



Ecological survey of two Calomyscidae species; Goodwin's brush-tailed mouse and Hotson's brush-tailed mouse (Rodentia) in the eastern parts of Iran



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ABSTRACT

Calomyscus elburzensis and *C. hotsoni* are two species of the rodents family Calomyscidae which are distributed mainly in Iran. Herein, we evaluated the habitat and ecological differences of these two brush-tailed mice in order to test the credibility of a hypothesis stating that species from habitats with different climates and vegetation show greater intraspecific differentiation than those from areas with more similar climates and vegetation. This study was carried out in four rocky regions in Iran between 2013 and 2015. Totally 52 brush-tailed mice were captured from Kopet-Dag, Khaje-Morad, Ark, and Shadan and Olang during the field studies. Maximum parsimony analysis inferred from mitochondrial DNA sequences (*Cytb*) was used for species identification, and also comparison of mean Kimura 2-parameter distances was performed. According to the molecular studies, specimens from the first two regions were assigned to *C. elburzensis* and samples from Ark, and Shadan and Olang belonged to *C. hotsoni*. The mean distances within all examined Iranian samples of both *C. elburzensis* and *C. hotsoni* were 2.3% and 0.9%, respectively. Based on our field studies, *C. elburzensis* were captured either from “cold mountainous” climate zone with *Juniperus excelsa* as main vegetation cover or from “Mediterranean” in which *Pistacia atlantica* is predominant vegetation. *C. hotsoni* were found in “hot dry desert” and “cold semi-desert” regions both characterized by *Ephedra* sp. and *Avena sativa* vegetation cover. Dog rose seeds were the main food of *C. elburzensis* in Kopet-Dag, whereas brush-tailed mice in the other three regions fed mainly on Mount Atlas pistache fruits. *C. elburzensis* inhabited concealed rock crevices, but *C. hotsoni* were found living in burrows which were dug in the soft soils. Individuals of *C. hotsoni* showed more calm behavior as compared with *C. elburzensis*. *Meriones persicus* and *Cricetulus migratorius* (Rodentia) as well as *Ochotona rufescence* (Lagomorpha) were the most abundant small mammals encountered with *C. elburzensis*, while *M. persicus* was the most successful rodent with sympatric colonies with *C. hotsoni*. In conclusion, in accordance with the greater genetic distances observed in *C. elburzensis* populations as compared with *C. hotsoni*, more significant differences in the habitat structure were also found for the first species in different parts of its distribution range.

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1. Introduction

Brush-tailed mice are a family of small rodents found in rocky outcrops and semimountainous areas in desert regions of Iran, Turkmenistan, Afghanistan, Pakistan, Azerbaijan, and Syria. Although they were traditionally known as “mouse-like hamsters”, they are not true hamsters [1]. They represent an early divergence from the rest of the

mouse-like rodents (such as mice and rats), thus brush-tailed mice have been placed in a separate family, Calomyscidae Vorontsov and Potapova, 1979 [2–5].

Calomyscidae consists of eight known species which all belong to a single genus, *Calomyscus* Thomas, 1905 [2]. Despite several studies on morphological [2,6–13], biological [14], molecular [1,15–21] and karyologic [22–28] traits of this genus, relatively little is known about habitat and ecology of any species of *Calomyscus* [29–39]. The favorite habitat of *Calomyscus* species is considered as well-drained rocky slopes in arid steppes, semi-deserts and desert regions [30,34]. There is a record of this rodent nesting in a narrow horizontal crevice in rock strata in Iran with storing fine grasses and sheep wools [29]. In few literatures there are descriptive notes on vegetation covers in the habitats of most of

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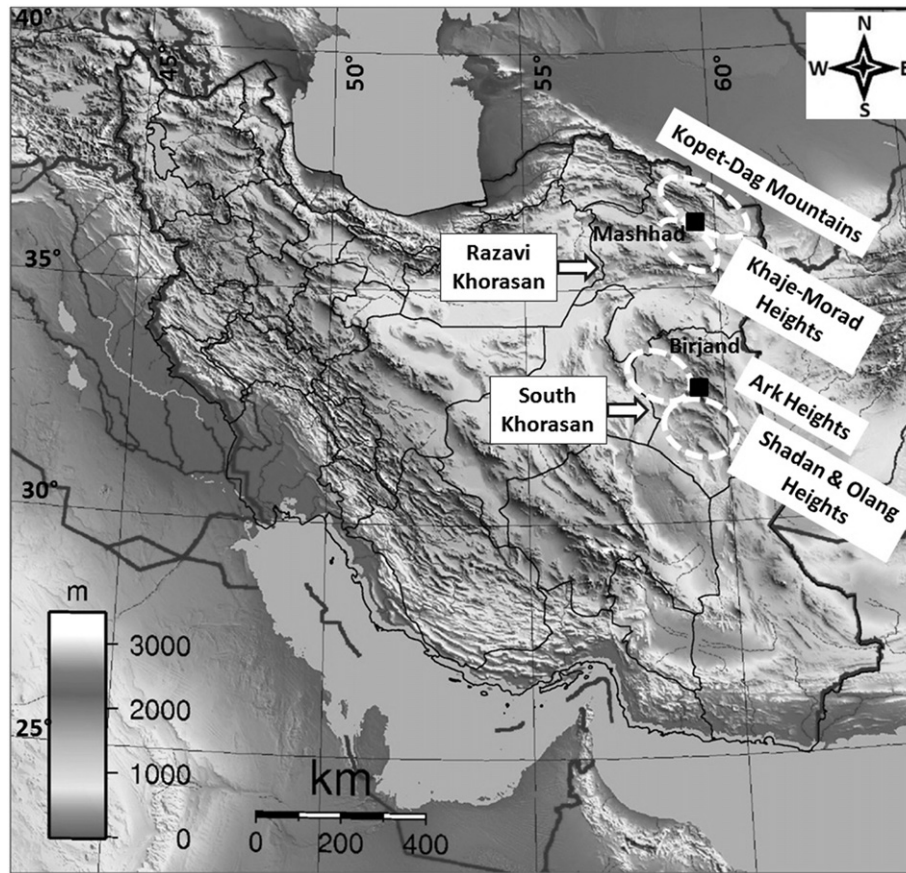


Fig. 1. Study areas and sampling localities. “Kopet-Dag Mountains” and “Khaje-Morad” heights are located in Razavi Khorasan province. “Ark” and “Shadan and Olang” heights are situated in South Khorasan province (reproduced from iranpoliticsclub.net/maps/maps14).

Calomyscus species which consist of scant vegetation of grass clumps, nettle weed, legumes, thistle, and wild rose bushes [29,33,37]. They feed mainly on seeds, leaves, buds and flowers of wild plants and are used to storing their food for consuming in cold months [31]. They also willingly eat animal matter [36] and are cannibalistic in captivity [35].

Three species of the genus *Calomyscus* are distributed in the eastern parts of Iran including Afghan mouse-like hamster (*C. mystax* Kashkarov, 1925), Goodwin’s brush-tailed mouse (*C. elburzensis* Goodwin, 1938) and Hotson’s brush-tailed mouse (*C. hotsoni* Thomas, 1920). However, the distribution ranges of these species are not completely known [2]. *C. elburzensis* has been reported from mountains of north and northeast of Iran [10], eastern parts of Yazd province (Iran) [28], southwest and south of Turkmenistan and also northwest of Afghanistan [2]. This species is found in barren, dry and rocky mountain sides with little vegetation. It nests in concealed rock crevices, and feeds on brome grasses (Poaceae; *Bromus* Scop.) [40]. *C. hotsoni* has been recorded from southeastern parts of Iran and southwestern regions of Pakistan [1,2]. Recently we reported this species from South Khorasan province, in the northeast of Iran (e.g. [21]). This species is found in arid rocky habitats in association with dwarf mazari palm (Arecaceae; *Nannorrhops ritchieana* (Griff.) Aitch.) and dry rocky mountain tops with sparse shrubby vegetation [1].

In our recent molecular study (analysis of *Cytb* and *COI* gene sequences) [19], one major clade for *C. elburzensis* in the northeast of Iran was considered to consist of four subclades as follows: 1) a subclade which includes samples from the middle of the Kopet-Dag Mountains in Razavi Khorasan province (Tandure, Chenaran), 2) a subclade which contains those samples captured from the type locality (Kurkhud; North Khorasan province) and the central Kopet-Dag (Saluk and Dasht; North Khorasan province), and a single individual from Chenaran; Razavi Khorasan province) or nearby (Sabzevar), 3) a subclade which

includes samples from Khaje-Morad, Binalud Mountains (Neyshabur), eastern Kopet-Dag (Saraks), southern parts of Razavi Khorasan province (Bajestan, Torbat) and northeast of South Khorasan province (Ghaen, Darmian), and finally 4) a subclade consisting of one individual from Gazik (South Khorasan province) and samples from central Iran (Taft, Fakhrabad; Yazd province). Moreover, in this study the mean genetic distances within samples of *C. elburzensis* from Iran were recorded as 1.9% for *Cytb* and 1.2% for *COI*. Comparative genetic distances (for both *Cytb* and *COI* genes) between different sets of subclades in *C. elburzensis* populations showed that genetic differences increased linearly with geographic distances [19]. Furthermore, based on our phylogenetic trees obtained from *Cytb* and *COI* data set [21], only two subclades of *C. hotsoni* were identified in Iran: 1) a subclade including samples from Saravan (the southernmost known locality for *C. hotsoni* in Iran), and 2) a subclade containing samples from Birjand, Zahedan, and Khash (in Iran) and also samples of a site near the type locality (in Pakistan). These two molecular subclades along with a subclade containing samples from the vicinity of the type locality and also its western parts in southern Pakistan, exhibited low mean genetic divergence (1.8% for *Cytb*) [21].

Herein, we aimed to study the climatological, geological and ecological characteristics of *C. elburzensis* and *C. hotsoni* in details. We hypothesize that differences observed in the habitat and ecological characteristics within the distribution range of these two species are in accordance with divergence at intraspecific level and the topology of molecular trees. In other words, we assume that species which are distributed in areas with different climates and vegetation might show greater intraspecific differentiation than species which inhabit areas with more similar climates and vegetation. Thus, integration of ecological surveys with molecular studies may bring about novel findings.

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