Diurnal activity of juvenile Russian flying squirrels recorded by camera trapping

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Abstract: We describe the diurnal behaviour in juvenile Russian flying squirrels (*Pteromys volans*) revealed by camera trapping. Photographs showed that juvenile Russian flying squirrels of up to approximately 30 days old are only active in daytime and often peeped out of the breeding cavity. In addition, juveniles of approximately 40 to 45 days old showed a cathemeral activity pattern: they investigated the immediate surroundings of their breeding cavity in both daytime and night-time. In contrast, older juveniles showed only nocturnal activities. These observations show for the first time that juveniles of wild Russian flying squirrels are active in the daytime when growing up, while gradually shifting to an exclusively nocturnal activity pattern when getting older. Meanwhile we emphasise that our observations concern only one litter.

Keywords: activity pattern, juvenile, rodent, Russian flying squirrel.

Introduction

As Jackson (2012) states, all species of flying squirrels are believed to be nocturnal. However, such information is usually based on adult-biased observations (e.g. Decousey 1961, Baba et al. 1982). In contrast, little is known about the behaviour and activity of juvenile gliding mammals, because finding their breeding-nest is difficult.

Among flying squirrel species, the behavioural and activity patterns of the Russian flying squirrels (*Pteromys volans*) are well known. Adult Russian flying squirrels are mainly active between sunset and sunrise (Airapetyants & Fokin 2003), and leave their nests approximately half an hour after sunset (Yamaguchi & Yanagawa 1999). At night-time, they glide between trees (Suzuki et al. 2012) and forage in canopy areas (Asari et al. 2008), mainly feeding on leaves, buds, and catkins of a variety of tree species (Hanski et al. 2000a). During the daytime, they usually rest in tree cavities (Hanski et al. 2000b, Suzuki et al. 2013).

When Russian flying squirrels were kept in captivity pre-weaned juveniles peeped out of the entrance of their nests at the age of approximately 30 days onwards and investigated the area around the nest cavity when they were 40–45 days old (Airapetyants & Fokin 2003). However, more detailed studies of the behaviour and activity patterns of free-ranging juveniles are still lacking. To get more insight in these aspects we first of all need simple observations of juveniles in their natural habitat. For this purpose we located a breeding nest of Russian flying squirrels and succeeded in

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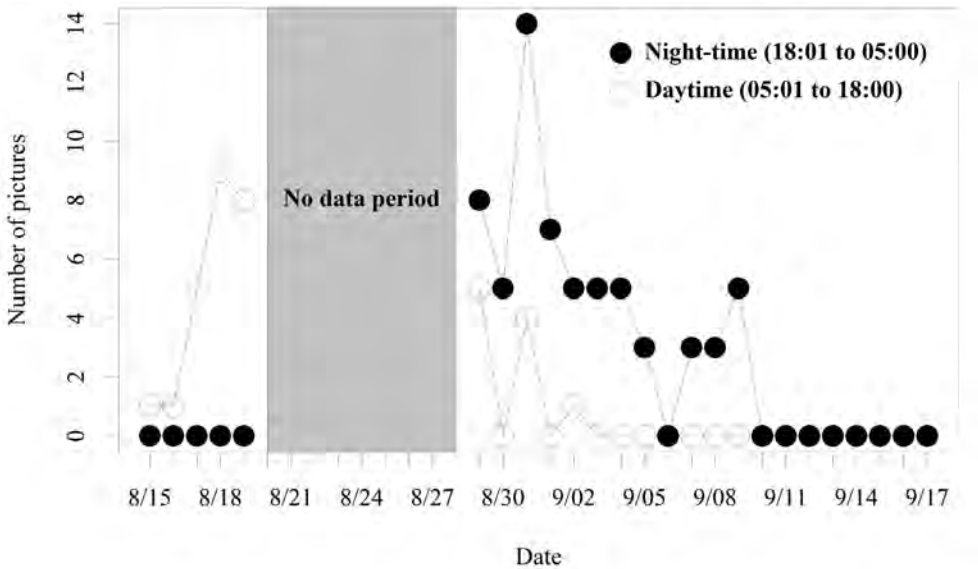

Figure 1. Number of juvenile Siberian flying squirrel pictures per calendar day in the daytime and the night-time during the study period.

photographing juvenile behaviours using a camera trap directed at the nest entrance. Here, we describe the juvenile behaviour and their activity patterns, and we evaluate these aspects concerning their ecological impact.

Methods

The Russian flying squirrel inhabits a large area, ranging from the Baltic Sea in the west (i.e. in Europe only in Finland), via Siberia, Mongolia, northern China and Korea to Hokkaido Island (Japan) in the east (Oshida 2009).

One cavity with a litter of the Russian flying squirrel was found in the trunk of a Japanese larch (*Larix kaempferi*) with the use of a CCD [charge-coupled device] camera (SNAKE-09, Kenko, Tokyo, Japan) on 15 August 2013. The larch stands in a windbreak forest (42°51′33″ N, 143°09′32″ E) in Obihiro City on Hokkaido Island, northern Japan. The entrance height of the cavity was approximately 2.6 m above the ground. At that time, the juveniles in the nest already had body hair.

For photographing the juveniles we used an automatic camera equipped with an infra-red motion sensor (SG565F, HCO Georgia, USA). The delay between pictures was set to five minutes. The time lag between animal detection by the sensor and the actual image was approximately 1.2 seconds. We placed the camera 1.5 m away from the nest, directed at the cavity at 2.6 meter height. Pictures were taken from 15 August to 17 September 2013 and the set-up continued to work all day through almost the whole study period. We changed the memory cards of the camera at noon on 20 August and 28 August. However, due to a memory card failure, there was a data gap from 20 August afternoon to noon August 28.

We counted the number of pictures taken during each hour as an indicator for the level of activity of the juvenile flying squirrels. The period from 5:01 to 18:00 was defined as daytime based on sunrise (approximately 5:00) and sunset (18:00) (Japan Coast Guard 2015).

Results

The camera trap photographed both juvenile

Figure 2. Pictures of juvenile Siberian flying squirrels during daytime (A and B) and night-time (C). Large adult flying squirrels were clearly visible during the night-time hours (D).

and adult flying squirrels. The adult flying squirrel(s) were clearly larger than the juveniles, but whether the photographed specimens represented only a single individual, i.e. the mother of the juveniles, could not be established. The juveniles were photographed only in the daytime from August 15 to 19 and during both day and night from 29 August to 2 September 2 (figure 1). Thereafter, the juveniles were photographed at night-time only, from 3 to 9 September (figure 1).

During the exclusive daytime activity period (15 to 19 August), the juvenile flying squirrels often peeped out of the cavity (figure 2A). The juveniles showing such behaviour were estimated to be approximately 30 days old based on similar behaviour of captive juveniles (Airapetyants & Fokin 2003). According to the number of pictures per hour, wild juvenile squirrels showed bimodal activity peaks around 9:00 and 17:00 (figure 3A).

From 29 August to 2 September, a maximum of three juveniles was simultaneously detected on the branches and the tree trunk within one metre from the cavity (figure 2B). We estimate from similar behaviour in captive juveniles (Airapetyants & Fokin 2003), that these wild juveniles investigating the immediate surroundings around the cavity were approximately 40 to 45 days old. In this period, juveniles showed a cathemeral activity pattern* (figures 3B and 2C), with a higher

* The activity of an organism may be regarded as cathemeral when it is distributed approximately evenly throughout the 24 h of the daily cycle, or when significant amounts of activity, particularly feeding and/or traveling, occur within both the light and dark portions of that cycle.

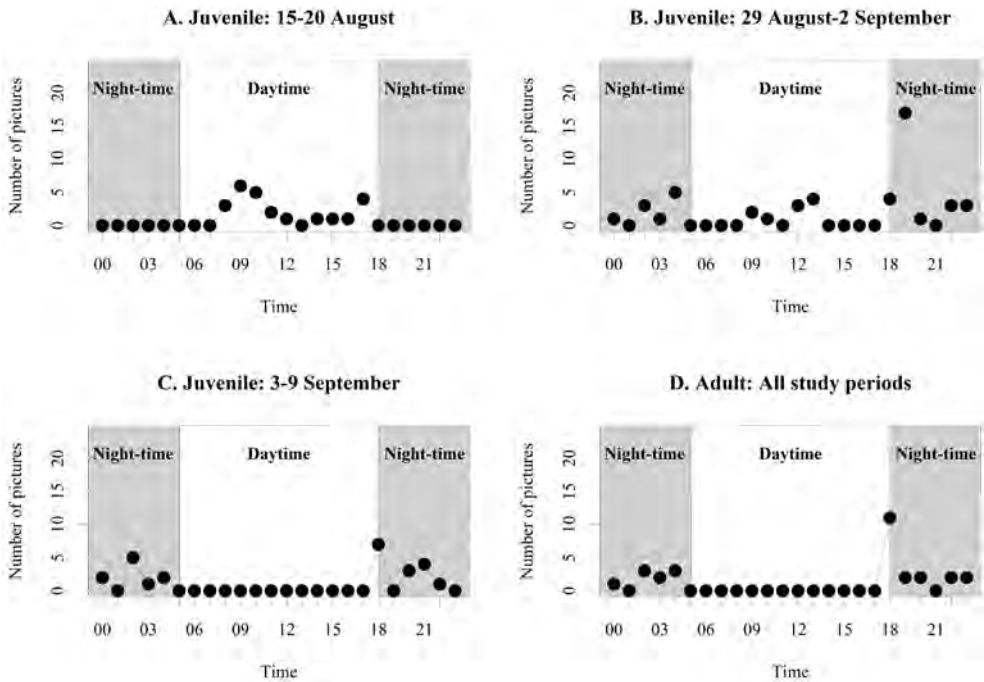

Figure 3. Number of pictures of juvenile (A to C) and adult (D) flying squirrels per hour as an indicator for activity.

night-time activity (10 photographs during the day and 39 times during the night). In the same period, juveniles showed trimodal activity peaks around 3:00, 12:00, and 19:00 (figure 3B).

From 3 to 9 September, juveniles were photographed 24 times, but only during night-time. They displayed then bimodal activity peaks around 2:00 respectively from 18:00 to 21:00 (figure 3C). This pattern is rather similar to the one of adult Russian flying squirrels photographed on the same tree trunk (figure 2D). The investigated adult flying squirrels had nocturnal bimodal activity peaks, from 2:00 to 4:00 and at approximately 18:00, throughout the entire study period (figure 3D).

Discussion and conclusions

Previously, there was only fragmented information on Russian flying squirrels' diurnal activities, such as chases in mating season (Hanski et al. 2000a) and outdoor activities of a nursing female and its young (Tormala et al. 1980). In addition, Airapetyants & Fokin (2003) mention that the flying squirrels leave their nest cavity in March and that they are equally active in day- and night-time during the short-night period, i.e. when the dark period duration is less than six hours. In contrast, this study demonstrates that juveniles can show some activity in the daytime and appear to stop doing this when getting older (figure 1). Meanwhile we emphasise that our observations concern only one litter, so the presence of this behaviour in general including its significance has still to be established.

All species of flying squirrels have been considered as nocturnal (Jackson 2012) and one of the explanations for this behaviour is a reduction of predation risks by diurnal predators (Lindenmayer 2002). Raptors, especially the Ural owl (*Strix uralensis*), eagle owl (*Bubo bubo*), and goshawk (*Accipiter gentilis*,), the main predators of Russian flying squir-

Russian flying squirrel (*Pteromys volans*). *Photo: Kei K. Suzuki.*

rels (Selonen et al. 2010), usually attack gliding mammals in the air (Lindenmayer 2002). Because juvenile Russian flying squirrels show gliding behaviour after being approximately 50 days old (Airapetyants & Fokin 2003), juveniles with an age of 30–45 days may still be unable to glide. In addition, juveniles of that age (30–45 days old) usually limit their activities in and/or around the breeding cavity (Airapetyants & Fokin 2003). Thus, they can quickly hide in the cavity when they face predators and are hence less prone to predation. In conclusion, because non-gliding juveniles seem relatively safe staying around the nest cavity compared with adults gliding between trees, juveniles do not need to limit their activity to night-time to avoid diurnal predators. Juvenile flying squirrels with an estimated age of 30 to 45 days and diurnal activities are still breast feeded (Airapetyants & Fokin 2003). It is possible that the juveniles' diurnal activities are limited to the time when they can access their mother's milk when she is resting in the cavity during the day.

Previously, diurnal and cathemeral activity patterns of flying squirrel species remained unnoticed because, so far, their activity patterns were usually investigated by direct observations in the night (Baba et al. 1982, Yamaguchi & Yanagawa 1999). In contrast, by using 24-hour camera surveillance, we were able to show that juvenile Russian flying squirrels have diurnal activity. Because our sample size was rather limited, we hope that future investigations will further improve our knowledge of the circadian activity pattern in juvenile Russian flying squirrels. Their nesting cavities can be easily detected by collecting their feces at the foot of the cavity trees (Suzuki et al. 2011). In addition, the possibility of pregnancy can be predicted by measuring fecal progesterone (Shimamoto et al. 2015). Thus, breeding cavities of flying squirrels may be found by the combination of these two methods. Further investigations with camera traps will yield more data and will enable us to get more insight in the activity patterns of the Russian flying squirrel.

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Samenvatting

Jonge vliegende eekhoorns zijn overdag actief

Aan de hand van beelden verzameld met een cameraval beschrijven wij het activiteitsritme van (wilde) jonge vliegende eekhoorns binnen en buiten de nestholte. De beelden laten zien dat halfwas jongen tot ongeveer 30 dagen oud alleen overdag naar buiten kwamen. Jongen van ca. 40-45 dagen oud bleken zowel overdag als 's nachts actief, terwijl oudere jongen tenslotte alleen nachtelijke activiteit vertoonden. Hiermee is voor het eerst aangetoond dat juveniele vliegende eekhoorns op jonge leeftijd overdag actief zijn. We benadrukken dat deze waarnemingen gebaseerd zijn op de gegevens verzameld bij slechts één nest.

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