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Research Article

Some ecological peculiarities of the Fat Dormouse (*Glis glis* Linnaeus, 1766) in Hyrcanian relict forests of Northern Iran

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Abstract

Fat dormouse (*Glis glis*) is the only member of the Gliridae family in Iran. It passed interesting evolutionary history in the Hyrcanian old-growth forests as the easternmost part of its global distribution realm. Knowledge about the species' ecology and biology is necessary to improve the conservation and management of relict forest habitats. Because of its strictly nocturnal activity, nearly all published papers and reports describe dormice habitat affinities based on artificial nest boxes' installation. For the first time, we studied habitat associations of the Fat dormouse (*Glis glis*) along the ancient Hyrcanian forests of the southern Caspian Sea coast with the direct spotlighting method and measuring micro and macro habitat variables during its activity period. Our research was executed over four years from May 2014 to November 2017. Habitat variables were measured in the presence of circular plots and were compared by absence-paired plots. Our results indicated that the presence of feeding items especially berry and nut-producing plants as well as the connectivity of the tree's canopy are the most essential factors in the species' habitat selection. Logistic regression analysis could successfully distinguish the most important habitat variables that affect Fat dormouse habitat selection in the study area. With regards to the habitat requirements of

the species, both in micro and macro habitat scales we can infer some conservational actions in such valuable and relict forest ecosystems.
Keywords: Hyrcanian refugium, habitat affinities, forest ecosystems, *Glis glis*, conservation

Introduction

As an exclusively arboreal species, Fat dormouse (*Glis glis*) is completely dependent to the connected forest canopy of mostly mixed forests from Europe to southwestern Asia. Hyrcanian forests of Northern Iran are the easternmost part of its distributional range in the world (Fig. 1). Fat dormouse is a completely nocturnal species with some unique characteristics compared to other small mammals such as long life expectancy, prolonged hibernation (up to 7 months), and periodic patterns of reproduction (Kryštufek 2010). It is the only species belonging to the Gliridae family that can be found in Iran (Karami et al. 2008). Long survival in the Hyrcanian refugium (Naderi et al. 2013), and experiencing distinct selective pressures made it to somewhat different morphological and genetic characteristics (Naderi et al. 2013). Mainly habitat selection by the species has been investigated by using nest boxes in different experimental designs (e.g. Juskaitis and Siozinyte 2008; Bright and Morris 1993; Juskaitis 2000). Nearly all such studies unanimous that Fat dormouse habitat selection is positively affected by the presence of oak trees, forest canopy cover connectivity and density (Millazo et al. 2003: Juskaitis and Siozinyte 2008), maturity of forest stands (Juskaitis and Siozinyte 2008), and understory density and the height of trees (Millazo et al. 2003). The main purpose of this study was an investigation of the most important environmental variables that affect the Fat dormouse habitat selection by a method other than nest boxes like direct spotlighting along the transects.

Material and methods

Study area

This research was carried out over four years from 2013-2016 along the Caspian Sea Hyrcanian forests of Northern Iran. In Iran, this ancient Ecoregion includes the coast along the Caspian Sea and the northern slopes of the Alborz Mountains. This remnant refugium (Naderi et al. 2013), covers parts of five provinces of Iran from east to west including North Khorasan, Golestan, Mazandaran, and Ardabil Province. Oriental Beech (*Fagus orientalis*) covers about 32.7 percent of the Hyrcanian forest. A main feature of the region is the lack of conifers except for relict small patches of

coniferous species including European yew (*Taxus baccata*), Junipers (*Juniperus* spp.), Mediterranean Cypress (*Cupressus sempervirens* var. *horzontalis*) and Chinese Arborvitae (*Platycladus orientalis*). The Caspian Sea coastal plains were once covered by Chestnut-leaved Oak (*Quercus castaneifolia*), European Box (*Buxus sempervirens*), Black Alder (*Alnus glutinosa* subsp. *barbata*), Caucasian Alder (*Alnus subcordata*), Caspian Poplar (*Populus caspica*) and Caucasian Wingnut (*Pterocarya fraxinifolia*), but these forests have been almost entirely converted to urban and agricultural land (Mosadegh, 2000; Marvie Mohadjer, 2007). Predominating vegetation was floristically rich Hyrcanian temperate deciduous broadleaved forest which was degraded in Lavandevil and Nour. *Carpinus betulus* and *Fraxinus ornus* were the only widespread dominant trees. Of the other tree species, *Malus orientalis, various Prunus* spp., *Vitis sylvestris*, and *Rhamnus catharetica* were restricted to the western sites (Kotah-koma and Lavandevil), while *Alnus glutinosa, Ficus carica, Gleditschia caspica,* and *Quercus castanefilia* characterized the eastern localities (Ramsar and to the east of it).

Data recording

By traversing continuous line transects during four years, we detected different major populations along the Hyrcanian forests (Fig. 2 and table 1). The relative abundance of the Fat dormouse populations in the studied habitats also was investigated. Spotlights were used from sunset to one hour before sunrise to detect individuals' presence points and recording its locality coordinates. By recording geographical coordinates of the individuals' presence and marking the first detected trees, we were able to measure habitat variables during day length. Totally we detected 210 presence plots and the same number of the absence plots (paired plots) along the line transects. The paired plots were selected randomly in about 1 km away from the presence plots. Since the maximum home range radius of the species is about 0.5 km (Krystufek, 2010), we decided to point paired plots in one km away from presence ones. In each presence point a 20 m circular plot surrounding the observation points was plotted and different environmental categories including topographical (terrain slope and elevation), vegetation and distance variables were measured: 1) Tree diameter at the breast height (DBH), 2) Canopy percent cover (CPC), 3) Distance to the nearest water resource (DNW), 4) Vegetation type (VGT), 5) Distance to the nearest traffic road (DNT), 6) Distance to the nearest human settlements (DNS), 6) Tree canopy height (TCH), 7) The number of tree stands (NTS), 8) Distance to the nearest *Fagus* sp. or *Quercus* sp. forest type (DNQ). The arithmetic mean

of the measurements of each variable was considered as the value of the variable for the presence plots and the paired plots.

Table1. Localities detected along the study area

Habitats	Mean elevation (m)	Coordinates
Lavandevil	218	38˚18´N, 48˚48´E
Ramsar	25	36˚53´N, 50˚39´E
Siahkal	495	37° 02'N, 49° 55'E
Nour	-9	36° 34'N, 52° 07'E
Kalaleh	384	37˚25´N, 55˚31´E

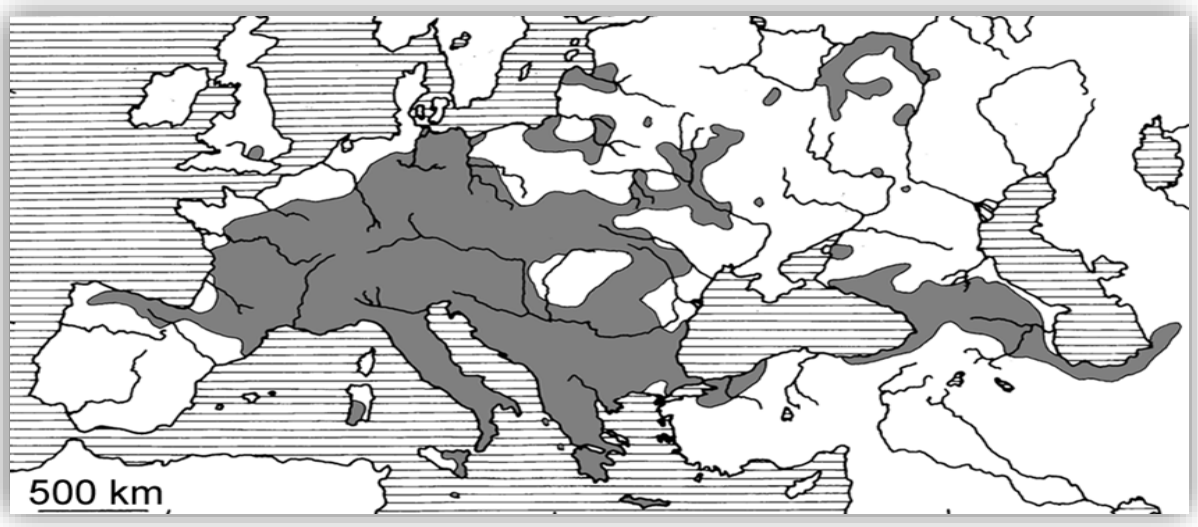

Figure 1. Fat dormouse distribution in the world (adopted from Krystufek 2004)

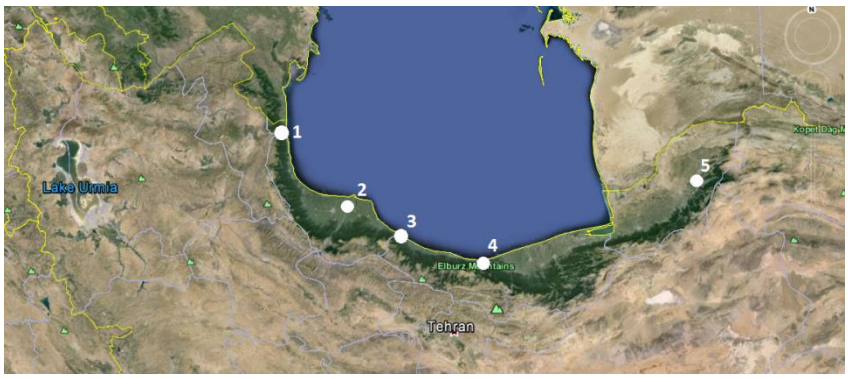

Figure 2. geographical relative location of the studied populations

Data analysis

Relative abundance differences in the studied habitats were compared by ANOVA. A Two-way ANOVA was used to compare microhabitat variables between presence and paired plots across the whole study area with habitat types and the presence versus the absence of the individuals as the fixed factors. The principal component analysis (PCA) was used to determine the most influential microhabitat variables including DBH, CPC, DNW, VGT, DNT, DNS and NTS. on the species site selection. To determine important microhabitat characteristics for the habitat use within each habitat type, a paired t-test was used to compare microhabitat variables measured in presence and paired plots. The SPSS 19.0 statistical package was used for statistical analysis.

Results

Paired t-test analysis confirmed that the presence of fruit producing trees are the main factor that mainly affected the species habitat use ($t=64.31$, $P<0.005$). ANOVAs comparing habitat variables between presence and paired plots simultaneously across all habitats, showed the effect of habitat was significant for all habitat variables ($p<0.005$). In addition, mean percent cover of all variables were significantly different between presence and paired plots ($p<0.001$).

Logistic regression correctly classified 89.8% of total cases. Of the eight variables used for logistic regression, five variables retained in the model (table 2). The probability of the event occurring (individual's presence) increased as integration of the canopy cover increased. A Hosmer-Lemeshow Lack-of-Fit test indicates a relatively good fit of the data to this model. Our results also indicated that there is significant differences in population detection probability and its abundance between *Fagus* sp. mixed forest patches and the other habitat types (*ANOVA:* $F_{4,209}= 38.21$ $P<0.005$). The PCA analysis for microhabitat characteristics produced two components that together accounted for 81.34% of the variance. The first component (48.61% of the variance) was related positively to closeness of the canopy cover (or tree's stands density) and negatively to presence of *Fraxinus sp*. The second component (32.73%) represents the importance of closeness to the *Fagus* sp and *Quercus* sp habitat patches.

Fat dormouse is distributed along the Hyrcanian forests of the Northern Iran and its abundance shows declining trends in the eastern parts of the forests. Integration of the canopy cover is one of

the most affecting factors in the species' habitat selection since the species is solely dependent on the tree canopy cover. From another view, Fat dormouse needs considerable lipid storage for a relatively long hibernation period and feeding newborns therefore it feeds in all activation periods. Therefore, the presence of edible fruit's producing trees depending on the season (spring, summer and early fall) is one of the major habitat variables that affect species' habitat use. Regression analysis confirmed these results namely the integration of the canopy cover and presence of edible fruit's producing trees such as different Berries, Cherry plum, Grape, Common Fig, Walnut, Gleditschia and Chestnut. Based on regression analysis distance to the nearest water resources also affect the species habitat use.

Table 2. Regression analysis results to distinguish the most affecting factors in Fat Dormouse habitat selection (the mentioned variables have been remained in the regression model)

Habitat variables	P value	Exp(β)	Wald	SE	β	Nagelkerke's R squared
VGT	<0.001	0.230	21.34	0.04	0.164	0.791
DNW	<0.001	1.229	16.21	0.021	0.387	
TCH	<0.005	1.214	7.81	0.043	0.132	
NTS	0.002	0.714	12.90	0.081	0.945	
DNQ	<0.05	0.314	6.54	0.033	0.351	

Discussion

In the most situations, habitat selection of the mammals studied by comparing its activity area characteristics and randomly selected areas (Bertolino and Cordero, 2007; Gregory et al. 2010; Cudworth and Koprowski, 2011). Our results indicated that both habitat structure and combination of tree species are important in the species habitat selection. It seems that higher elevations are used much less than lowland areas because of temperature impact, trees height and edible fruit producing capability of the timberline trees. In the elevations lower than 100 m above sea level, the temperature stress is much lower while tree species richness is more, resulting in more food and cover, dense

lower story and hereon higher population abundance and density (Milazzo et al. 2003). Integration of the canopy cover is an important issue that had been pointed in different previous studies (Juskaitis, 1995; Juskaitis and Siožinytė, 2008; Jones-Walters et al. 1991; Gaisler et al. 1977). We also found that main habitat requirement's juxtaposition (especially food and cover) is one of the most affecting habitat characteristics in the species habitat use. For instance, the presence of *Smilax excelsa* as an acanaceous plant species which will also grow over trees and other plants up to 10 m height, their hooked thorns allowing them to hang onto and scramble over branches.

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