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Camera Traps Recorded Use of Sett Sites by Badgers (*Meles meles* L., Mammalia) in Different Habitats

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Abstract: Two main badger setts were monitored in different habitats (lowland and mountain) by Moultrie camera traps (model I-40 with infrared flash) from September 2008 till August 2009 (totally 712 trapnights – 353 in lowlands and 359 in mountain).The camera traps were set to make 5 second video clips, accompanied with info photo about time, temperature and moon phase. From 3343 registered events ($n_{lowland}$ = 2774; $n_{mountain}$ = 569) 1891 were of badgers ($n_{lowland}$ = 1676; $n_{mountain}$ = 215). The data analysis shows that badgers spend more time near the sett during winter and spring than other seasons. The peak hours are right before and after full moon (gibbous moon) similar for both habitats. In the mountainous habitat there are two peaks of activity at sett emerge and return time – from 19:00 to 21:00 and from 3:00 to 5:00 h. Unique activity can be observed only in this habitat from 13:00 to 15:00 h due to less disturbed environment. Daytime emerge and sleeping near the sett are observed only in the remote mountainous area. In the lowland area the emerge peaks are at the same time from 19:00 to 21:00 but the return time peak is not definite. Higher activity can be observed in both habitats at the temperature interval between -2° and 12 °C.

Key words: badger, *Meles meles*, camera trap, activity, sett

Introduction

Most mammal species are difficult to observe due to their biological characteristics, strong anthropogenic pressure over time and/or destruction of their habitats. As a result they inhabit remote areas, shift their activity to dusk or night hours or are living underground. Studying animals with secret way of live is always a challenge to researchers. The data collected about their behaviour and activity is often indirect (mainly tracks and signs of animals presence), and can be freely interpreted by observers. The standard methods could be costly and very time consuming and often do not provide detailed information. Therefore, for studying of such animals remote recording devices like camera traps appear to be very suitable for the purpose. Overall, distance photography requires less time, money and is less invasive than most of the traditional research methods, while there are numerous applications (Cutler 1999).

In Bulgaria the use of objective recording devices for scientific purposes is a new idea and currently there are only few studies based on them (Zlatanova *et al*. 2009). Yet, these devices are frequently used in other countries for studying the population density of endangered and rare species (Karanth 1995, 1998, Trolle & Kery 2005, Heilbrun *et al*. 2006). They also help to reveal different aspects of the biology and behaviour of more widespread predatory species such as red fox (*Vulpes vulpes* L.), American black bear (*Ursus americanus* P.) and other (Moruzzi *et al*. 2002, Bridges *et al*. 2004, Hegglin *et al*. 2004).

Camera traps are becoming more and more popular in studies on Mustelid species (Griffiths 2008, Yoxon 2008). Being fossorial and nocturnal, the badger (*Meles meles* L.) is an ideal model species for studying its activity pattern in different

habitats using remote recording devices (Stewart *et al*. 1997, Dixon *et al*. 2006).

The aim of this study is to record the use of setts and the main activity patterns related to them. This study is the first of its kind in Bulgaria, dealing with analyses of animal activity via objective recording devices (camera traps).

Material and Methods

The study was conducted in two different model habitats of Southwest Bulgaria. The first study site is in a forest region on 1550 m a. s. l. (N42 12 45.4 E22 38 07.2) in Osogovo Mountain. The observed badger main sett consists of one main hole and one annex. It is situated in old beech (*Fagus sylvatica* L.) forest and was dig out under a rock (Fig. 1a). The climate is pronounced mountainous with 130 days of snow cover, mean annual temperatures in altitudinal gradient during winter are -1 to -6 °C and 21 to 11 °C during summer. The mean annual rainfall is 600 mm/m^2. The area is remote and the nearest permanently inhabited human structure is 1.9 km away (a mountain chalet). The nearest village is at 5 km distance.

The mountain site contrasts markedly to the second study site in lowlands where the landscape is prevailed by open agricultural areas. The studied main sett in the lowlands (N42 19 10.1 E22 40 16.8) consist of one main hole (Fig. 1b) and four annex. It is situated on a river bank, covered by dog rose (*Rosa canina* L.), hawthorn (*Crataegus monogyna* Jacq.), acacia tree (*Robinia pseudoacacia* L.) and blackthorn (*Prunus spinosa* L.). The mean annual temperatures in the area during winter are 0 °C and 20 to 22 °C during summer. The mean annual rainfall is 589 mm/m^2. The anthropogenic pressure is high because of a nearby village (distance 750 m) and busy road (330 m). The sett site is very often visited by stray dogs, goats, cows and people. Additionally, the badgers take advantage of the crops and orchards they are surrounded by.

The holes to be monitored were chosen by preliminary scanning with camera traps for short periods near each sett and by additional assessment of their usage by tracks registration.

Two camera traps Moultrie GameSpy with infrared flash light (model I-40) were used. The cameras are 4.0 MPx, capable of producing photos, 5 sec night clips and 30 sec day clips. The interval between shots is 1 min and the flash can light up to 15 m distance. The percentage of empty clips was low, mainly due to activation by wind, snow or rain. The close set up of the cameras allowed us to identify the individual animals (Dixon 2003). The last frame of the video clip is also a photo containing information about the date and time of video clip event, ambient temperature, moon phase and camera ID (location).

One camera trap was situated in each model habitat directly in front of the main holes of the observed badger setts.

The research period was from September 2008 till the end of August 2009. During that time 712 camera trap-days were carried out altogether – 353 in lowlands and 359 in the mountainous area. For all the data collected, the registration success of the cameras was assessed. Additionally, for every variable (date, time, temperature, moon phase and location) the number of badger registration was counted and number of individuals on a registration event was taken under consideration.

(a) b)

Fig. 1. Badger setts in mountain (a) and lowland (b) habitats.

Results

Registration success

There were totally 3343 registered events from which 1891 are badger clips (Table 1).

The registration success in both habitats was higher that 50%. In the mountain the registration failure was higher (46.40 %) due to the harsh weather conditions causing fake activation of the camera.

The camera trap-days in both habitats were the same but the total amount of registrations was much higher in the lowland area (82.98 %) than in the mountains (17.02 %). The percent of badger registrations were also higher in the lowland (60.42%). This difference is probably because in the lowland area the badgers are returning to this sett every night. The food resources there are close and concentrated and they spend more time near the sett. In the mountains the food is scattered and they have to travel long distance and stay away from this sett longer.

In the lowland area 90% of all registrations were of single badgers, 8.5% of two, 1.4% of three and 0.1% of four. In the mountain habitat 64.66% of all registrations are of only one badger, 27.07% of two, 6.77% of three and 1.5% of four. There are no registrations of more than four badgers in both habitats. In the mountain there are more group registrations because there is only one main entrance to the sett and the probability to detect all the badger family members at once is higher.

Seasonal variation

In both habitats, badgers spent most of the time (40-50%) near the sett during winter (Fig. 2). In the lowlands this activity drops rapidly during spring while in the mountains it is still high. In the summer when the food availability is greater, badgers in both habitats spent most time away from the sett.

In the mountains, most of the badger activity near the sett was recorded in February and March, while in the lowlands such a peak was registered in March-April. In March the recorded activity was the same for both habitats (Fig. 3).

Table 1. Comparison of registration success in mountain and lowland habitats.

	Mountain	Lowland	Total
Total registrations	569 (17.02 %)	2774 (82.98 %)	3343
Badger registrations	215 (37.79 %)	1676 (60.42 %)	1891
Unsuccessful registrations	264 (46.40 %)	819 (29.52 %)	1083
Other animals	90 (15.82 %)	279 (10.06 %)	369

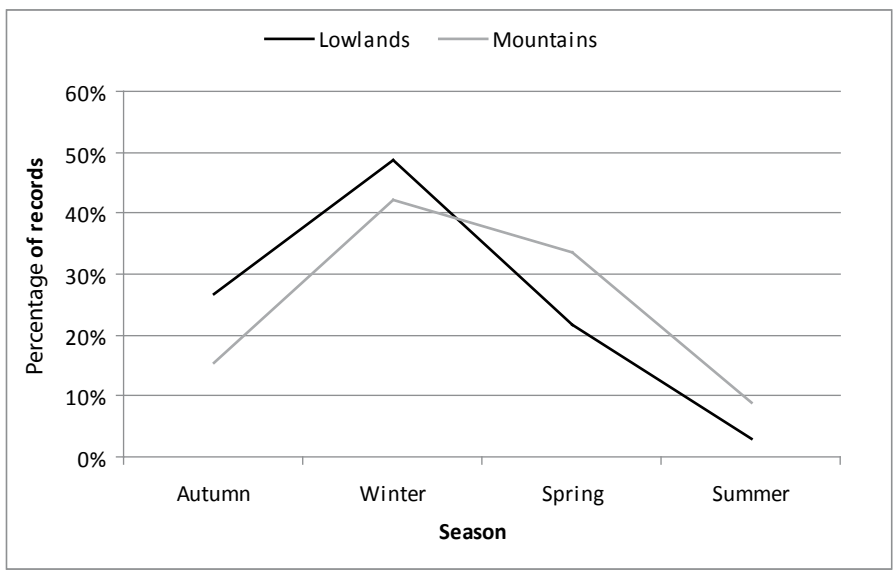

Fig. 2. Seasonal activity near the sett in mountain and lowland habitats.

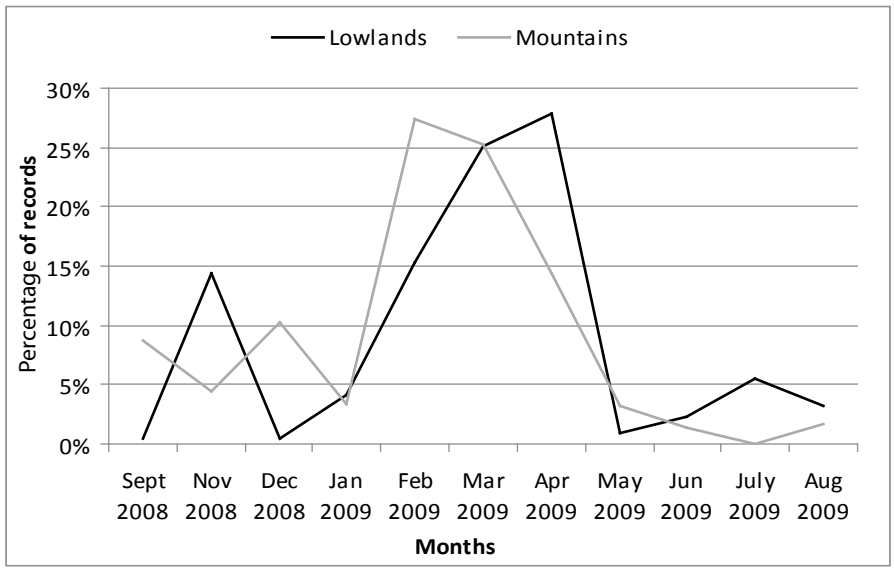

Fig. 3. Mounthly activity near the sett in mountain and lowland habitats.

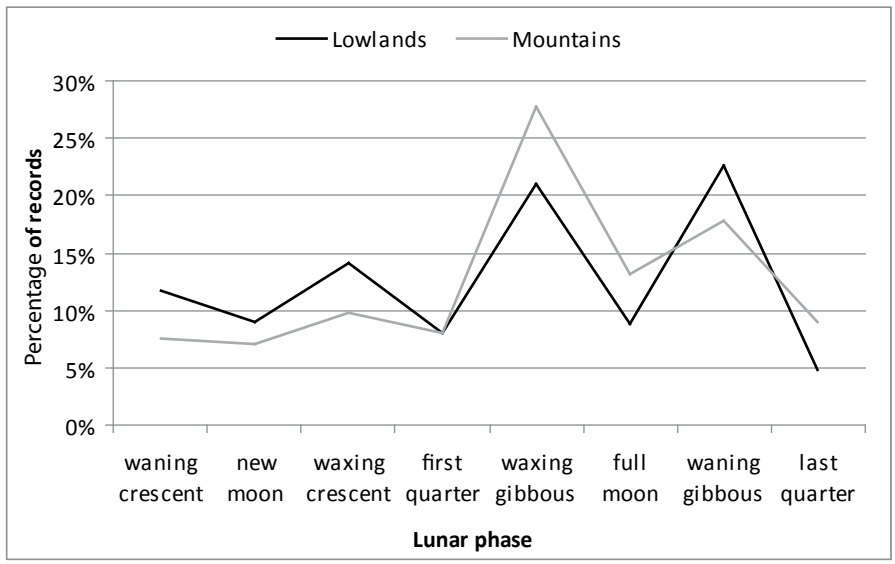

Fig. 4. Moon related activity near the sett in mountain and lowland habitats.

Moon related activity

The activity near the setts in both habitats related to the moon phase is almost identical. We recorded two distinctive peaks (Fig. 4) – right before and after full moon, i.e. waxing gibbous and waning gibbous moon. Weaker peaks are also registered before and after new moon.

Diurnal activity

In the mountains the earliest emerge from the sett was recorded at 17:34 h in February, while the latest return time is at 6:54 h, again in February. There are two distinctive peaks of activity at sett emerge (from 19:00 to 21:00 h) and return time (from 3:00 to 5:00 h) (Fig. 5). Unique daily activity was observed only in the mountains due to the less disturbed environment – a daytime emerge and sleeping near the sett.

In the lowlands the earliest first emerge was recorded at 18:19 in November, while the latest return was also in February (7:25 h). Activity peaks were recorded at the same time period as in the mountains (from 19:00 to 21:00), but the return time was not definite.

Temperature

Higher activity was observed in both habitats at the temperature interval between -2° and 12 °C (Fig. 6).

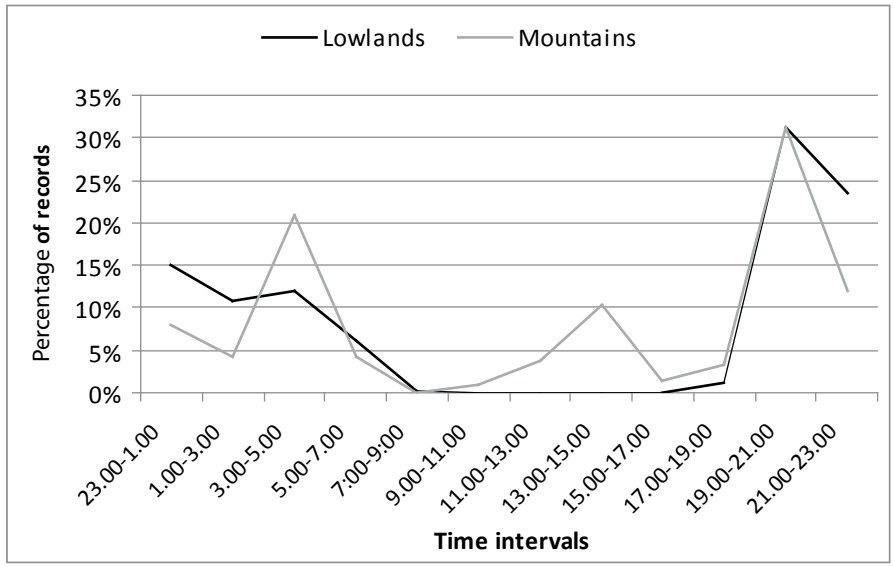

Fig. 5. Diurnal activity near the sett compared in mountain and lowland habitats.

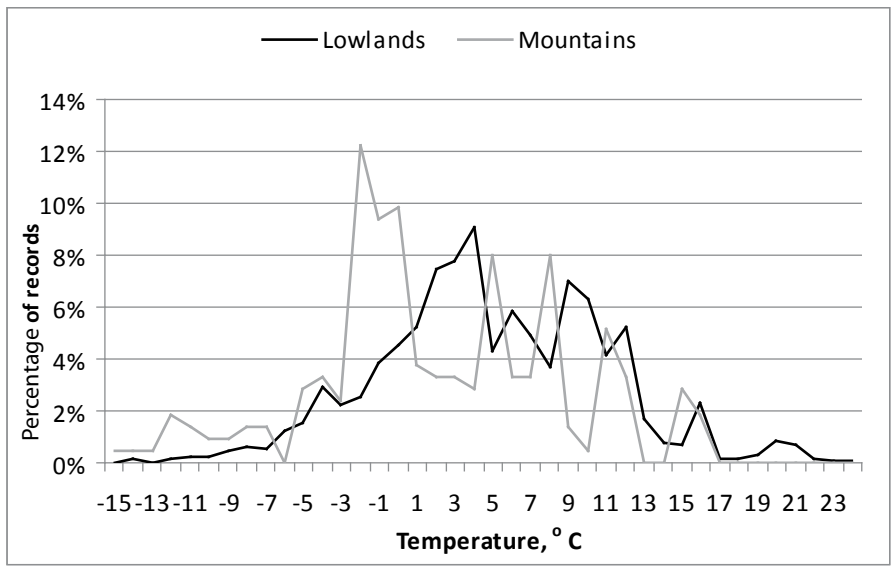

Fig. 6. Temperature related activity near the sett compared in mountain and lowland habitats.

In the mountain habitat the activity near the sett at negative temperatures is higher than in the lowlands and the activity is shifted to lower temperatures. The registrations are sparse in the lowland area and missing in the mountainous at temperatures above 17 °C.

Discussion

The camera trap data provides valuable information about the badger circadian and seasonal activity near the sett in the wild. Badgers got very quickly used to the cameras and showed more or less undisturbed behaviour, which allowed us to draw conclusions about the groups' dynamics. Additionally, during the recording process a lot of other species were registered providing an insight about the biodiversity of the research sites. At the mountain site for the first time we recorded some rare species of Bulgarian fauna – the marbled polecat (*Vormela peregusna* Gueldenst.) and even the thought to be extinct in the country lynx (*Lynx lynx* L.) (Zlatanova *et al.* 2009).

The observed seasonal variation in the activity pattern is related to feeding and breeding factors. The peak of activity recorded near the sett in the mountains is similar to the activity peak recorded in Great Britain in February, while in the lowland area the peak is shifted to April (Neal 1977). The lowest recorded activity near the sett in the study sites of

the lowlands (May, September and December) and mountains (July) coincides mainly with the food availability. Additionally, in the lowlands there is a clear peak of the activity in November, when we had also observed copulations.

During winter and the beginning of spring, due to the scarce availability of food badgers in both study sites spent more time near the sett engaged with grooming, bedding material collection and social interactions. The only available food then (mainly roots) could be found with the same success in proximity to the sett so we observed them spending some time digging for food near the sett entrance. In summer, badgers forage for food away from the sett and the registrations near the sett are rarity.

Our findings about the mean emerge from the sett time and return time concur with the data reported by Neal (1997) for Great Britain and Kowalczyk *et al*. (2003) for Poland. The peak of sett emerges and presence near the sett in both study sites is between 19:00-21:00 h. In the mountains the food availability is lower and the badgers need to spend most of the night away searching for food so they return at the sett only after 3:00. In the lowlands, where is a lot of food in a relative proximity to the sett, sometimes badgers can return earlier to the sett, resulting in indefinite peak of return time.

Dixon *et al.* (2007) proved that the moon is influencing the badger reproductive activity. Yet, the effect of the lunar cycles on the overall badger activity is not proved in anyway. Our results show that there is a relation between the higher activity near the sett and pre- and postfull moon periods in the study area. In general badgers tend to be more active and spend more time away from the sett on dark phase nights (around new moon) .Further study is needed to confirm or overrule this effect of the lunar cycles on the badger.

The weather conditions are also among factors affecting badgers activity (Cresswell & Harris 1988). There is a clear straight correlation between the rise of the temperature from -15 ^{o}C to 0 and the number of recorded badgers near the setts. Additionally, the further rise of temperature above 10 ^{o}C leads to less presence of badgers near the sett, correlated with the warmer seasons, availability of food and foraging away from the sett.

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