

# Rodent fauna of the western Golestan Province in northeast Iran

GHORBANI<sup>1</sup> F., J. DARVISH<sup>\*1,2</sup>, H. GHOLI KAMI<sup>3</sup> AND O. MIRSHAMSI<sup>1,2</sup>

*1 Biology Department, Faculty of Sciences, Ferdowsi University, Mashhad, Iran*

*2 Rodentology Research Department, Ferdowsi University, Mashhad, Iran*

*3 Biology Department, Faculty of Sciences, Golestan University, Gorgan, Iran*

Golestan province is located in northeastern Iran, southeast of the Caspian Sea, a region thought to be one of the most important refuge areas during glacial periods. During three years of fieldwork in the area, 13 species of rodents belonging to five families were identified including: Muridae (*Rattus rattus*, *Rattus norvegicus*, *Mus musculus*, *Apodemus hyrcanicus*, *Apodemus uralensis*, *Apodemus netherbyi*, *Rhombomys opimus*, *Nesokia indica*), Dipodidae (*Allactaga elater*, *Pygeretmus pumilio*), Gliridae (*Glis glis*), Cricetidae (*Cricetulus migratorius*), and Hystricidae (*Hystrix indica*). Standard external morphologic and morphometric characters, including cranial and dental, are given.

**Key words:** Elburz Mountains, Hyrcanian forest, Caspian Sea, Rodents

## INTRODUCTION

Iran comprises a variety of geographic and climatic habitats. It is located in the Palearctic region and forms a bridge between the Middle East and Indian subcontinents. It is also the crossroads between three major faunal regions, the Palearctic, Ethiopian, and Oriental.

Golestan Province, situated southeast of the Caspian Sea in northeastern Iran, is thought to be one of the most important refuge areas during glacial periods, and many species that now range across Europe would have taken refuge there (Hewitt, 1996). The region constitutes a corridor between the Caucasus and central Asia, although the Koppe Dagh Mountains may restrict permeability. The most influential factors modulating the faunal composition of the area are the Caucasus, Mediterranean, and Turkmenistan faunas. Topography and climate vary noticeably in Golestan Province, and two main regions are represented in the studied area: the Caspian and Hyrcanian mixed deciduous forests and mountain forests of the northern slopes of Elburz Mountain with a temperate climate in the south and southeast of the province including the Gorgan plain and Golestan National Park, and the lowlands and semi-desert region in the north section of the province, the boundary between Iran and the Turkmenistan Republic.

Paleontological data suggest that the northeastern Elburz mountain range (southeast of the Caspian Sea) was part of the Gondwanan supercontinent during the Late Ordovician (Ghavidelsyooki, 2007), and the semi-desert region at the border of Iran and the Turkmenistan Republic belongs to the Pliocene-Quaternary deposit complex (Alinejad, 2009).

The diversity and the level of endemism of rodents of this ecological region made it an important area for survey. Many of the species recorded in the area have been poorly described; therefore, a biosystematic approach for identification and precise descriptions of the species is valuable.

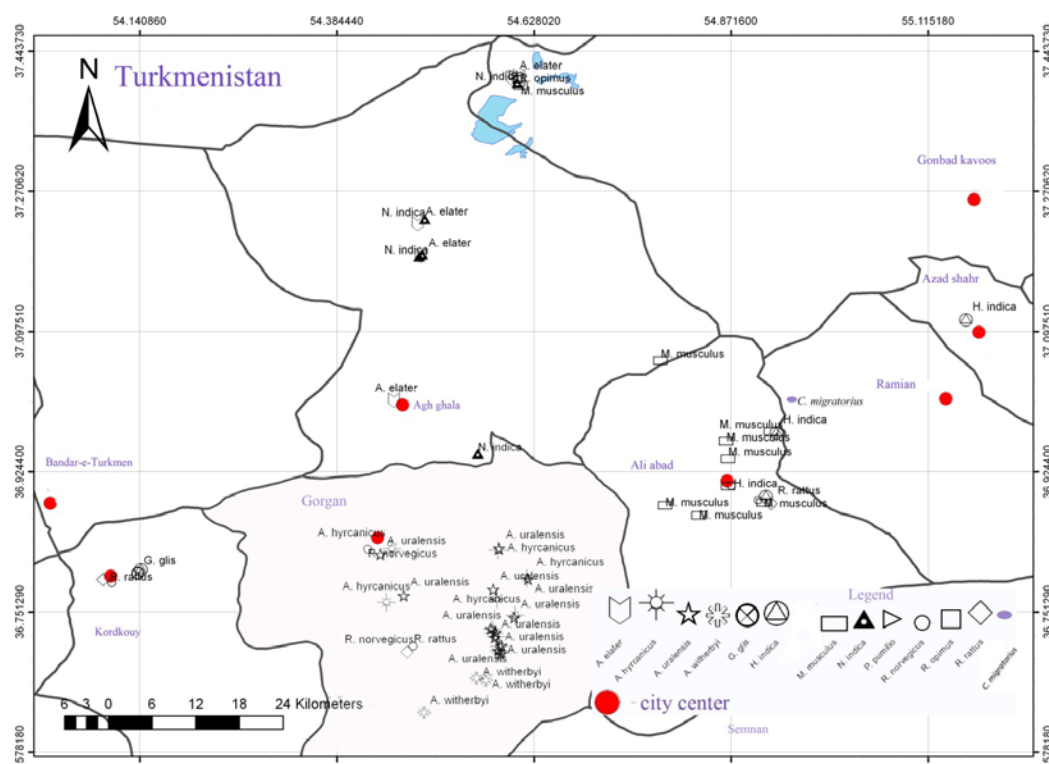


FIG. 1.- Collecting sites of specimens in western Golestan Province.

## MATERIAL AND METHODS

The study was carried out along a gradient of elevation from -5 m to 2700 m in west Golestan province. A total of 134 specimens belonging to 13 species were collected by snap traps and Sherman live-traps (Muridae, Cricetidae, Gliridae), using motorcycle and searchlight (Dipodidae), and by shooting (*Hystriidae*). The samples were examined between December 2006 and December 2009. Voucher specimens were deposited in the Zoology Museum of Ferdowsi University of Mashhad (ZMFUM). Four standard external characters were measured using a ruler, and ten cranial variables using vernier calipers. Dental characters were measured with a Nikon measuring microscope MM-40. Wilson and Reeder (2005) was used as a guide for the taxonomic status. The distribution range of specimens and records were added to the list. The distribution map was plotted by ArcGIS ver.9.2 software.

## ABBREVIATIONS OF MEASUREMENTS

*W*: weight, *HBL*: head and body length, *TL*: tail length, *FL*: hind foot length, *EL*: ear length, *CL*: condylobasal length of skull, *OL*: occipito-nasal length of skull, *RL*: length of rostrum, *ZB*: zygomatic breadth, *MT*: maxillary tooth-row length, *IC*: interorbital constriction, *BB*: breadth of braincase, *WR*: width of rostrum, *RH*: height of rostrum, *BU*: length of bullae. The cranial and dental characters are as described by Kryštufek and Vohralík (2005). *M1/L*: length of first upper molar, *M1/W*: width of first upper molar, *M2/L*: length of second upper molar, *M2/W*: width of second upper molar, *M3/L*: length of third upper molar, *M3/W*: width of third upper molar, *M/1L*: length of first lower molar, *M/1W*: width of first lower molar, *M/2L*: length of second lower molar, *M/2W*: width of second lower molar, *M/3L*: length of third lower molar, *M/3W*: width of third lower molar.

### ECOLOGICAL ASPECTS

There are a variety of habitats in the study area, such as closed forest, open woodland and shrub, mountain meadows, steppes, halophytic communities, and wetlands. Within Eurasia this region represents relic refugia for mesophilic tree and shrub flora (Browicz, 1989). The forests along the southern shores of the Black and Caspian Seas, known as Euxino-Hyrcanian forests, harbor many Arcto-Tertiary relics. Species such as *Quercus castaneifolia*, *Parrotia persica*, *Acer velutinum*, and *Gleditsia caspica* are Hyrcanian elements restricted to the southern coast of the Caspian Sea, phytogeographically described as the Hyrcanian province of the Euro-Siberian Region (Browicz, 1989; Akhiani, 1998; Kürschner et al., 2000), and numerous Euro-Siberian plant species can be found in the area (Misonne, 1959).

The vegetation of the Hyrcanian regions below altitudes of 1000 m consists mainly of thermophilous species such as *Zelkova carpinifolia*, *Parrotia persica*, *Diospyros lotus*, *Pterocarya fraxinifolia*, *Hedera pastuchovii*, and *Smilax aspera*. In south and southeast Golestan Province, altitudes up to approximately 2000 m is habitat for deciduous forests including *Parrotia persica*, *Buxus hyrcana*, *Crataegus* sp., *Quercus castaneifolia*, *Tilia begoniifolia*, *Acer velutinum*, *Alnus subcordata*, *Sorbus torminalis*, *Prunus caspica*, *Alnus glutinosa*, *Carpinus betulus*, *Tilia platyphyllos*, and plants such as *Rubus persicus*, *Rubus caesius*, *Scrophularia aquatica*, *Sambucus ebulus*, *Polypodium vulgare*, *Ruscus hyrcanus*, *Hypericum triquetrifolium*, *Equisetum arvense*, *Cyclamen goudotii*. The highlands above 2000 m consist of sparse coniferous forests of *Taxus baccata*, *Thuja orientalis*, *Cupressus* sp., and *Juniperus polycarpus*, *J. communis*, and *J. sabina*, as well as shrubs such as *Berberis* sp. The steppes above 2300 m constitute a pasture region covered with *Acantholimon* sp., *Astragalus* sp., and *Artemisia aucheri*. The northern part of the province includes two main wetlands of Iran Alagol and Almagol and a semi-desert area covered with *Tamarix aphylla*, *Typha angustifolia*, *Carex* sp., *Potamogeton pectinatus*, *Phragmites australis*, *Ceratophyllum demersum*, *Ranunculus trichophyllus*, *Juncus* sp., *Polygonum amphibium*, and *Albaga maurorum*.

### SPECIES LIST

Superfamily Muroidea Illiger, 1811

Family Muridae Illiger, 1811

Subfamily Murinae Illiger, 1811

Genus *Mus* Linnaeus, 1758

*Mus musculus* Linnaeus, 1758

Type locality: Sweden, Uppsala County, Uppsala (Wilson and Reeder, 2005).

Distribution: Spread over the world's continents and islands (except Antarctica): (Wilson and Reeder, 2005).

Lay (1967) surveyed and revised the range of the house mouse in Iran. Fars: Shiraz, Lurestan: Faraman; Kerman: Pishin, Kalagan, Bampur, Dizak, Mashish; Khuzistan: Deh Diz, Bakhtyari Mountains, 160 km northeast of Ahvaz; Isfahan: 45 km south of Isfahan, Sistan; Kurdistan: Saqiz; Azerbaijan: 10 km southwest of Urmia, Qazvin; Mazandaran: south coast of the Caspian Sea, Elburz Mountains near Damavand; Damghan: 5.6 km north of Semnan; Khorasan: Dasht; Golestan: Kaleh Peninsula, Turkmen Desert, Dar Kaleh, Pahlavi Dezh. Etemad (1978) stated that *Mus musculus* was found throughout Iran except in the Lout plain and Kavir plain.

Genus *Rattus* Fischer, 1803

*Rattus rattus* (Linnaeus, 1758)

Type locality: Sweden, Uppsala County, Uppsala (Wilson and Reeder, 2005).

Distribution: Native to Indian Peninsula and introduced worldwide in temperate zones and parts of the tropical and sub-antarctic zones; southernmost limit is the sub-antarctic Macquarie Isles where *R. rattus* was introduced by sealers during the 19th century (Wilson and Reeder, 2005).

Lay (1967) reported this species in Gilan: vicinity of Bandar-e-Pahlavi, Rasht, Kerman; Golestan: Dar Kaleh and Qarnabad village, south coast of the Caspian Sea; Persian Gulf: Tunb Island. Etemad (1978) reported *Rattus rattus* from Astara to Gorgan and Chah Bahar to Abadan and Minab.

*Rattus norvegicus* (Berkenhout, 1769)

Type locality: Great Britain (Wilson and Reeder, 2005).

Distribution: Original distribution assumed to be SE Siberia, N China, and Hondo region (islands of Honshu, Shikoku, and Kyushu of Japan but introduced worldwide where it is more common in colder climates of higher farther N and S latitudes. In warmer regions and the tropics restricted to habitats highly modified by humans. It is considered extinct in Norway (Wilson and Reeder, 2005).

The Norwegian rat has been reported by Lay (1967) in Gilan: Rasht; Mazandaran: Sama; Tehran: Tehran, the Caspian Sea coastal plain, the Turkmen Plains, the Khuzistan plains, and the entire length of the Persian Gulf coastal plain, Abadan, Khoram Shahr, Ahvaz, Bushehr, and Bandar Abbas.

Genus *Nesokia* Gray, 1842

*Nesokia indica* (Gray, 1830, in 1830-1835)

Type locality: India (Wilson and Reeder, 2005).

Distribution: Modern range covers Bangladesh, N India (Bihar, west Bengal, Punjab, Haryana, Delhi, Uttar Pradesh, Gujarat and Rajasthan), Pakistan, Afghanistan, Iran, Iraq, Syria, Saudi Arabia, Jordan, NE Egypt, NW China (Xinjiang, south of Tian Shan), Turkmenistan, Uzbekistan, and Tajikistan (Wilson and Reeder, 2005).

Lay (1967) revised the distribution range of bandicoot rat in Iran and reported the species had been recorded in Kerman: Kalagan; in Golestan: Bandar Gaz, Dar Kaleh, Turkmen Desert, Mian Kaleh Peninsula; in Khorasan: Guladagh, Sabzewar; in Mazandaran: Mashed Sar; in Qazvin: Hesarak; and in Isfahan: Mahallat; Lurestan: Qasr Shirin. He trapped specimens in Qazvin, Gorgan, Damghan, Khuzistan, Fars, Kerman, Iranshahr, Azad Shahr, and the vicinity of Gonbad Kavoo. *Nesokia indica* has been recorded in Varamin, Sabzewar, Tous, Bushehr, Babolsar, Guladagh in Bojnord (Etemad, 1978), Toos and Sabzewar (Ellerman, 1948).

Genus *Apodemus* Kaup, 1829

*Apodemus nitherbyi* (Thomas, 1902)

Type locality: S Iran, Fars Province, Shul (Wilson and Reeder, 2005).

Distribution: Plains, mountain and plateau steppes, and highland semi-deserts (not found in desert depressions) from E of the Dnepr River in the S Ukraine, Crimea, N Caucasus, S Caucasus (Georgia, Armenia, and Azerbaijan), Anatolian Turkish steppe and Bozcaada Isle, Palestine, NW Jordan, throughout most of C and N Iran in provinces of Azerbaijan, Kurdistan, Ilam, Lurestan, Isfahan, Fars, Semnan, Tehran, C and E Mazandaran, N and E Khorasan, Koppe Dagh Mountains of SW Turkmenistan and eastward in WC Pakistan; probably also occurs in Afghanistan, NE Iraq, Lebanon and adjacent SW Syria (Wilson and Reeder, 2005). Corbet (1978) described it as *Apodemus sylvaticus* in northern Iran. Not recognized by Lay (1967).

*Apodemus uralensis* (Pallas, 1811)

Type locality: Russia, S Ural Mountains (Wilson and Reeder, 2005).

Distribution: C Europe (E Germany, S Poland, Czech Republic, Slovakia, NE Austria, N Hungary, S to E Croatia, N Serbia and Montenegro, Bulgaria, and N Romania), Baltic region (NW Lithuania, Latvia, and Estonia), E through W Russia and Ukraine to E Kazakhstan, Siberian Altai in S Russia,

NW China, and the Altai of Mongolia, S in the Caucasus and throughout N Turkey; E and S boundary of range in C Asia unresolved (Wilson and Reeder, 2005).

Not recognized by Lay (1967). *Apodemus uralensis* first reported by Kryštufek and Hutterer (2006) from Makidi in Arasbaran, E Azerbaijan (Karami et al., 2008).

*Apodemus hyrcanicus* Vorontsov, Boyeskorov, and Mezhzherin, 1992

Type locality: Azerbaijan, Caucasus, Astarinski (Wilson and Reeder, 2005).

Distribution: E Caucasus, where it is found in the low mountain broadleaf forests of the Talysh region of SE Azerbaijan. Ranges eastward in the Hyrcanian forests (deciduous formations in which *Quercus*, *Fagus*, and *Carpinus* predominate) along the southern border of the Caspian Sea in N Iran (on the coast and northern slopes of the Elburz Mountains) from Astara on the west coast, through Sama, Sari, and Amol on the southern border to Dar Koleh on the SE coast; extends E of the Caspian Sea on northern slopes of the Elburz Mountains in Khorasan Province of NE Iran through Gorgan, Guladagh, Azad Shahr, and Bojnord to the vicinity of Dasht, which is the easternmost record of the species. Possibly also occurs in SW Turkmenistan on eastern border of the Caspian Sea (Wilson and Reeder, 2005). Javidkar et al. (2004) recorded *Apodemus hyrcanicus* in Noor, Mazandaran Province. Recognition of this species post-dates Lay (1967).

Subfamily Gerbilinae Gray, 1825

Genus *Rhombomys* Wagner, 1841

*Rhombomys opimus* (Lichtenstein, 1823)

Type locality: Kazakhstan, Kzyl-Ordinskaya, KaraKumy Desert (Wilson and Reeder, 2005).

Distribution: From S Mongolia and N China (Xinjiang, Gansu, Nei Mongolia) to Kazakhstan, Iran, Afghanistan, and SW Pakistan (Wilson and Reeder, 2005).

Lay (1967) reported the Great Jird in Khorasan: Dasht, Maravih, Nardin, Farad Dach, Bouroun, Robat Qarabil, Sarakhs; Golestan: Esterabad, Pahlavi Dezh; Isfahan: Julfa; and Kerman: Talab Well, Chah Navar, Tasuki, and stated that *Rhombomys opimus* inhabits the Turkmen plains, the NW highlands from Dasht to Mashhad, and possibly the entire eastern basin region.

Family Cricetidae Fischer, 1817

Subfamily Cricetinae Fischer, 1817

Genus *Cricetulus* Milne-Edwards, 1867

*Cricetulus migratorius* (Pallas, 1773)

Type locality: W Kazakhstan, lower Ural River (Wilson and Reeder, 2005).

Distribution: SE Greece, NW Romania, SE Bulgaria, and S European Russia, eastwards through Kazakhstan to S Mongolia and N China; southwards through Turkey and Transcaucasia to Palestine, Lebanon, Iraq, Iran, Afghanistan, Pakistan, and N India (Wilson and Reeder, 2005).

The gray hamster has been reported in Kerman: Mashish; Kurdistan: Saqiz, Sanandaj, Sameleh; in Fars: Shiraz; in Azerbaijan: Menzil, Astara, west of Maku, Mushabad, SW Urmia, W of Sarab; in Zanjan: Soltanieh; in Isfahan: Zard Kuh, Kohrud; in Tehran: Doab, Tehran; in Mazandaran: Sama, Koleh Sefid, Naghadeh, Tuiserkhan, Aghbolagh Morched, Lurestan, Kermanshah; in Golestan: 16 km. southeast of Gorgan, Turkmen Plains; in Damghan: 5.6 km north of Semnan; in Khorasan: 3 km E of Dasht; in Lurestan: Faraman (Lay, 1967).

Superfamily Dipodoidea Fischer, 1817

Family Dipodidae Fischer de Waldheim, 1817

Subfamily Allactaginae Vinogradov, 1925

Genus *Allactaga* Cuvier, 1837

*Allactaga elater* (Lichtenstein, 1828)

Type locality: W Kazakhstan, Kirgiz Steppe (Wilson and Reeder, 2005).

Distribution: SW Pakistan, Afghanistan, Iran, E Turkey, Armenia, Azerbaijan, Georgia, N Caucasus, north along W Caspian Sea to Lower Volga south to Turkmenistan, E through Kazakhstan to NE Xinjiang, Mongolia, China (Wilson and Reeder, 2005).

This species has been recorded from Fars: Katur and Sarjan, Khuzistan; in Kerman: Surab; in Khorasan: Qaen, Sabzewar, Sarakhs; in Tehran: vicinity of Karaj; in Azerbaijan: southeast of Maku, Kurdistan; in Kerman: Pishin (Lay, 1967). Goodwin (1940) recorded *Allactaga elater* from the Turkmen plains, NE of Gorgan. Etemad (1978) reported it from Baluchestan, Isfahan, and Saveh.

Genus *Pygeretmus* Gloger, 1841

*Pygeretmus pumilio* (Kerr, 1792)

Type locality: Kazakhstan, between the Caspian Sea and the Irtysh River; Kirghiz steppe (Wilson and Reeder, 2005).

Distribution: From the Don River through Kazakhstan to the Irtysh river, NE Iran, E to S Mongolia, China (Wilson and Reeder, 2005).

*Pygeretmus pumilio* has been reported in Dach Bouroun, northern Agh Ghala and N of Gonbad Kavous as *Alactagulus pumilio* (Lay, 1967).

Family Gliridae Muirhead, 1819

Subfamily Glirinae Muirhead, 1819

Genus *Glis* Brisson, 1762

*Glis glis* (Linnaeus, 1766)

Type locality: Slovenia, Carniola (Wilson and Reeder, 2005).

Distribution: Europe, N Turkey, the Caucasus, N Iran, SW Turkmenistan, N Spain, France, Switzerland, Belgium, Netherlands, Germany, Poland, Ukraine, N to Belarus, Lithuania and Latvia, E to the Volga River, S to Saratov and Voronezh, the Caucasus Mountains S to N Iran and SW Turkmenistan, the Mediterranean (except S and C Iberia and the Balearic Isles), Corsica, Sardinia, Sicily, Elba, Italy (including Sicilia, Eolia, and the N Adriatic Isles), Austria, Czech Republic and Slovakia, Hungary, Croatia, Romania, Albania, Macedonia, Bulgaria, Greece, Turkish Thrace, N Turkey. In Europe, this species has been introduced into England (Wilson and Reeder, 2005).

The edible dormouse has been reported in Gilan: Roudbar, Rasht, Ramsar, Rezvandeh; in Khorasan: Guladagh; in Mazandaran: Galander, Sama, W of Chalus; throughout the forested northern slopes of the Elburz Mountains and forested regions of the Caspian coastal plain; in Golestan: Dar Koleh and Esterabad (Goodwin, 1940; Ognev, 1947; Lay, 1967), Bojnord and Golestan National Park (Etemad, 1978).

Family Hystricidae, Fischer, 1817

Genus *Hystrix* Linnaeus, 1758

*Hystrix indica* Kerr, 1792

Type locality: India (Wilson and Reeder, 2005).

Distribution: Transcaucasus, Asia Minor, Palestine, Arabia to S Kazakhstan and India, Sri Lanka, Tibet (Wilson and Reeder, 2005).

The range of the crested porcupine is through the Turkmen Plains; the forested northern slopes of the Elburz Mountains; in Kerman: Jalk; in Khuzistan: mound of Susa, Menzil; in Azerbaijan: Moghan steppes, 15 km W of Bilasawar; in Mazandaran: Plain of Ramsar; in Golestan: Tirtash near Behshahr, 14.5 km N and 1.6 km W of Gorgan; in Mazandaran: Sama; in Khuzistan: S of Shush; and in Fars: E of Kazerun, the Zagros Mountains in the vicinity of Kazerun (Lay, 1967).

## DISCUSSION

Northeastern Iran is a point of overlap among ranges of species with extreme variation in regional topography and penetration of species from other regions. It is an area of contact between two cradles of endemism, northeastern Iran and southern Turkmenistan (Darvish et al., 2006). The Elburz Mountains extend from the Moghan steppes in the NW to Mashhad in the NE and separates the Caspian Sea from other parts of Iran and contributes to the semi-tropical climate S of the Caspian Sea (Misonne, 1959) as well as the occurrence of water-dependant species such as *Rattus rattus*, *Rattus norvegicus*, *Apodemus uralensis*, *Apodemus hyrcanicus*, *Apodemus witherbyi*, and *Nesokia indica* in the region.

The Turkmen steppes in northern Golestan Province are a continuation of the Turkmenistan desert and are home to semi-desert species such as *Allactaga elater* and *Rhombomys opimus*. Despite the fact that the Koppe Dag Mountains form a barrier between Iran and Turkmenistan, *Pygeretmus pumilio* has entered this region. *Hystrix indica* occurs in both arid regions and semi-tropical forests. Various species of *Apodemus* occur in sympatry, and their distributional ranges overlap in the region. *Apodemus hyrcanicus* was collected at lower altitudes, including the Hyrcanian forests and grasslands. *Apodemus uralensis* is a new record from this region and was captured in forests, grasslands, and woodlands at higher altitudes (Darvish et al., In Press). *Apodemus witherbyi* was collected from woodlands and grasslands above 1800 m. It seems that competitive displacement which causes incumbent replacement does not govern the distributional range of this genus. The W of Golestan Province is a region of sympatry of these three species, and they share resources without displacing one another. Syntopic species of wood mice (*Apodemus*) depending on resources such as acorns, insects, and other small invertebrates show resource partitioning, and the coexistence of two or more species is thought to be associated with the biogeographic history of this genus and its speciation processes (Montgomery and Montgomery, 1990; Suzuki et al., 2008). They can adjust their diets as a function of the vegetation cover. They feed essentially on seeds in deciduous forests but can compensate for limited availability of preferred foods through harsh seasons by increasing their intake of other foods (Renaud and Michaux, 2003). In contrast to *Apodemus witherbyi*, which ranges from 1800 to 2700 m, two other species of *Apodemus*, *A. hyrcanicus* and *A. uralensis*, are restricted to the Hyrcanian forests lower than 2300 m, and their expansion is confined by the Elburz Mountains. It seems that greater tolerance of *A. witherbyi* to climate changes and higher altitudes as well as a broad preference of diet facilitates an extended distribution range in Iran. However, it cannot traverse the central deserts of Iran, Kavir, and the Lout plains.

## LITERATURE CITED

- ABDOLI, A. 2000. The Inland Freshwater Fishes of Iran (In Farsi). *Iranian Museum of Nature and Wildlife*, Tehran, 378 pp.
- AKHANI, H. 1998. Plant biodiversity of Golestan National Park. Iran. *Stapfia*, 53: 1-411.
- ALINEJAD, S. 2009. The region under control of environment protection organization of Golestan province. Environment protection organization publication.
- BROWICZ, K. 1989. Chorology of the Euxinian and Hyrcanian element in the woody flora of Asia. *Plant Systematics and Evolution*, 162: 305-314.
- CORBET, G. B. 1978. *The mammals of the Palaearctic region, a taxonomic review*. British Museum (Natural History). London. 314 pp.

- DARVISH, J., SIAHSARVIE, R., MIRSHAMSI, O., KAYVANFAR, N., HASHEMI, N., SADEGHIE SHAKIB, F. 2006. Diversity of the rodents of northeastern Iran. *Iranian Journal of Animal Biosystematics*, 2, 1: 57-76.
- DARVISH, J., AKBARY RAD, S., SIAHSARVIE, R., HOSEIN POUR FEIZI, M. A., GHORBANI, F. 2010. New record on Pygmy field mice (Genus *Apodemus*, Muridae, Rodentia) from northeast Iran. *Hystrix*, (In press).
- ELLERMAN, J. R. 1948. Notes on some Asiatic rodents in the British Museum. *Proceedings of the Zoological Society of London*, 117:259-271.
- ETEMAD, E. 1978. *Mammals of Iran*. Vol. I: Rodents and key to their identification. National Society of Natural Sources and Human Environment Protection Publications. Tehran. 288 pp.
- HEWITT, G. M. 1996. Some genetic consequences of ice ages, and their role in divergence and speciation. *Biological Journal of the Linnean Society*, 58: 247-276.
- GHAVIDELSYOOKI, M. 2007. Palynostratigraphy and palaeogeography of the Gorgan schists in southern Gorgan city (southern Caspian Sea), eastern Alborz range, northern Iran. CIMP Lisbon'07. Joint meeting of spores/pollen and Acritarch subcommissions.
- GOODWIN, G. G. 1940. Mammals collected by the Legendre 1938 Iran expedition. American Museum Novitates. 1802 pp.
- JAVIDKAR, M., DARVISH, J., RIAHI BAKHTIARI, A. 2004. New record of hyrcanian wood mice, *Apodemus hyrcanicus* in Noor region. *Mohit Shenasi Journal*, 39: 69-74.
- KARAMI, M., HUTTERER, R., BENDA, P., SIAHSARVIE, R., KRYŠTUFÉK, B. 2008. Annotated check-list of the mammals of Iran. *Lynx*, 39: 63-201.
- KRYŠTUFÉK, B., HUTTERER, R. 2006. The Ural field mouse *Apodemus uralensis* – a mammal species new to Iran. *Zoology in the Middle East*, 38: 111-112.
- KRYŠTUFÉK, B., VOHRALIK, V. 2005. Mammals of Turkey and Cyprus. Rodentia . Vol. I: Sciuridae, Dipodidae, Gliridae, Arvicolinae. Knjižnica Annales Majora. Koper. 292 pp.
- KÜRSCHNER, H., PAPP, B. AKHANI, H. 2000. Studies on the flora and vegetation of the Golestan National Park, NE Iran. New records to the bryophyte flora of Iran. *Nova Hedwigia*, 71: 509-518.
- LAY, D. M. 1967. A study of the mammals of Iran resulting from the street expedition of 1962-63. *Fieldiana Zoology*, 54: 1-282.
- MISONNE, X. 1959. Analyse zoogeographique des mammiferes de l'Iran. Mémoires d'Institut Royal des Sciences Naturelles de Belgique, deuxième serie. 59: 1-157.
- MONTGOMERY, S. S. J., MONTGOMERY, W. I. 1990. Intrapopulation variation in the diet of the wood mouse *Apodemus sylvaticus*. *Journal of Zoology*, 222: 641-651.



OGNEV, S. I. 1947. Mammals of the U.S.S.R. and adjacent countries. Vol. V: Rodents. Akademiya Nauk. Moskow.

RENAUD, S., MICHAUX, J. R. 2003. Adaptive latitudinal trends in the mandible shape of *Apodemus* wood mice. *Journal of Biogeography*, 30: 1617–1628.

Suzuki, H., Filippucci, M. G., Chelomina, G. N., Sato, J. J., Serizawa, K., Nevo, E. 2008. A biogeographic view of *Apodemus* in Asia and Europe inferred from nuclear and mitochondrial gene sequences. *Biochemical Genetics*, 46: 329- 346.

Vorontsov, N. N., Boyeskorov, G. G., Mezhzherin, S. V., Lyapunova, E. A., Kandaurov, A. S. 1992. Systematics of the Caucasian wood mice of the subgenus *Sylvaemus* (Mammalia, Rodentia, *Apodemus*). *Zoologicheskii Zhurnal*, 7: 119–131.

Wilson, D. E., Reeder, D. M. 2005. *Mammal species of the world: a taxonomic and geographic reference*. Vol: II. 3rd ed. John Hopkins University Press, Baltimore.

Archive of SID

**TABLE 1.** - Standard external measurements (Mean  $\pm$  SD, in mm) of species of rodents in Golestan province. Data are not provided for *Hystrix indica* (see the text for abbreviations).

Taxa	N	HBL	TL	FL	EL	W
Muridae						
<i>Mus musculus</i>	29	67.19 $\pm$ 7.89	66.52 $\pm$ 7.28	16.88 $\pm$ 1.30	12.61 $\pm$ 1.02	-
<i>Rattus rattus</i>	4	160.00 $\pm$ 32.40	176.50 $\pm$ 34.50	35.50 $\pm$ 1.73	20.50 $\pm$ 2.51	-
<i>Rattus norvegicus</i>	7	196.00 $\pm$ 20.11	179.40 $\pm$ 15.59	39.00 $\pm$ 2.34	18.20 $\pm$ 0.83	-
<i>Nesoka indica</i>	4	165.75 $\pm$ 20.93	114.25 $\pm$ 7.27	31.50 $\pm$ 0.57	18.75 $\pm$ 0.95	119.62 $\pm$ 35.55
<i>Apodemus witherby</i>	6	87.60 $\pm$ 4.67	89.50 $\pm$ 12.06	21.80 $\pm$ 0.83	15.80 $\pm$ 1.92	15.50
<i>Apodemus uralensis</i>	16	87.58 $\pm$ 12.93	87.16 $\pm$ 10.28	22.14 $\pm$ 0.77	15.15 $\pm$ 1.28	21.54 $\pm$ 6.62
<i>Apodemus hyrcanicus</i>	12	83.00 $\pm$ 10.60	82 $\pm$ 4.26	21 $\pm$ 0.98	14.00 $\pm$ 1.08	17.58 $\pm$ 4.32
<i>Rhombomys opimus</i>	4	163.25 $\pm$ 9.25	152.25 $\pm$ 9.42	40.25 $\pm$ 2.0	14.00 $\pm$ 0.81	157.37 $\pm$ 31.90
Cricetidae						
<i>Cricetulus migratorius</i>	1	110	35	15	18	-
Gliridae						
<i>Glis glis</i>	1	158	125	30	16	-
Dipodidae						
<i>Allactaga elater</i>	10	90.10 $\pm$ 7.35	147.80 $\pm$ 11.56	50.10 $\pm$ 1.91	30.80 $\pm$ 1.93	39.60 $\pm$ 10.25
<i>Pygeretmus pumilio</i>	1	94	132	46	25	37.2
Hystriidae						
<i>Hystrix indica</i>	7	-	-	-	-	-

**TABLE 2.** - Standard cranial measurements (Mean  $\pm$  SD mm) of species of rodents in Golestan Province. Data are not provided for *C. migratorius* (see the text for abbreviations).

Taxa	N	CL	OL	RL	ZB	MT	BB	WR	IC	RH	BU
Muridae											
1- <i>Mus musculus</i>	29	20.06 $\pm$ 1.06	21.21 $\pm$ 1.03	10.18 $\pm$ .54	10.89 $\pm$ 0.76	3.37 $\pm$ .16	9.60 $\pm$ .27	3.55 $\pm$ .21	3.45 $\pm$ .14	4.95 $\pm$ .37	4.91 $\pm$ .21
2- <i>Rattus rattus</i>	4	39.08 $\pm$ 2.72	41.63 $\pm$ 3.78	21.03 $\pm$ 1.4	19.63 $\pm$ 1.07	6.86 $\pm$ .29	16.13 $\pm$ 1.31	7.51 $\pm$ .42	5.96 $\pm$ .30	9.78 $\pm$ .48	8.41 $\pm$ .61
3- <i>Rattus norvegicus</i>	5	43.60 $\pm$ 2.27	45.16 $\pm$ 1.89	22.96 $\pm$ 1.24	22.14 $\pm$ 1.62	7.17 $\pm$ .29	17.17 $\pm$ .61	8.46 $\pm$ 1.10	6.58 $\pm$ .53	11.33 $\pm$ .89	9.07 $\pm$ .27
4- <i>Nesokia indica</i>	4	39.11 $\pm$ 2.25	37.13 $\pm$ 1.73	23.63 $\pm$ 1.28	24.33 $\pm$ 1.11	8.22 $\pm$ .41	16.30 $\pm$ .50	7.42 $\pm$ .17	5.96 $\pm$ .26	12.36 $\pm$ 1.03	9.35 $\pm$ .29
5- <i>Apodemus witherbyi</i>	6	25.33 $\pm$ 0.83	-	-	12.9 $\pm$ 0.47	-	10.83 $\pm$ 0.24	4.68 $\pm$ 0.56	4.18 $\pm$ 0.19	5.49 $\pm$ 0.23	6.11 $\pm$ 0.47
6- <i>Apodemus uralensis</i>	15	25.61 $\pm$ 1.53	-	-	13.08 $\pm$ 69.24	-	11.78 $\pm$ 0.38	4.58 $\pm$ 0.32	4.12 $\pm$ 0.24	5.53 $\pm$ 0.38	6.14 $\pm$ 0.45
7- <i>Apodemus hyrcanicus</i>	12	24.21 $\pm$ 1.04	-	-	12.51 $\pm$ 0.34	-	11.55 $\pm$ 0.23	4.39 $\pm$ 0.38	4.16 $\pm$ 60.45	5.16 $\pm$ 0.21	5.91 $\pm$ 0.37
8- <i>Rhombomys opimus</i>	4	39.56 $\pm$ 1.57	41.95 $\pm$ 1.64	21.86 $\pm$ .82	24.75 $\pm$ 1.05	7.21 $\pm$ .30	23.25 $\pm$ .65	6.66 $\pm$ .26	7.70 $\pm$ .61	11.31 $\pm$ .67	12.90 $\pm$ .28
Cricetidae											
9- <i>Cricetulus migratorius</i>	-	-	-	-	-	-	-	-	-	-	-
Gliridae											
10- <i>Glis glis</i>	1	33.4	36	29.1	21.5	8.1	17.4	7.7	5	8.1	8.2
Dipodidae											
11- <i>Allactaga elater</i>	10	24.87 $\pm$ 1.03	25.68 $\pm$ .48	13.57 $\pm$ .49	19.30 $\pm$ 0.96	4.72 $\pm$ .17	15.57 $\pm$ .53	4.68 $\pm$ .15	8.70 $\pm$ .30	5.99 $\pm$ .41	8.00 $\pm$ .40
12- <i>Pygeretmus pumilio</i>	1	24.35	25.2	14.2	19.75	4.9	15.55	5	7.95	5.7	7.65
Hystriidae											
13- <i>Hystrix indica</i>	7	149.38 $\pm$ 4.51	58.35 $\pm$ 25.9	80.70 $\pm$ 9.17	82.60 $\pm$ 2.17	30.35 $\pm$ 5.2	61.75 $\pm$ 3.74	53.77 $\pm$ 7.3	-	59.00 $\pm$ 2.82	21.5
											8 $\pm$ 1.37

**TABLE 3. -** Dental measurements (Mean  $\pm$  SD, in mm) of species of rodents in the northeast Iran. Data are not provided for *C. migratorius* (see the text for abbreviations).

	N	M1/L	M1/W	M2/L	M2/W	M3/L	M3/W	M/1L	M/1W	M/2L	M/2W	M/3L	M/3W
Muridae													
1- <i>Mus musculus</i>	29	1.79 $\pm$ 0.08	1.07 $\pm$ 0.04	0.93 $\pm$ 0.05	0.96 $\pm$ 0.04	0.56 $\pm$ 0.05	0.62 $\pm$ 0.04	1.50 $\pm$ 0.06	0.90 $\pm$ 0.04	0.93 $\pm$ 0.05	0.87 $\pm$ 0.04	0.58 $\pm$ 0.06	0.59 $\pm$ 0.03
2- <i>Rattus rattus</i>	4	3.47 $\pm$ 0.23	2.09 $\pm$ 0.12	1.93 $\pm$ 0.11	1.95 $\pm$ 0.13	1.63 $\pm$ 0.11	1.63 $\pm$ 0.10	2.91 $\pm$ 0.14	1.88 $\pm$ 0.23	2.00 $\pm$ 0.13	2.03 $\pm$ 0.18	1.97 $\pm$ 0.11	1.65 $\pm$ 0.11
3- <i>Rattus norvegicus</i>	5	3.38 $\pm$ 0.23	2.12 $\pm$ 0.04	1.97 $\pm$ 0.01	1.97 $\pm$ 0.04	1.66 $\pm$ 0.18	1.52 $\pm$ 0.12	3.09 $\pm$ 0.22	1.95 $\pm$ 0.13	2.03 $\pm$ 0.09	2.1 $\pm$ 0.05	1.93 $\pm$ 0.26	1.71 $\pm$ 0.08
4- <i>Nesokia indica</i>	4	4.38 $\pm$ 0.41	2.78 $\pm$ 0.17	1.88 $\pm$ 0.06	2.43 $\pm$ 0.18	1.61 $\pm$ 0.11	2.11 $\pm$ 0.04	3.06 $\pm$ 0.19	2.36 $\pm$ 0.12	2.32 $\pm$ 0.51	2.51 $\pm$ 0.09	3.05 $\pm$ 0.27	2.13 $\pm$ 0.25
5- <i>Apodemus witherbyi</i>	6	1.82 $\pm$ 0.03	1.20 $\pm$ 0.02	1.16 $\pm$ 0.03	1.15 $\pm$ 0.04	0.84 $\pm$ 0.04	0.85 $\pm$ 0.05	1.74 $\pm$ 0.06	1.05 $\pm$ 0.05	1.18 $\pm$ 0.05	1.05 $\pm$ 0.04	0.99 $\pm$ 0.06	0.87 $\pm$ 0.08
6- <i>Apodemus uralensis</i>	15	1.8 $\pm$ 0.05	1.16 $\pm$ 0.04	1.16 $\pm$ 0.03	1.12 $\pm$ 0.05	0.85 $\pm$ 0.06	0.83 $\pm$ 0.04	1.69 $\pm$ 0.05	1.07 $\pm$ 0.04	1.17 $\pm$ 0.06	1.07 $\pm$ 0.05	0.97 $\pm$ 0.06	0.91 $\pm$ 0.05
7- <i>Apodemus hyrcanicus</i>	12	1.74 $\pm$ 0.06	1.16 $\pm$ 0.02	1.14 $\pm$ 0.05	1.11 $\pm$ 0.03	0.77 $\pm$ 0.06	0.79 $\pm$ 0.05	1.65 $\pm$ 0.05	1.05 $\pm$ 0.02	1.14 $\pm$ 0.05	1.05 $\pm$ 0.04	0.89 $\pm$ 0.07	0.86 $\pm$ 0.04
8- <i>Rhombomys opimus</i>	4	3.8 $\pm$ 0.41	2.11 $\pm$ 0.14	1.85 $\pm$ 0.08	1.89 $\pm$ 0.14	1.31 $\pm$ 0.11	1.61 $\pm$ 0.22	3.38 $\pm$ 0.14	1.95 $\pm$ 0.13	2.16 $\pm$ 0.16	1.28 $\pm$ 0.49	1.25 $\pm$ 0.12	1.36 $\pm$ 0.17
Cricetidae													
9- <i>Cricetulus migratorius</i>	1	-	-	-	-	-	-	-	-	-	-	-	-
Dipodidae													
10- <i>Allactaga elater</i>	10	1.89 $\pm$ 0.07	1.41 $\pm$ 0.09	1.61 $\pm$ 0.07	1.4 $\pm$ 0.1	0.82 $\pm$ 0.08	1.02 $\pm$ 0.08	1.93 $\pm$ 0.05	1.38 $\pm$ 0.05	1.95 $\pm$ 0.1	1.39 $\pm$ 0.07	1.32 $\pm$ 0.12	1.13 $\pm$ 0.08
11- <i>Pygeretmus pumilio</i>	1	1.85	1.30	1.75	1.27	1.11	1.08	2.35	1.53	1.99	1.56	1.41	1.23
Gliridae													
12- <i>Glis glis</i>	1	2.22	2.30	2.16	2.41	1.72	2.05	2.31	2.26	2.29	2.35	2.22	2.14
Hystriidae													
13- <i>Hystrix indica</i>	7	7.69 $\pm$ 0.93	7.67 $\pm$ 0.94	8.01 $\pm$ 0.64	7.32 $\pm$ 0.78	7.27 $\pm$ 0.69	6.96 $\pm$ 0.9	7.47 $\pm$ 1.09	6.77 $\pm$ 0.31	8.35 $\pm$ 0.69	6.88 $\pm$ 0.52	8.11 $\pm$ 0.8	6.74 $\pm$ 0.44