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Circadian activity and nest use of *Dryomys nitedula* as revealed by infrared motion sensor cameras

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Abstract. Summer and autumnal activity patterns of juvenile and adult *Dryomys nitedula* were investigated in the wild using infrared motion sensor cameras. The study revealed that the forest dormouse is mainly crepuscular and nocturnal during the summer and autumn. Foraging activity started on average 8 min before sunset in June and shifted towards 26 min after sunset in September. The activity usually ended 40 min before sunrise independently of the season. The investigative activity around the nestboxes had three main periods: one between 20:00 and 22:00, one around midnight between 00:00 and 01:00, and a third one before sunrise between 4:00 and 6:00. Diurnal activity was also recorded but it occurred mainly in autumn and was restricted to the nestbox entrance; animals never switched nestboxes during the day if not disturbed. During the night activity, dormice used to investigate almost all nestboxes within their territory. However they showed preferences for only a few nestboxes which were used more frequently as daytime resting sites.

Key words: Gliridae, forest dormouse, passive IR trail cameras, territory, nest use

Introduction

The activity pattern of any animal species is an important aspect of its ecology since it can provide an image of how the species is adapted to its environment. In the particular case of *Dryomys nitedula* Pallas 1778, the information gathered so far is still scarce and contradictory. Saint Girons & Lenkiewicz (1965) observed nocturnal and crepuscular activity, Nowakowski (1998) recorded high levels of both diurnal and nocturnal activity, and Popescu & Murariu (2000) suggested that daytime activity occurs during the mating season only. It is also worth mentioning that the only two papers published so far were based on indoor observations only (Saint Girons & Lenkiewicz 1965, Nowakowski 1998), while Popescu & Murariu (2000) have made only sporadic field observations.

Knowledge is also scant regarding the use of the nests within a certain territory. The only study on nest sites was done recently by Ściński & Borowski (2006) using radio telemetry, but the authors marked just three individuals and tracked them for 10 to 14 days. The same authors found that *D. nitedula* used up to seven different nests. Nothing is known yet about the frequency of the nest use and reuse, frequency of nest investigations by night, or nest predation and behavioural interactions between sympatric dormouse species.

Given the present state of knowledge, with scarce information regarding circadian activity and nest use, the present article aims to address this lack of knowledge on *D. nitedula* by using infrared (IR) motion sensor cameras.

Until now, the studies of different dormouse species under natural conditions required regular checking of the artificial nestboxes once or twice per month, occasional live trapping (Ściński & Borowski 2006, Madikiza et al. 2010), and radio telemetry (Bright & Morris 1991, 1992, Ściński & Borowski 2006, Bertolino & Di Montezemolo 2007). But by doing so the effective field observations are either restricted in time, as in the case of nestbox and live trapping, or very expensive and time consuming, as in the case of radio tracking. The approach applied in the present study, although not new in the field of wildlife surveillance, is implemented here for the first time in dormouse research and provides new and exciting data on activity, frequency of nighttime nest investigations and frequency of nest use and reuse.

Study Area

The investigations took place on the steep and rocky slopes of Domogled Mountain in south-western Romania (N 44 51.896 E 22 25.757) in an area covering 60 ha. The actual study site has a pronounced sub-Mediterranean climate, which of course has an impact on the main plant associations found there. Sixty-five percent of the site is covered by *Syringo-Fraxinetum orni* Borza, 1958 em. Resmerita, 1972 with the following tree species: *Syringa vulgaris*, *Fraxinus ornus*, *Cotinus coggygria*, *Quercus cerris*, and sporadically *Corylus colurna*, *Tilia tomentosa*, and *Juglans regia* while the rest of the site is covered by *Corylo colurnae-Fagetum* (Jov., 1955) Bohr., 1963, with the main tree species being *Fagus sylvatica*, *Corylus colurna*, *Tilia tomentosa*, *Quercus petraea*, *Cornus mas*, *Prunus avium*, and *Acer pseudoplatanus*.

Material and Methods

In 2009, 178 wooden boxes were installed on Domogled Mountain and the number was increased to 250 in the following spring. These were spaced on average 50 m apart from each other (x̄ = 49.13 m; range = 19-70 m). The boxes had internal dimensions of 12 × 12 × 24 cm with a circular entrance hole 4 cm in diameter. They were placed on trees at heights that varied between 1.2 and 3.4 m (x̄ = 1.65 m SD = 0.93) with the entrance hole facing the tree trunk. The nestboxes of the study site were checked once a month in May and October and twice per month from June to September (the total number of days on which nestboxes were checked varied between five and ten days/month, and was usually 6.5 days/month). All dormice found in them were marked by ear tattoo or metal rings made of aluminum sheet (0.4 mm thick × 4 mm wide × 12 mm long) attached to the hind leg (Juškaitis 2008).

During the periods 13-29 June, 5-11 July, and 6 August-3 September, special attention was paid to the territory of one adult female with a litter of five pups (four males and one female), which was surveyed with five IR Bushnell TrophyCam model 119445 cameras. Two cameras were stationary during the study period, surveying the same nestboxes, while the other three were used irregularly and were moved between six nestboxes. The cameras were set to take films of up to one minute. The sensor was set to the highest level and the time of response to another external stimulation was set to just one second. The cameras were placed 20-38 cm from the nestboxes. Given the small distance between the cameras and boxes, large parts of the illumination source were covered to reduce the amount of IR light falling on the nearby subjects.

The exact times of sunrises and sunsets at the study site were obtained with the help of the NOAA solar calculator (http://www.esrl.noaa.gov/gmd/grad/solcalc/). The local temperature at the site was registered with a Thermochron iButton DS1921G placed under the lid of a nestbox, 1.6 m above ground level.

In order to determine whether the observed differences in activity differed statistically between summer and autumn, the t-test and chi-square test were used. The program STATISTICA 7 was used to analyse the basic statistics, perform tests, and produce graphs in this study.

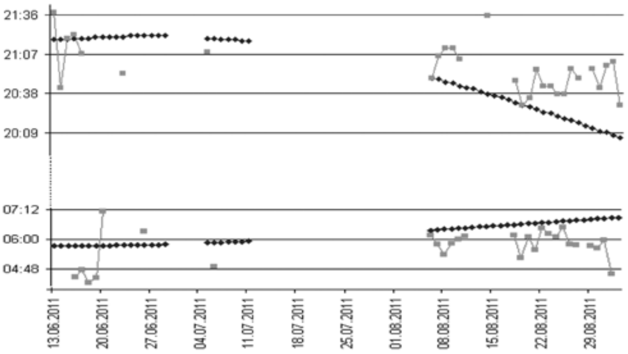

***Fig. 1.** Circadian activity of* Dryomys nitedula *in relation to the sunrise and sunset.*

Results

At the study site *D. nitedula* and *Muscardinus avellanarius* were co-dominant species during both 2009 and 2010, while *Glis glis* had a low density. The camera surveillance was carried out for a period of 132 days and 944 video clips were recorded.

The activity of *D. nitedula* during the study period was mainly crepuscular and nocturnal. Foraging started on average around sunset (x̄ = 8 ± 18.65 min before sunset in June and x̄ = 26 ± 15.86 min after sunset in late August and September) and ended just before sunrise (x̄ = 43 ± 65.84 min before sunrise in June and x̄ = 41 ± 21.97 min before sunrise in late August and September). During the survey period, although the length of the night increased by 2 h 25 min, the activity of *D. nitedula* increased by only 1 h 4 min, from 8 h 2 min in June-July to just 9 h 6 min in August and the beginning of September (Fig. 1).

The differences between June-July and August-September were statistically significant for the start of

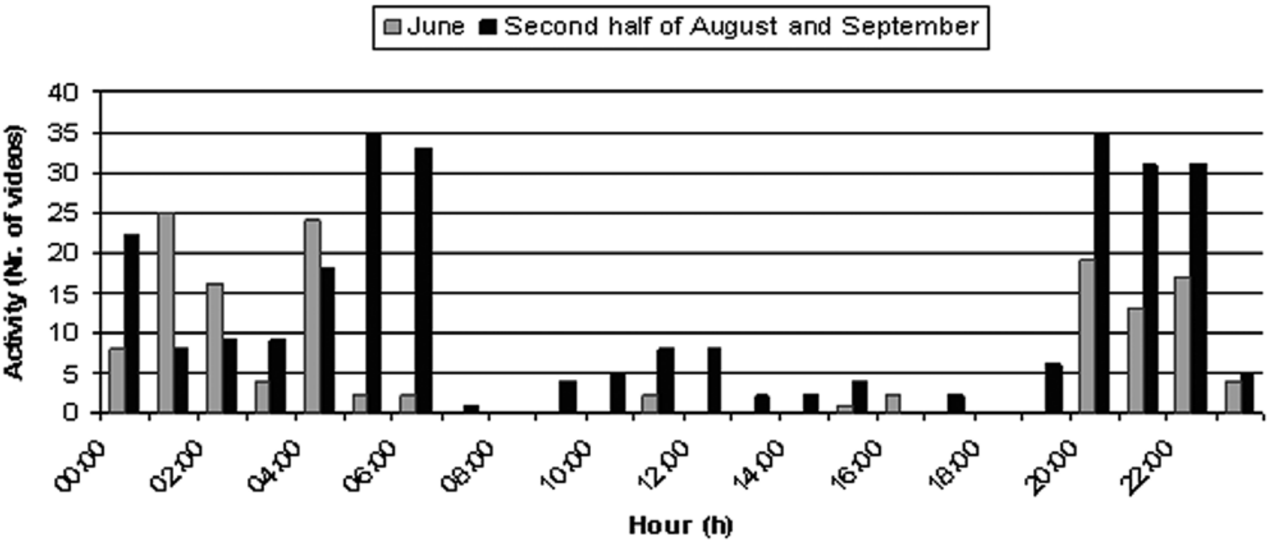

***Fig. 2.** Intensity of dormouse activity measured as the number of videos recorded per hour.*

activity (t = 3.9456, d.f. = 20, p = 0.0008) but not for the activity end (t = 1.948, d.f. = 19, p = 0.05).

From the beginning of the activity to its end the animals were always on the move and nocturnal rest was not registered within the nestboxes. However the animals frequently investigated nestboxes during the night.

The intensity of the dormouse activity around nestboxes, measured as the number of registered videos/hour, had three main periods: one related to the beginning of activity was registered around and after sunset (20:00-22:00), the second at midnight between 00:00 and 01:00, and a third before sunrise when the animals ceased their activity: around 04:00 in June, shifting towards 06:00 in late August (Fig. 2).

Daytime activity was recorded mainly in autumn and was always restricted to the entrance of the wooden box; animals never left their nestboxes in search of another one during the daytime. Daytime activity was significantly higher during autumn than in June and July ($c^2 = 21754$, d.f. = 10, $p = 0.016$) and its maximum intensity occurred at midday (12:00 to 13:00) (Fig. 2).

Between 13 June and 3 September the animals used seven out of eight surveyed nestboxes scattered over an area of 2.2 ha. The number of nestboxes used by the observed *D. nitedula* family increased from just one in June to three in July and seven in August and September. The box that was not occupied but only investigated was in fact used frequently by one male *G. glis*. During the 132 surveyed nights, the seven nestboxes were used as daytime resting sites on 45 occasions ($\bar{x} = 0.3409$, SD = 0.4758). However, the nestboxes were visited by night much more frequently, namely during 103 nights out of 132 surveyed ($\bar{x} = 0.7803$, SD = 0.4156).

During the 132 days of surveillance, the cameras did not record any predatory attacks. However on five occasions, representing 3.78 % of the surveyed period, the nestboxes were visited by possible terrestrial predators and competitors. One investigation was carried out by a wild cat *Felis silvestris* (0.75 %) and four by the sympatric fat dormouse *G. glis* (3.03 %) (Fig. 3A, C).

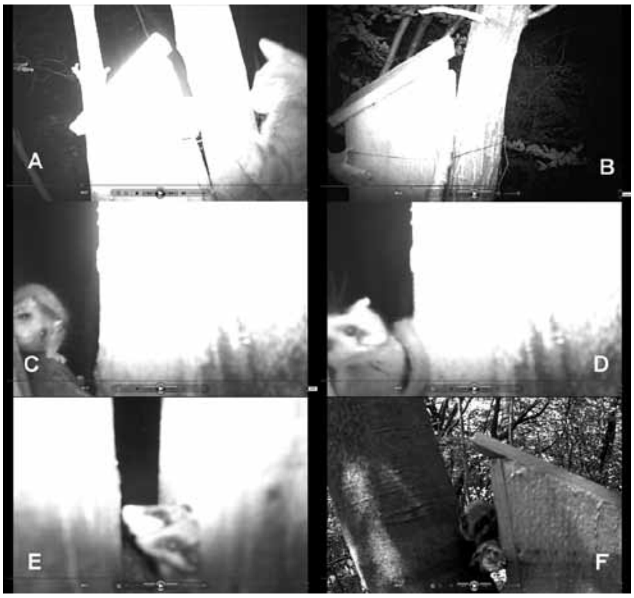

***Fig. 3.** A – *Felis silvestris *investigating one* Dryomys nitedula *nest; B – Investigation of the nest by* Muscardinus avellanarius*; C – An* Glis glis *attack; D – Night investigation of the nest by* Dryomys nitedula*; E – The use of the nest by two members of the same family of* D. nitedula*; F – Daytime activity recorded only around the nest.*

Discussion

Dormouse species in general are mainly nocturnal animals (Popescu & Murariu 2000, Juškaitis 2008) but daytime activity was also recorded in common and forest dormice. The daytime activity of *M. avellanarius* is related with temperature (Bright & Morris 1996), and lactation (Kahmann & Frisch 1950), while that of *D. nitedula* is supposed to be associated with mating season (Popescu & Murariu 2000).

The summer and autumn surveys performed under natural conditions in the present research showed that the forest dormouse is mainly nocturnal. So the results obtained in the field fit the frame of activity observed by Saint Girons & Lenkiewicz (1965) but do not agree completely with the observations of Nowakowski (1998), who reported high levels of daytime activity and lack of any relationship between the light intensity and dormouse activity. The cameras revealed that dormouse activity is strongly related with sunset and sunrise. Although daytime activity was recorded especially at noon (12:00-13:00) towards the autumn, the animals never left their nestboxes in search of other ones during the day but merely quickly investigated the box entrance (Fig. 3F) for less than 2 min.

The period of activity increased steadily in length towards the autumn as the nights became longer and the differences compared to the June activity are significant from a statistical point of view. However it is still difficult to say whether the increased activity is caused by the need to accumulate more fat for hibernation, difficulties in finding proper food, or the increased length of the night. The same increased activity during the autumn was observed in other dormouse species like *G. glis* (Rodolfi 1994) and also in the smaller relative *M. avellanarius*, especially in the less fit (lighter) individuals (Juškaitis 2008).

The intense investigations of the nests especially during the midnight were always short and resumed just to sniffing and/or marking activity. So this behavior may be important for the animals to reassure the safety of their nestboxes and probably to provide informations about other dormice from the same or other species that passed throw.

Multiple nest use has been recorded so far in all European dormouse species (Bertolino & Di Montezemolo 2007), and although some explanations for this have been put forward, what drives dormice to use multiple nests remains unclear. Some authors suggest that by doing so they reduce the accumulation of ectoparasites (Bertolino & Di Montezemolo 2007), reduce the risk of predation, or protect themselves better from extreme weather conditions (Nowakowski 2001, Juškaitis 2008).

The present study showed that a family of *D. nitedula* used at least seven nestboxes as resting sites; one or more members of the family used all boxes irregularly. The use of multiple nests was already reported for the species by Ściński & Borowski (2006) and for other dormouse species by Juškaitis (2008) and Bertolino & Di Montezemolo (2007).

Also, the irregular use of the nestboxes might have implications for the methodology of nestbox checking, especially when nestboxes are dispersed in a coarse grid of 4 units/ha. In such cases more frequent investigations of the nestboxes are necessary in order to find all dormice from a given territory.

Cameras also revealed that data on dormouse activity cannot be obtained by nestbox checking in the way that Nowakowski (1998) rechecked his indoor data, since disturbances created by handling, weighing, or marking alter the behaviour of forest dormice.

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