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Distribution, habitat selection and facial morphology of setts of badgers (*Meles meles* Linnaeus, 1758) in the region of Erdőspuszták (Eastern Hungary)

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Abstract. The badger's population density has shown a general increase in Hungary since the 1980s. The data show that the species has occurred in wide range in areas (like lowland areas) which are not known as traditional distribution area of badgers. The traditional habitats of badgers in Hungary are the hilly deciduous forests. But in the lowland area around Debrecen we recognized increasing distribution and population density of the species. In this study we show the present status of the species in the semi-natural and planted forests and deforested areas around Debrecen and the habitat selection and the morphology of inhabited setts of the badgers living in these forests in a sample area.

We recorded data on general distribution by questionnaires sent to hunting companies. The population density and habitat selection of the sample area was measured by recording of locality of setts of badgers. We used the method of line transect and analysis of habitat type through satellite pictures and GPS coordinates. To have data on morphology of setts we recorded the number of entrances, the exposure, covering, macro- and microrelief, occurrence of latrines.

Our data show that the badgers are widely distributed in this area and their population density reached the density of the species traditional habitats (2,44 setts/hectare). The habitat selection shows a small preference (Ivlev-index = 30%) to the forested areas. This small preference to the forests shows that the covering of the habitat is not the single crucial factor of their habitat selection. The level of preference to the several forest types shows that the badgers of the sample areas prefer (Ivlev-index = 58 %) the planted pine forests (Pinus sylvestris). This result is similar to other research results made in other part of Hungary but out of accordance to the results of researches made in England.

Keywords: badger, sett density, habitat preference

Introduction

The legal status of badger in Hungary has changed in the last years. The species was a protected carnivore of the Hungarian fauna since 1974 till 2001. In this period the experts of game management recognised a general increase of population size and area range of badgers in the whole country (Heltai et al., 2001). Because of this trend and the generally known ecological role of this carnivore species the badger is actually a fair game species in an open season (between 01 July and 28 February). The density of badgers in the European countries shows a big variance. In Eastern-Europe we find data on 1-6 specimens/1000 hectares but for example in Scotland it reaches the 60 specimens/1000 hectares (Mitchell-Jones et al. 1999). In the second period of the 20th century there was a general decrease of population density in Europe. The reasons were the legal and illegal hunting, the changes of habitats, increasing traffic accidents besides other human effects (Griffiths, 1993; 1993; Griffiths and Thomas, 1993). But since the second part of the 1980's the scientists and field experts recognised an inverse process: even the area enlargement was recorded in the northern part of Europe.

In Hungary the study of badger density in country-wide scale was carried out in several years by using questionnaires sent to hunters' associations (Heltai et al., 2001; Szemethy, 1989, 1994; Szemethy and Heltai, 1996, 2000; Szemethy et al., 2000). These data show that the occurrence of the species was grown and formerly non-inhabited areas like lowland areas got inhabited. The forested area of Erdőspuszták is probably a traditional inhabited area for the species but the significant growing of its population size was recorded by these studies. The questionnaire survey is a good and effective method to study the representation and the changes of representation of a species in wide range scale but to have sufficient data to make decisions in game management in a smaller area and to measure the real population size of the species we need to use other methods also (Heltai and Kozák, 2004; Szemethy és Heltai, 2000; Szemethy et al., 2000). The badgers are using their setts throughout the whole year. They use main and alternative setts in their territory. The setts can be the home for several generations of the badger family (Neal and Cheeseman, 1996). It is not so easy to determine the number of badgers in the family living together. The number of setts and their size, the number of latrines and tracks can indicate the badger's population size (Cheesemann et al. 1987; Cresswell et al. 1990; Neal and Cheeseman, 1996). To use a place for digging setts is multifactoral choice of badgers. The main factors could be the soil, the covering of vegetation, intensive agricultural use or the feeding opportunities (Cresswell et al., 1990; Cheeseman et al., 1987; Kruuk et Parish, 1982; Neal et Cheeseman, 1996; Silva Da et al., 1994; Roper et al., 1986).

Materials and Methods

The two sample areas are situated next to Debrecen in the south-western part of the land called Erdőspuszták. They represent the characteristic landscape of the region. The average percentage of forest is higher than 55%. We can find small grasses, agricultural fields and wetlands among the semi-natural and planted forests. The main tree species are the endemic Quercus robur, the planted Robinia pseudoacacia and Pinus sylvestris. The open areas are presented principally by cultivated fields. The soil is mainly sand soil but we can find hard ground as well.

To measure the population density of badgers we recorded the density of setts in our sample areas. To get general data on the territory of Erdőspuszták we used the method of the country-wide study. We sent questionnaires to hunters' associations. We amended this method with personal discussions with hunters, foresters and rangers.

To have more accurate data we chose two sample areas near to Debrecen and studied the density of setts by using a line transect method. We recorded the setts along lines carried out 500-800 m far away from each other. The study areas were 3012 and 2680 hectares. In the line transects we could see the 20,4 and 22,5 % of the sample area which means a representative sample. From the sett density of the line transects we made a statistical sample: each line gave us a sett density. From the lines we chose 5 ones in randomly. We repeated this random sampling 7 times. From these 7 data we counted an average sett density (Heltai and Kozák, 2004).

For the habitat selection we recorded the localization of the setts by GPS. The GPS coordinates and the habitat types were processed by satellite pictures. The habitat selection was expressed by Ivlev-formula (Ivlev, 1961): $P_x=(A-B) / (A+B)$

A= the percentage of setts in the habitat type

B= the percentage of habitat type in the whole sample area

P_x= preference to the habitat type – from (+1) to (-1): (+1) means preference to the habitat type, (-1) means an avoidance to the habitat type.

To have data on morphology of setts we analyzed the features of 14 inhabited setts. We recorded the number of entrances and tracks, the exposure, scrub and tree covering above the setts, macro- and microrelief.

Results and Discussions

The country-wide scale studies measure the population density in specimens/1000 hectare dimension. In our questionnaires we recorded the number of setts. After the analyses of questionnaires and personal interviews we checked a part of the setts. Our field experiences show that only a part of the known setts are inhabited and the number of the badger family could be quite different. From these field experiences we calculated the potential number of specimens/km^2. In the first table (Table 1.) we show our data and compare to the country-wide data.

Table 1. The data of questionnaires and personal interviews

Name of the hunters' association	Density of setts (setts/km^2)	Density of badgers (specimens/km^2)
Nyírábrányi Vt.	0.65	0.324
Egyetértés Vt.	0.2	0.095
Nyírerdő Nyírségi Erdészet	0.78	0.393
Farkasvölgye Vt.	0.7	0.351
Nagylétai Bocskai Vt.	0.22	0.111
Hosszúpályi Liget Vt.	0.33	0.165
Average of these companies 2003	**0.32**	**0.239**
Average of Hungary 2000 (Heltai et al., 2001)	**-**	**0.316**
Average of Eastern part of Hungary 2000 (Heltai et al., 2001)	**-**	**0.107**

Our data show similar values like the country-wide data. The average badger density is lower than the country wide data but higher than the data of the eastern part of the country where the main part of our lowland areas with deforested territories is situated.

At the same time we have to analyse the data of our line transect studies. There are only a few similar studies in Hungary. We show our data compared to the data of these studies in the second table (Table 2.).

Table 2. The density of badger setts in several sample areas

Sample area	Densitty of inhabited setts (setts/1km^2)	Study
Erdőspuszták	**1.07**	**This study**
Bosrsodivánka	0	Heltai and Kozák, 2004
Abádszalók	0	
Egyek	0.061	
Pély	0.032	
Hortobágy	0.3	

We can declare that in the last decades the badger density in the forested lowland area of Eastern-Hungary is significantly higher than in the deforested lowland areas and reached the value of the traditionally high density of the hilly areas of the Transdanubian region. The badgers show an increasing population density in the area of Erdőspuszták. The differences between the data of density of setts of several territories of hunters' associations in the region of Erdőspuszták (Table 1.) and our sample areas are partly explicable with this increase. Thus, we can confirm that to have accurate data for the sake of decision making of game management or nature conservation of a smaller area we need to make detailed studies to avoid the mistakes of general estimation.

The two sample areas are representing the average composition of habitat types of Erdőspuszták. In the third (Table 3.) and the fourth table (Table 4.) we show the percentage of the main habitat types in our sample areas.

Table 3. Data of habitat types in the sample areas with aggregated habitat types

Main habitat type	Percentage (%)
Forest	54
Deforested area	43
Wetland	2
Urban area	1

The habitat preference of the species can also help the estimation of the role of badgers in a smaller area. We studied the badger's habitat preference with analysing the placing of the setts from the point of view of the habitat type like forested or deforested area, type

of vegetation, urban area, etc. The preference of the several habitat types is characterized with the Ivlev-formula. We show our results in the first (Figure 1.) and the second figure (Figure 2.).

Table 4. The data of habitat types in the sample areas

Habitat type	Percentage (%)
Arable	35
Bush	1
Grass	7
Pinus sylvestris forest	14
Quercus forest	7
Robinia pseudoacacia afspring (1-8 ages)	7
Robinia pseudoacacia forest	26
Urban area	1
Wetland (ponds, streams and rush-beds)	2

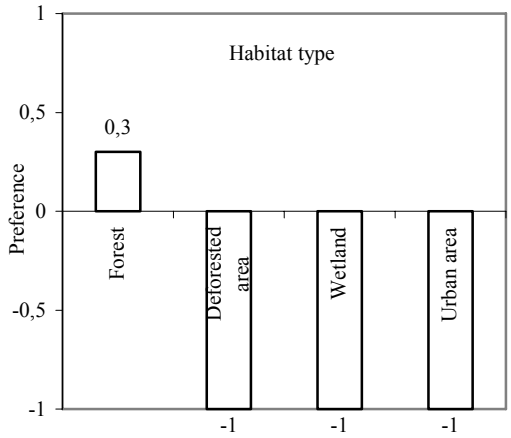

Figure 1. The habitat preference in the sample areas with aggregated habitat types

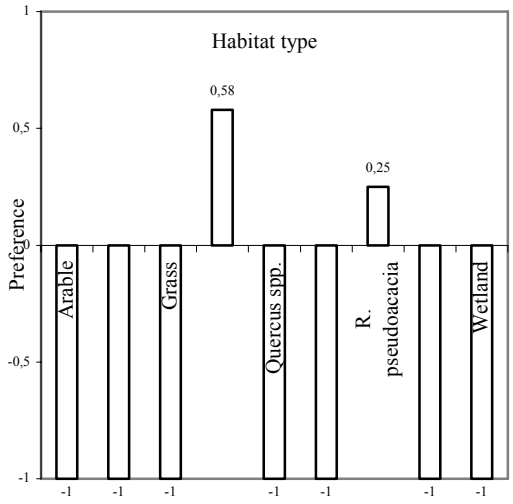

Figure 2. Habitat preference in the sample areas

The badgers show only a middle level preference to the forest. They avoid wetlands because a high level of underground or vadose water is unsuitable to dig a sett. They avoid urban areas as well but we have data on a badger sett in a suburban area from an other part of Debrecen. We think that the increasing population size and the food supply of urban and suburban areas will involve at least the semi-urbanization of the species.

When we analyze the habitat preference to the several kinds of the main habitat types we can recognize that badgers prefer the planted pine forests (Pinus sylvestris). This result is similar to other results of researches made in an other part of Hungary (Kiss, 2005) but out of accordance to the results of researches made in England. In our study area we can explain this preference with the quality of the habitat of the planted Pinus sylvestris forests. These trees were planted in places (mainly on sand dunes) where the soil, the macro- and microrelief are perfect to dig a sett. The habitats of the planted Pinus silvestris forests are therefore perfect for setts and because of their small (1-10 hectares) size there are suitable food supplies in the variable surroundings even in he home-range of the badger clan.

In Table 5. we have summarized the main external morphological characters of the inhabited setts situated in the sample areas.

Table 5. The main data of the inhabited setts of the sample areas (n= 14)

		Percentage (%)
Number of entrances		
	1-3	14
	4-9	65
	>10	21
Macrorelief		
	On a hill	71
	In deep	0
	In average high	29
Angle of slope (microrelief)		
	0^0	50
	1^0-10^0	28
	10^0-45^0	22
Covering of shrub		
	0 %	50
	1-49 %	22
	>50 %	28
Covering of trees		
	0 %	0
	1-49 %	29
	>50 %	71
Exposure of entrances		
	North	28
	East	24
	South	26
	West	22

The inhabited setts seem to be home of viable badger families. Although the number of entrances do not mean the number of used entrances and chiefly do not mean the number of the badger clan but show us that most of the setts are in use since years and these

badger families occur probably continually in these territories.

We have never found a badger sett in a scoop. Most of the setts are situated on a mound. The level of underground water can explain this choice.

In the Erdőspuszták we have found inhabited setts only under vegetation cover. Every setts were found in forest but we experienced that the badger clan are loyal to their home in the case of clear-felling of forests as well. We have data of existing badger setts before, and after clear-felling of Robinia pseudoacacia forest. In this case after the felling the place was reforested.

The microrelief and the exposure of the entrances do not show any significant preference.

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