Diagnosis: It is the largest species of the genus *Allactaga* in Iran; dorsal hair is pale gray, hairs are dark gray at bases and cream at apexes; ventral hairs are completely white; dorsal color varies from gray to pale light yellow toward flanks; tail color is similar to dorsal part; the sub terminal part of the flag is pale black while terminal part is white; Ears are long; hind foot more than 60 mm; penis shorter than 4 mm and covered with some less than 50 denticles. Skull is flat; rostrum is relatively short and narrow; tympanic bullae is of medium size; upper incisors are proodont; the upper and lower molars are with roots and there is no enamel folded; M1/ and M2/ are with four roots, m2 with three roots (Appendix 1). Karyology of the species has been demonstrated by $2N=48$ and $FNa=92$.

DISCUSSION

Northwest of Iran is situated within a crossroad of two significant hotspots; the Caucasus and Irano-Anatolian regions. It is not only affected by the Central Asian hotspot but also by Asian Minor elements (Mittermeier et al., 2012; Musser and Carleton, 2005). Valleys and high mountains provide patchy climate (Khalili, 1973) and favorable conditions for high endemism and speciation (Misonne,

1959; Agakhanjanz and Breckle 1995; Noroozi et al., 2008). The region also includes Zagros Mountains which contains a lot of endemic species (International, C., 2008). Misonne (1959) called northwest of Iran as Armano-Kord region and mentioned that it is one of the cradles of endemism. Generally speaking, Alborz and Zagros mountainous ranges are the most important centers of endemism (Misonne, 1959) providing a corridor (Lerp et al., 2013) and barrier (Tchernov, 1988; Jacobs et al., 1999) between the humid Mediterranean basin, the Caucasus (Kamrani et al., 2011) and dry plateaus of western Asia. The region has also been affected by glacial period events. During glacial period while central part of Iran got drier, higher elevations of northwest of Iran were covered with glaciers (Bobek, 1937; 1953) but some refuge areas remained in lower elevations (Noroozi et al., 2008). In the northwest of Iran, east-west extension of Alborz Mountains from the north crossed with eastern branches of Alborz causing nearly isolation of the region (Misonne, 1959). Northwest of Iran is also characterized by its extremely cold winters and spring rainfalls, comparing to other parts of Iran (Khalili, 1973). Cold winter is one of the limiting factors for presence of species and mountainous feature of the region bounds some species to pass this domain. For example, distribution of *Nesoki indica*, *Tatera indica* and *Rhombomys opimus* have been confined strictly to southern margin of the region. On the other hand, some species have been restricted to the northern part of Caucasus or northern part of the Aras River and they are absent from Iranian part of the Caucasus. Expansion of broad leaf forests of the south Caucasus in western part of Caspian Sea beside, Karakum and Kyzyl Kum desert in eastern part totally blocked some taxa.

In contrary, the region would not serve as a barrier for some species such as *Mus macedonicus*, *Meriones tristrami*, *Meriones vinogradovi*, *Spermophilus xanthopyrmnus*, *Allactaga williamsi*, *Cricetulus migratorius*, *Ellobius lutescens*, *Microtus levis*, *Microtus majori*, *Microtus socialis*, *Microtus arvalis*, *Chionomys nivalis*, *Arvicola amphibius*, *Dryomys nitedula* and *Hystrix indica* (Özkurt et al., 2007; Musser and Carleton, 2005).

In details, two different scenarios were suggested for occurrence of the *Mus musculus* in Iran. The first one proposed north Indian origin and northward expansion through northeast of Iran and establishment of *Mus musculus musculus* in central Asia and westward radiation of *Mus musculus domesticus* in northwest Iran and Turkey (Bonhomme et al., 1994). Moreover, Prager et al. (1998) suggested the western part of the Zagros Mountains as an origin place of *M. musculus domesticus*. The second one is Transcaucasian cradle of *Mus musculus musculus* and consequent expansion to Central Asia (Milishnikov et al., 2004). But, the real history of the genus has been subject of many questions (Darvish, 2008).

Mosaic and patchy distribution of *Dryomys nitedula* in Iran (recorded from northwest, northeast, central deserts, southwest and southeast of Iran; Lay 1967; Obuch, 2001; Darvish et al., 2006) and Middle East suggests complex immigration scenario. Also, *Glis glis* distributed through broad leaf Hyrcanian forest of Aras valley and expanded through southern forested margin of Caspian Sea to Golestan National Park in northern parts of Iran.

Presence of the genus *Spalax* in Iran has not been investigated yet but *Terricola daghestanicus* and *T. majori* possibly occur in northwest Iran (Musser and Carleton, 2005). Since, species of the genus *Arvicola* are more European elements than Asian it is supposed that *Arvicola amphibius* expanded through the Caucasus or Anatolia so that this species is restricted to the northwest of Iran and has not reached central part of Iran Plateau. Pierny et al. (2005) argued that two different post-glacial haplotypes of *Arvicola amphibius* are related to different refugium; Iberian Peninsula and eastern European but origin of post-Pleistocene population of the species which has distributed through Irano-Anatolia should be revealed clearly.

In spite of the fact that fossil forms of the genus *Ellobius* have spread from Eastern Europe to North Africa, contemporary forms of the genus *Ellobius* are Central Asian elements (Musser and Carleton, 2005). Most of the range expansion of the genus *Ellobius* includes Central Asian countries and the oldest fossil of this genus was found in Central Asia (Lychev and Savinov, 1974; Zazhigin, 1988).

The genus *Mesocricetus* is restricted to Mediterranean basin and seems to pass all barriers and occupies its associated niche in the northwest of Iran although, presence of *M. auratus* in Iran has been under debates (Lay, 1967; Yiğit et al., 2006).

Despite, the late Pleistocene distribution of the genus *Prometheomys* in western part of Asia, the only extant species of this genus, *Prometheomys schaposchnikovi*, is restricted to eastern part of Black Sea (Agadzhanyan, 1993) and our data could not support its presence in Iran.

Different species of the genus *Meriones* show different behavior to the mountainous barrier of Ararat and Zagros. *Meriones vinogradovi* passed it thanks to its resistance in cold weather and its deep burrows while some other could not (Misonne, 1959). This mountainous range serves as a barrier for *Meriones dabli*, confined and endemic species to northern Turkey and south Armenia maybe because of its dependence to sandy lowlands and not mountainous habitats (Özkurt et al., 2001). However, Krystufek and Vohralik (2009) didn't reject possibility of its occurrence in northwest of Iran.

Colak et al., (1998) mentioned that a wide gap between distributional range of *Allactaga williamsi* in the northwest of Iran and north Afghanistan indicates exchange of species through Alborz Mountains. However, Misonne (1959) mentioned its possible occurrence in eastern Alborz between Gorgan and Shahroud which can fill the gap described by Colak et al., (1998). In conclusion, to study the distributional patterns of the species and making a comprehensive synthesis of the global diversity, gaps should be filled applying more investigations on different regions.

ACKNOWLEDGMENTS

The first author wishes to thank Mr. Mohammad Hanifi and Dr. Ehsan Mostafavi head of the Department of Epidemiology, Pasteur Institute of Iran for providing specimens of *Meriones vinogradovi*, *Ellobius lutescens* and *Arvicola amphibious*. We would like to thanks Maryam Jangjoo for preparing some of the museum specimens and the members of Rodentology Research Department, Ferdowsi University of Mashhad for their helps and providing the specimens for this research.

LITERATURE CITED

- Agadzhanyan, A.K., 1993. A new vole like rodent (Mammalia, Rodentia) from the Pliocene of the Russian Plain. *Paleontological Journal*, 27: 126-140 (Translated from *Paleontologicheskii Zhurnal*, 2: 99-111).
- Agakhanjanz, O., Breckle, S.W., 1995. Origin and evolution of the mountain flora in middle and central Asia. In: Chapin, III, F.S, Kerner, C. (eds), *Arctic and Alpine Biodiversity: Patterns, Causes and Ecosystem Consequences*. *Ecological Studies*, 113: 63-80.
- Awise, J.C., Arnold, J., Ball, R.M., Bermingham, E., Lamb, T., Neigel, J.E, Reeb, C.A., Saunders, N. C., 1987. Intraspecific phylogeography: the mitochondrial DNA bridge between population genetics and systematics. *Annual Review of Ecology, Evolution, and Systematics*, 18: 489-522.
- Bobek, H., 1937. Die Rolle der Eiszeit in Nordwestiran. *Zeitschrift für Gletscherkunde und Glazialgeologie*, 25: 130-183.
- Bobek, H., 1953. Zur eiszeitlichen Vergletscherung des Alborzgebirges, Nordiran. *Carinthia*, 2: 97-104.
- Bonhomme, F., Anand, R., Darviche, DJ., Din, W., Boursot, P., 1994. The House Mouse as a Ring Species? In: Moriwaki K. (ed.), *Genetics in Wild Mice: Its Application to Biomedical Research*. *Japan Scientific Societies Press*, Tokyo: 13-23.
- Colak, E., Yiğit, N., 1998. Ecology and biology of *Allactaga elater*, *Allactaga euphratica* and *Allactaga williamsi* (Rodentia: Dipodidae) in Turkey. *Turkish Journal of Zoology*, 22: 105-117.

- Corbet, G.B., 1978. The mammals of the Palearctic region, a taxonomic review. *British Museum (Natural History), London*.
- Darvish, J., 1995. [Presence of two sympatric species of *Mus musculus* and *Mus macedonicus* (Muridae, Rodentia) in Qazvin region of Iran]. *Journal of Science University of Tebran*, 21(1) (in Farsi).
- Darvish, J., 2008. Biosystematic approach to geographic variations of house mouse group, *Mus musculus* L. 1766. *Iranian Journal of Animal Biosystematics*, 4: 31-54.
- Darvish, J., Siah sarvie, R., Javdikar, M., Mirshamsi, O., 2005. New records of the snow vole *Chionomys nivalis* (Rodentia: Arvicolinae) from the Binaloud and Elbruz Mountains in Iran. *Acta Zoologica Cracoviensia A*, 48: 67–70.
- Darvish, J., Siah sarvie, R., Mirshamsi, O., Kayvanfar, N., Hashemi, N., Sadeghie Shakib, F., 2006. Diversity of the rodents of northeastern Iran. *Iranian Journal of Animal Biosystematics*, 2: 57-76.
- De Bonis L., Brunet, M., Heintz, E., Sen, S., 1993. La province Greco-irano-afgane et la repartition des faunes mammaliennes au Miocene superieur. *Paleontology and evolution*, 24-25: 96-106.
- Etemad E., 1978: *The Mammals of Iran. Volume 1. Rodents and Key to Their Classification*. National Society for Protection of Natural Resources and Human Environment, Teheran, 288 pp (in Farsi, with a summary in English).
- Firouz, E., 1999. Fauna of Iran (Vertebrates). Iran University Press, Tehran, 508 pp (in Farsi).
- Golenishchev, F.N., Malikov, V.G., Nazari, F., Vaziri, A.S., Sablina, O.V., Polyakov, A.V., 2003. New species of vole of “*quentheri*” group (Rodentia, Arvicolinae, *Microtus*) from Iran. *Russian Journal of Theriology*, 1: 117-123.
- Gharkheloo, M.M., Kivanc E., 2003. A study on the morphology, karyology and distribution of *Ellobius* Fisher, 1814 (Mammalia: Rodentia) in Iran. *Turkish Journal of Zoology*, 27: 281–292.
- Graphodatsky, A.S., Sablina, O.V., Meyer, M.N., Malikov, V.G., Isakova, E.A., Trifonov, V.A., Polyakov, A.V., Lushnikova, T.P., Vorobieva, N.V., Serdyukova, N.A., Perelman, P.L., Borodin, P.M., Benda, P., Frynta, D., Leikepova, L., Munelinger, P., Pialek, J., Sadlova, J., Zima, J., 2000. Comparative cytogenetics of hamsters of the genus *Calomyscus*. *Cytogenetics and Cell Genetics*, 88: 296-304.
- Gromov, I. M., Erbajeva, M. A., 1995. [The Mammals of Russia and Adjacent Territories. Lagomorphs and Rodents]. *Zoological Institute, Russian Academy of Sciences, Sankt-Peterburg*, 521 pp (in Russian).
- International, C., 2008. Biological diversity in the Irano-Anatolian. Retrieved from <http://www.eoearth.org/article/150645>
- Jacobs, B.F., Kingston, J.D., Jacobs, L.L., 1999. The origin of grass-dominated ecosystems. *Annals of the Missouri Botanical Garden*, 86: 590-643.
- Kamrani, A., Naqinezhad, A., Attar, F., Jalili, A., Charlet, D., 2011. Wetland flora and diversity of the Western Alborz Mountains, North Iran. *Phytologia Balcanica*, 17: 53 –66.
- Karami, M., Hutterer, R., Benda, P., Siah sarvie, R., Kryštufek, B., 2008. Annotated check-list of the mammals of Iran. *Lynx (Praba)*, 39: 63–102.

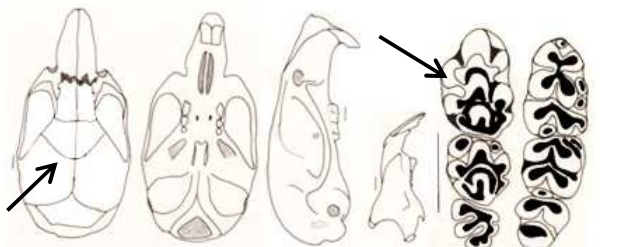
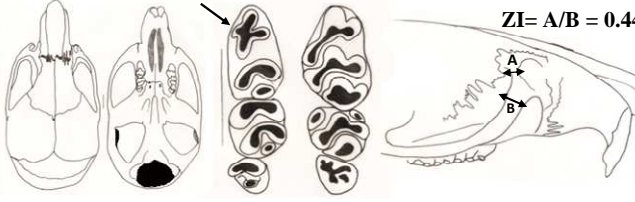
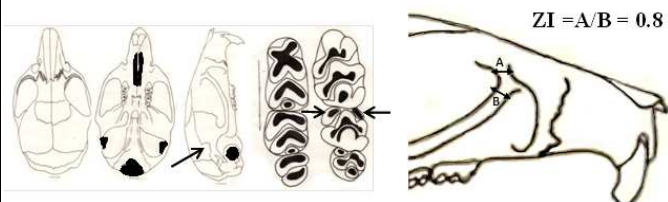
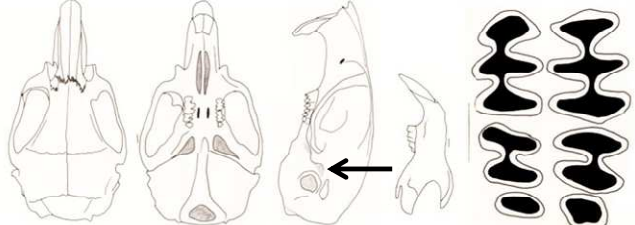
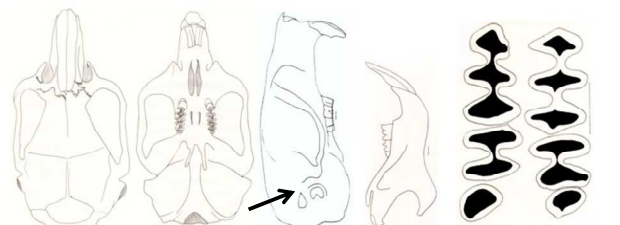
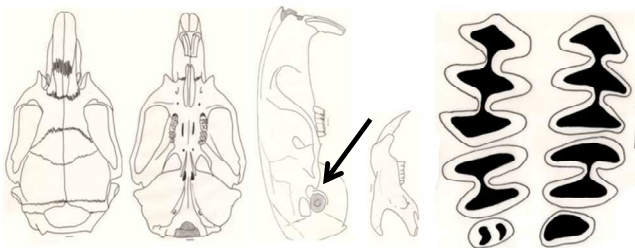
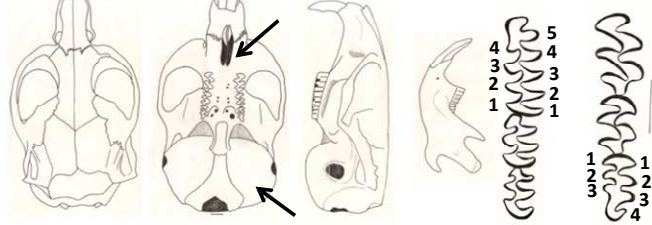
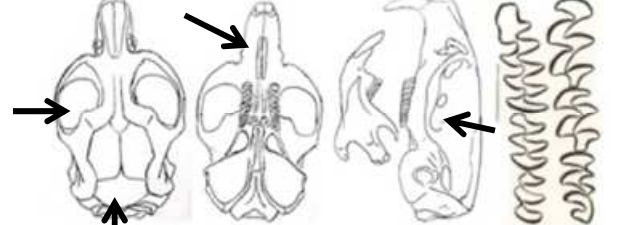
- Khalili, A., 1973. Precipitation patterns of Central Elburz. *Archives for meteorology, geophysics, and bioclimatology, Series B*, 21: 215–232.
- Kryštufek, B., Hutterer R., 2006. The Ural field mouse *Apodemus uralensis* – a mammal species new to Iran. *Zoology in the Middle East*, 38: 111–112.
- Kryštufek, B., Vohralik, V., 2005. Mammals of Turkey and Cyprus. Rodentia I: Sciuridae, Dipodidae, Gliridae, Arvicolinae. *Knjižnica Annales Majora*, Koper, 292 pp.
- Kryštufek, B., Vohralik, V., 2009. Mammals of Turkey and Cyprus. Rodentia II: Cricetinae, Muridae, Spalacidae, Calomyscidae, Capromyidae, Hystricidae, Castoridae. *Knjižnica Annales Majora*.
- Lay, D.M., 1967. A study of the mammals of Iran resulting from the street expedition of 1962–63. *Fieldiana Zoology*, 54: 1–282.
- Lerp, H., Wronski, T., Butynski, T. M., Plath, M., 2013. Speciation of Arabian gazelles. In: Speciation: Natural Processes, Genetics and Biodiversity. P. Michalak, ed. Nova Science Publications, Hauppauge, New York, USA, Pp. 59-82.
- Lomolino, M., Riddle, B., Brown, J., 2006. Biogeography, 3rd ed. Sinauer Associates, Sunderland, Massachusetts.
- Lytchev, G.F., Savinov, P.F., 1974. [Late Pliocene lagomorphs and rodents from Kiikbai]. *Materialy po Istorii I Faune Kazakhstana*, 6: 39–57 [in Russian].
- Mahmoudi, A., Darvish, J., Aliabadian, M., 2014a. New insight into phylogeography of Altai vole, *Microtus obscurus* (Arvicolinae: Rodentia) inferred from mitochondrial data. *18th National and 6th International Congress of Biology in Iran*, Kharazmi University, Karaj, Iran.
- Mahmoudi, A., Darvish, J., Aliabadian, M., Khosravi, M., Golenishchev, F., Krystufek, B., 2014b. Chromosomal diversity in the genus *Microtus* at its southern distributional margin in Iran. *Foila Zoologica*, 63(4):290-295.
- Mahmoudi, A., Darvish, J., Aliabadian, M., 2014c. Taxonomic identity of *Microtus qazvinensis* Golenishchev et al. 2003 (Rodentia, Arvicolinae) from the northwest of Iran. *Acta Theriologica*, DOI 10.1007/s13364-014-0205-x
- Milishnikov, A.N., Lavrenchenko, L.A., Lebedev, V.S., 2004. Origin of the house mice (superspecies complex *Mus musculus* sensu lato) from the Transcaucasia region: A new look at dispersal routes and evolution. *Russian Journal of Genetics*, 40: 1011–1026.
- Misonne, X., 1959. Analysis zoogeographique des mammiferes de l' Iran. *Memoires de l'Institut Royal des Sciences Naturelles de Belgique, Deuxième Série*, 59: 1–157.
- Mittermeier, R.A., Turner, W.R., Larsen, F.W., Brooks, T.M., Gascon, C., 2012. Global biodiversity conservation? the critical role of hotspots. Biodiversity hotspots distribution and protection of conservation priority areas (ed. by F.E. Zachos and J.C. Habel), pp. 3–22. Springer-Verlag Berlin, Heidelberg, Berlin.
- Mohammadi, Z., Darvish, J., Ghorbani, F., Haddad, F., 2013. Cytogenetic characterization of 23 species of rodents from Iran. *Iranian Journal of Animal Biosystematics*, 9: 57-72.

- Mohammadi, Z., Darvish, J., Haddad, F., Ghorbani, F., 2012. A Karyological Study of Some Murid Rodents (Rodentia: Muridae) of Iran. *Progress in Biological Sciences*, 2: 30-39.
- Musser, G.C., Carleton, M.D., 2005. Superfamily Muroidea. Pp. 894–1531. In: Wilson D.E. and Reeder D.M. (eds.): *Mammal Species of the World. A Taxonomic and Geographic Reference. Third Edition. Volume 2. The John Hopkins University Press, Baltimore*, 745–2142 pp.
- Myers, N., Mittermeier, R.A., Mittermeier, C.G., Da Fonseca, G.A., Kent, J., 2000. Biodiversity hotspots for conservation priorities. *Nature*, 403: 853–858.
- Neronov, V.M., Afarang-Azadand, A., Teslenko, E.B., 1974. [Distribution and status of gerbillid genera *Meriones*, *Tatera* and *Gerbillus* in Iran and questions of zoogeographical regionalisation of this country]. *Bjulleten Moskovskogo Obščestva Ispytatelej Prirody, Otdel Biologičeskij*, 79: 41–71 (in Russian).
- Noroozi, J., Akhiani, H., Breckle, S.W., 2008. Biodiversity and phyto geography of the alpine flora of Iran. *Biodiversity and Conservation*, 17: 493-521.
- Norris, R.W., Woods, C.A., Kilpatrick, C.W., 2008. Morphological and molecular definition of *Calomyscus hotsoni* (Rodentia: Muroidea: Calomyscidae). *Journal of Mammalogy*, 89: 306-315.
- Obuch, J., 2001. Dormice in the diet of owls in the Middle East. *Trakya University Journal of Scientific Research. Series B*, 2: 145-150.
- Özkurt, Ş., Yiğit, N., Çolak, E., Sözen, M., Verimli, R., 2001. Observations on the reproduction biology of *Meriones meridianus* Pallas, 1773 (Mammalia: Rodentia) in Turkey. *Zoology in the Middle East*, 23: 23-29.
- Özkurt, T.S.Ö., Sozen, M., Yiğit, N., Kandemir, I., Çolak R., Gharkheloo, M., Çolak, E., 2007. Taxonomic status of the genus *Spermophilus* (Mammalia: Rodentia) in Turkey and Iran with description of a new species. *Zootaxa*, 1529: 1–15.
- Piertney, S. B., Stewart, W.A., Lambin, X., Telfer, S., Aars, J., Dallas, J.F., 2005. Phylogeographic structure and post-glacial evolutionary history of water voles (*Arvicola terrestris*) in the United Kingdom. *Molecular Ecology* 14: 1435-1444.
- Prager, E.M., Orrego, C., Sage, R.D., 1998. Genetic variation and phylogeography of Central Asian and other house mice, including a major new mitochondrial lineage in Yemen. *Genetics*, 150: 835–861.
- Shenbrot, G.I., Krasnov, B.R., 2005. An Atlas of the Geographic Distribution of the Arvicoline Rodents of the World (Rodentia, Muridae: Arvicolinae). *Pensoft, Sofia*.
- Tchernov, E., 1988. The biogeographical history of the southern Levant. In: Yom-Tov Y, Tchernov E, editors. *The Zoogeography of Israel. The Distribution and Abundance at a Zoogeographical Crossroad*. Dordrecht, Boston, Lancaster: Dr W. Junk Publishers.
- Wessels, W., 1955. Miocene rodent evolution and migration Muroidea from Pakistan, Turkey and Northern Africa. Faculty of Geosciences, Utrecht University.
- Yiğit, N., Gharkheloo, M.M., Çolak, E., Özkurt, S., Bulut, S., Kankilic, T., Çolak, R., 2006. The karyotypes of some rodent species (Mammalia: Rodentia) from eastern Turkey and northern Iran with a new record, *Microtus schidlovskii* Argyropulo, 1933, from eastern Turkey. *Turkish Journal of Zoology*, 30, 459–464.

Zazhigin, V.S., 1988. [Paleontological descriptions: Insectivora, Lagomorpha, Rodentia], Vangengeim E.A. & Nikiforova K.V. (eds.). [Biostratigraphy of Late Pliocene-Early Pleistocene of Tadzhikistan (Mammalian Fauna)]. Moscow: Nauka Publishing House, 18–24 [in Russian].

Ziaie, H., 2008. A Field Guide to the Mammals of Iran. Department of Environment, Tehran, 299 pp (in Persian).

Appendix 1.

 <p><i>Apodemus wiberbyi</i>: from left to right, Dorsal, Ventral, Lateral view of the skull, Mandible, upper and lower Molars (Scale bar=1mm).</p>	 <p>$ZI = A/B = 0.44$</p> <p><i>Mus musculus domesticus</i>: from left to right, Dorsal and Ventral views of the skull and lower and upper Molars and Lateral skull (Scale bar=1mm).</p>
 <p>$ZI = A/B = 0.8$</p> <p><i>Mus macedonicus</i>: from left to right, Dorsal and Ventral view of the skull, Mandible, lower and upper Molars (Scale bar=1mm).</p>	 <p><i>Meriones persicus rossicus</i>: from left to right, Dorsal, Ventral and Lateral view of the skull, Mandible, upper and lower Molars (Scale bar=1mm).</p>
 <p><i>Meriones vinogradovi</i>: from left to right, Dorsal, Ventral, Lateral view of the skull, Mandible and upper and lower Molars (Scale bar = 1mm).</p>	 <p><i>Meriones tristrami bogdanovi</i>: from left to right, Dorsal, Ventral, Lateral view of the skull, Mandible and upper and lower Molars (Scale bar=1mm).</p>
 <p><i>Microtus socialis</i>: from left to right, Dorsal, Ventral, Mandible, Lateral view of the skull besides, upper and lower Molars.</p>	 <p><i>Microtus obscurus</i>: from left to right, Dorsal, Ventral, Mandible, Lateral view of the skull besides, upper and lower Molars.</p>

