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Short communication

Winter activity of European badger (*Meles meles*) in Slovakia

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Abstract

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In wide geographical distribution, the European badger is adapted to various climates, habitats and feeding conditions. At latitudes with severe winters, badgers build fat reserves in autumn and rest in winter. The effect of different temperature and climate to winter diurnal activity of badgers was studied in seven sites of the Javorie Mts and Pliešovská kotlina Valley in central Slovakia. Data were obtained from camera traps installed at badger setts and from snow tracking in three consecutive winters 2012–2015. As the considerable differences of weather conditions were found, also differences in diurnal activity in different winters appeared. The result shows that winter diurnal activity of badgers strongly depends on climate and air temperature. In average, badgers on five different setts were active more than 50% of days during January 2015 (average temperature –0.4 °C). Badgers were mainly nocturnal in winter months. Few cases of daylight activity were recorded only in second half of February, when also mating was recorded.

Keywords

camera trap, central Slovakia, diurnal activity, European badger, winter

Introduction

For wild European mammals, the winter season, even in Southern temperate regions, is a critical period for survival. In addition to unfavourable climatic conditions (low temperatures, frost and snow), natural sources of food are scarce and sometimes even disappear completely (Maurel and Boissin, 1983). In wide geographical distribution, the Eurasian badger is adapted to various climates, habitats and feeding conditions. At latitudes with severe winters, badgers build fat reserves in autumn and rest in winter (Bevanger et al., 1996). Reduced activity and confinement within sheltered setts, together with reduced body temperatures, enable the badgers to rely heavily on energy stored in adipose tissue during the autumn (Fowler and Racey., 1988). In central European conditions, badgers build fat reserve in autumn and spend winter time in rest and its duration depends on climate factors (Červený et al., 2004), but detailed information of their winter activity is missing from this area. Using the radio tracking it was found that badgers were largely inactive in December and January in eastern Poland (Kowalczyk et al., 2003). During these two months short-time emergences connected with short-distance excursions were recorded for 2–6% of days. This research was conducted from 1997 to 2001 with the coldest month January (average daily temperature –2.3 °C). Badgers used only the main sett for day time shelter in winter (Kowalczyk et al., 2004). In central Poland it was found that badgers restricted their activity to immediate vicinity of their setts in first half of winter (Goszczyński et al., 2005). Badgers left their setts in average once in 48 hours, while the longest period of uninterrupted inactivity recorded during study was two weeks. Do Linh San et al. (2007) study reports the first time data on the spatio-temporal

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ecology of badgers living in cold and wet mountain region of Swiss Jura Mountains. Nocturnal activity of badgers was low in winter and very high during all other seasons. Winter nights were characterized by an alternation of resting periods inside the sett with short over ground excursions lasting generally between 15 and 30 min. During the cold season badgers did not emerge from their sett more than 70% of night.

The aim of study is to describe the effect of air temperature on winter diurnal activity pattern of European Badger *Meles meles* in conditions of Slovakia.

Material and methods

The study area was located in the Javorie Mts and Pliešovská kotlina Valley in central Slovakia 48°27′–48°35′N, 19°06′–19°25′E). The altitude ranges from 270 to 1,043 m asl, the annual precipitation (in reference period 1961–1990) varies from 600 to 900 mm and mean average annual temperature from 6.2 to 7.9 °C. Duration of snow cover lasts from 60 to 85 days per year (source: Slovak Hydrometeorological Institute). The area is covered mainly by beech, oak-hornbeam and mixed deciduous woodlands (50%), meadows and pastures (26%) and arable land (16%) (source: National Forest Centre). Human settlements (except for urban areas) are mostly found in hamlets and farms surrounded by many abandoned orchards and gardens.

Badger belongs to common species currently inhabiting approximately 86% of Slovakia area (Krištofík and Hell, 2012). The latest estimate in 2014 refers to 10,454 individuals (Anonymus, 2014), which means density of 0.25 individual per square kilometre. Badgers live in pair or in groups with cubs and occupy underground setts used as daily shelters throughout the year. Some of badger's setts are very extensive and badgers are living there for several generations (Červený et al., 2004). Classification of badger sett is suggested by several authors. By Roper (1992a), they vary considerably in size, ranging from simple single-entrance burrows to complex tunnel systems hundreds of metres long with multiple entrances and underground chambers. A typical badger territory contains a main sett which acts a permanent home to the social group, plus several outlier setts which are used less consistently. Individuals usually rest alone within the main sett, except in winter when they sometimes clump together (Roper, 1992b). In conditions of Czech Republic, Matyáščík et al. (2000) defined four types of badger sett, including main and so-called subsidiary sett. By their knowledge, badgers use this type of sett characterized with 1–2 entrances with small or without spoil heaps, mainly in winter. In contrast of this, Roper (2010) found that badgers rest only in main sett in winter.

We used camera traps installed at badger setts and snow tracking to obtain badger's winter diurnal activity data. Camera traps allow to extend observations through time, space and to create a permanent record of passing animals (Kays and Slauson, 2008). Monitoring was conducted during the period of three consecutive winters 2012/13, 2013/14, 2014/15 in months December–February (Table 1). We used two models of camera traps, Reconyx PC900 and Keep Guard 680 KG. These were placed near (4–6 m) the most used sett entrance. The images were downloaded during one or two-week intervals. We evaluated the badgers over ground activity near the sett in different hours, days and months, badger activity at sub-zero temperatures and their behaviour. Occurrence of other animals near the setts was also recorded.

Table 1. Overview of monitored sites with active camera traps (x)

Sett	Area	Sett type	Number of sett's entrances	Winter		
				2012/13	2013/14	2014/15
A	Javorie Mts	Main	8	x	x	x
B	Javorie Mts	Main	18	x	x	x
C	Javorie Mts	Main	7	x		
D	Javorie Mts	Main	12		x	x
E	Javorie Mts	Main	19		x	
F	Javorie Mts	Subsidiary	2			x
G	Pliešovská Kotlina Valley	Main	15			x

Habitat characteristic of seven monitored badger setts

(A) Southern slope of a 40-year old oak (*Quercus petraea*) forest stand (630 m asl), distance from a permanent human settlement is 900 m (region Zvolen); (B) Southern slope of an 80-year old beech (*Fagus sylvatica*) and maple (*Acer pseudoplatanus*) forest stand (780 m asl). Its basis is formed by two large rocks. The sett is within 670 m of the nearest permanent settlement (region Detva); (C) The edge of a 100-year old forest stand consisting of beech, ash (*Fraxinus excelsior*) and hornbeam (*Carpinus betulus*), 625 m asl. The nearest permanent settlement is located 980 m away. The sett in area C is within 1,240 m from site B. The entrances were dug into the soil accumulated by machines during the reclamation of neighbouring pastures (region Detva); (D) In 90-year old forest stand consisting of beech, maple (*Acer platanoides*), oak and hornbeam (350 m asl). The nearest permanent settlement is located 350 m away (region Zvolen); (E) In 80-year old beech stand (450 m asl). The nearest permanent settlement is located 400 m away (region Zvolen); (F) North-eastern slope of 80-year old forest stand consisting of beech, oak and hornbeam (400 m asl). The nearest permanent settlement is located 1,020 m away (region Zvolen); (G) Small forest between two fields (405 m asl). The nearest permanent settlement is located 680 m away (region Sása).

Data of daily air temperatures were obtained from the weather station near Zvolen. In winter 2012/13, permanent snow cover was recorded from 4 December to the end of February. The average daily temperature in December was –2.6 °C, –2.8 °C in January and –0.3 °C in February. Following winters were, comparing to the previous one milder, with average daily temperatures 1.5 °C (December), 2.0 °C (January), 3.8 °C (February) in 2013/14 and 1.3 °C (December), –0.4 °C (January), –0.2 °C (February) in 2014/15. In both winters (2013/14, 2014/15), permanent snow cover was not recorded. Due to the fact that badgers activity was mainly nocturnal, the data of the lowest daily temperatures were used for analysis. To find relationship between the over-ground activity of badgers (hereafter OAB) and air temperature, Spearman's rank-correlation was used.

Results and discussion

We obtained 2,803 records of badger's movements near the setts (one record per one individual per one minute) by analysing more than 24 thousand photos frame by frame. As the considerable differences of weather conditions were found, also differences in frequency of OAB in different winters appeared. While the OAB was recorded in max of 6% and 3% days during December and January in winter 2012/13, during following mild winters (2013/14, 2014/15) it was in 24% days and in 49% days (December) and in 42% days and 51% days in January. Differences in OAB during study period were found in February, too. While OAB was recorded in average only in 36% of days of winter 2012/13, in winter 2013/14 it was already in average in more than 80% of days (Fig. 1). On site C, OAB was recorded during 100% of days and it was possible to observe also mating of badgers.

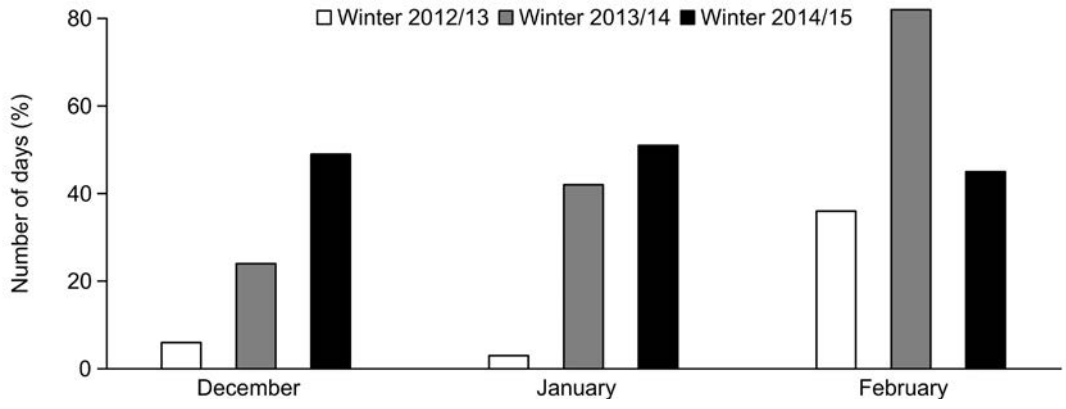

Fig. 1. Over-ground activity of European badgers near the sett during three winters (averaged values).

Previous results suggested the dependence of frequency of OAB in relationship to the air temperature in winter. To confirm these results, we focused to analyse obtained data by more detailed way. A situation at site D in December 2013 is provided as an example (Fig. 2). The number of OAB records decreased with decreasing air temperatures below zero and after subsequent warming increased again. In this case, OAB was not

registered during 19 days and only some foxes were recorded near the sett in this period. A similar pattern was recorded at several sites. In the case the OAB was really affected by low temperatures, it was necessary to determine whether this dependence is statistically significant. The set of data was created, where the number of records was assigned to the relevant air temperature below zero which had been measured. More than 70% (n = 1 964) of all obtained records were assigned. It was found that the relationship of OAB with the air temperatures below zero is highly significant ($r = 0.94$, $P < 0.001$; Fig. 3). It should be emphasized that a considerable proportion of OAB records in days with air temperatures below –5 °C were recorded mainly in the second half of February, or in days with sudden fluctuations of temperatures.

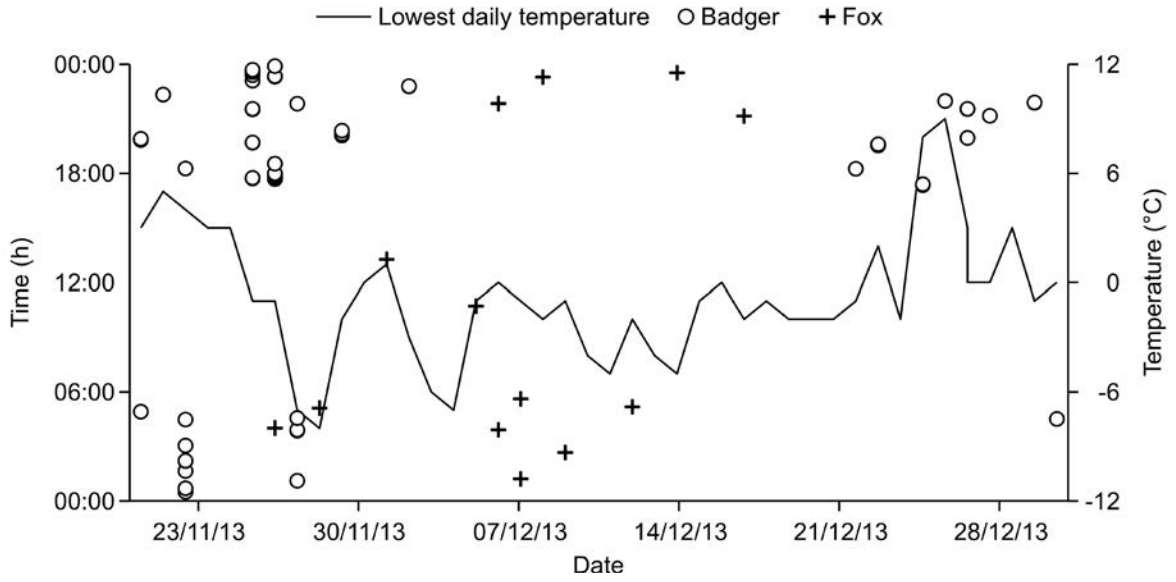

Fig. 2. Frequency of records of over-ground activity of European badgers and air temperature at site D in December 2013.

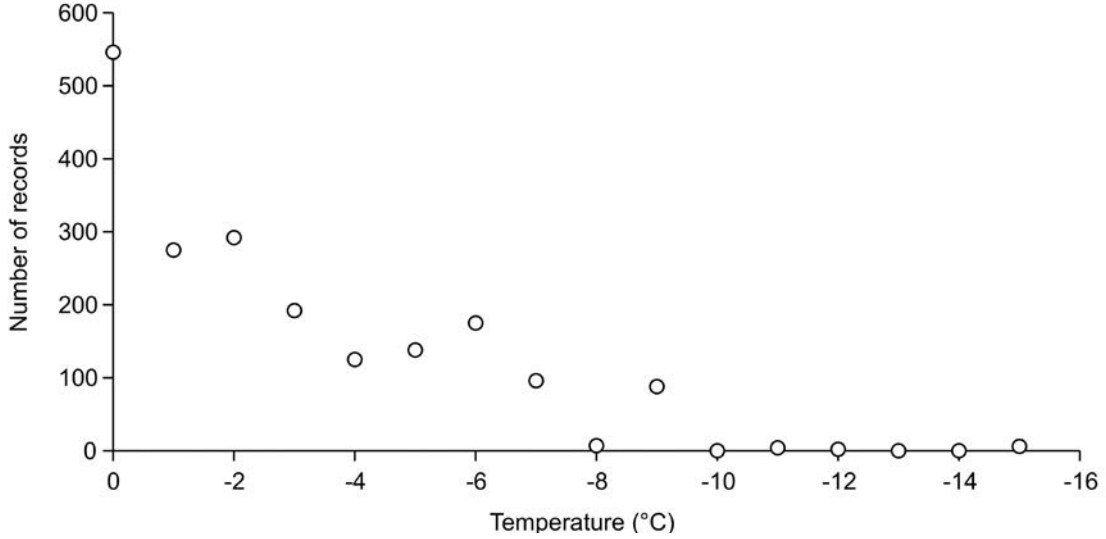

Fig. 3. Relationship of over-ground activity of European badgers number with the air temperature.

The badgers were mainly nocturnal. Peak of OAB near the sett was found between 18:00–20:00 hours (25.8%). However, the frequency of OAB between four following intervals (20:00–4:00 CET) was very high, too. Diurnal OAB was observed only in rare cases (Fig. 4). The number of individuals recorded on different locations ranged 1–3. Badgers avoided fresh and deep snow. In the case that more badgers wintered at the same sett, the night games and wrestling was running there. Mating of badgers was recorded at site B by two

consecutive nights on February 23, 2014 (1:50–2:06) and February 24, 2014 (2:04–3:28) near the entrance of the sett. Diurnal OAB was recorded at various locations and in different years, but equally between 20 and 22 February. On site F, there was recorded wintering of badgers in additional (or subsidiary) sett. Setts were often visited by foxes, but particularly at the time when badgers were inactive. From the other carnivores, Grey wolf *Canis lupus*, Eurasian lynx *Lynx lynx* (in the sett entrance), Wild cats *Felis silvestris*, and Polecats *Putorius* sp. were recorded near badger setts. However, inter-specific interactions were not recorded.

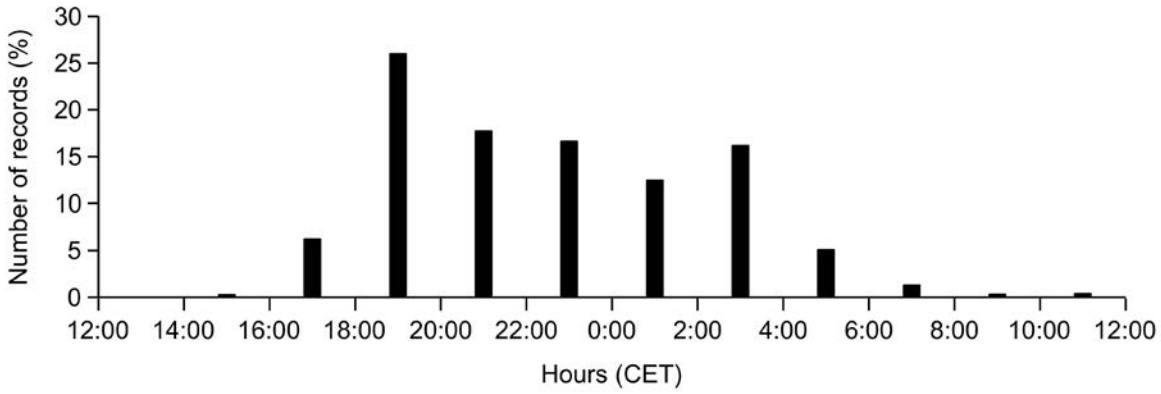

Fig. 4. Circadian pattern of over-ground activity of European badgers near the sett during winter days.

Behavioural pattern found during cold winter 2012/13 corresponds with data from Poland (Kowalczyk et al., 2003), Switzerland (Do Linh San et al., 2007) and from Bulgaria (Racheva et al., 2012). Badgers survived the cold winter in their setts and their over-ground activity was mainly in December and January very low. Their increase was observed since the first half of February, even when the cold weather continued. Setts emergences were registered even in snow and temperatures below –10 °C. But it was not unusual, similar findings are described by Clark (2010) and Pearce (2011). I assume, that winter resting of badgers in this period (February) ends and furthermore seems to be not significantly affected by climatic factors. Hell et al. (1988) stated that badgers in Slovak condition can mate from the spring to autumn, but most frequently it is in spring, soon after birth cubs. OAB increase could therefore be affected by mating time, which was found in late February. Summary of reproductive cycle of badgers in south England shows, that the mating time is possible to occur all year round, but most likely in February (Roper, 2010). Increase of badgers' activity in February (more than 40% of days) found Kowalczyk et al. (2003).

Behavioural pattern which was found during two following mild winters is more characteristic for the Mediterranean (Rodríguez et al., 1996), as for our region. In January 2015, OAB was recorded in over 50% of days on four different setts and even to 100% of days in February (2014, site C). Activity decrease was recorded only during coherent frosty weather in December and January. Macdonald et al. (2002, 2010) found that fecundity of badgers during any given year correlated with conditions in the preceding autumn, and badger survival also correlated with late winter weather conditions. By Byrne et al. (2015), there is prediction, that the climate change could increase the badger population. Size of badger social groups wintering at the single sites in the study area corresponds with result of Mysłajek et al. (2012) from southern Poland (mean 2.3 individuals). It is universally acknowledged that badgers are nocturnal, though they are certainly capable of diurnal activity if undisturbed (Roper, 2010). Indeed, most authors describe badgers diurnal activity in less disturbed mountainous areas, also in summer, and particularly by young individuals. Daily OAB in the winter months is rare. By Clark (2010), badgers daylight activity is generally associated in remote sites where there is less human disturbance or in hot summer, which may correspond with a very dry periods when badgers are hungry. Clark (2010) did not observe winter daylight emergence. Based on comparison of winter and summer circadian OAB (Slamka, 2015) we can assume that the badgers are mostly staying nearby setts in the winter. This is confirmed by the results of snow tracking and also published works from similar conditions (Kowalczyk et al., 2003; Goszczyński et al., 2005).

There was one important drawback related to our method of camera trapping of animals around the badger setts. All of setts included in the study comprised several entrances; therefore monitoring only limited number of them could lead to the omission of some individuals. Despite this, camera trapping can be useful tool for studying the utilisation of setts by badgers and other similar burrow-dwelling species.

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